Marvelmind Indoor Navigation System
Operating manual

v2024_11_19

www.marvelmind.com

Contents

Version changes

V2024_11_18

- Minor fixes and improvements

V2024_11_12

- Chapter 11.1 is updated. 200 Kbps profile, Super-Beacon-4, and Beacon Mini-TX-2 are added
- Minor fixes and improvements

V2024_11_11

- Chapters 11.14…11.22 are moved to 11.19 “Licenses”

V2024_11_05

- Chapters 11.14…11.22 are added

V2024_10_31

- Chapters 11.2.3. and 11.12. are added

V2024_10_30

- Chapter 12. was added
- Chapter “Autonomous DJI Drones Indoors” was moved to 12.1.

V2024_10_27

- Chapters 9.27., 9.27.1., and 9.27.2. are added

V2024_10_16

- Minor fixes and improvements

V2024_10_14

- Chapter 4.2.1 is added

V2024_10_05

- Chapter 3.1 is updated. Minimum system requirements for the Dashboard added

V2024_10_04

- Minor fixes and improvements

V2024_09_30

- Minor fixes and improvements

V2024_09_27

- Minor fixes and improvements

V2024_03_31

- Overall polishing and updates

V2023_06_26

- Chapter 2.2.4 is added. Description of a new Multi-modem architecture added
- Minor improvements

V2023_06_22

- Chapters 5.1.4, 9.27, 9.28 are updated
- Chapter Using hedgehog.log file is deleted
- Minor improvements

V2023_06_21

- Error fixes

- Minor improvements

V2023_03_28

- Sections 6.3, 6.4, 6.5, and 6.6 are updated. Turning on “Hedgehog mode” on the beacon step added.

V2023_01_16

- Section 2.3 updated. New links added
- Chapter 9.10 Floorplan feature updated
- Minor improvements

V2022_12_25

- Chapter 2.2 Indoor Navigation System Architectures updated

V2022_08_24

- Chapter 5.2.3 SW update via DFU updated
- Chapter 9.17 Paired beacons updated

V2022_08_24

- Chapter 6 updated
- Chapter 8 updated
- Section 11.3 updated
- Minor improvements

V2022_08_17

- Minor fixes and improvements

V2022_08_12

- Chapter 4 updated

V2022_08_10

- Section 9.11 Filters added
- Section 11.16 Sending path to robot updated
- Minor fixes and improvements

V2022_08_05

- Section 7.2 updated
- Section 9.12 added
- Section 9.2 Islands feature added
- Section 9.10 All hedgehogs update every cycle added
- Section 9.14.2 updated
- Chapter 10 updated
- Section 11.2.2 Static IP added

V2022_06_16

- Section 9.4 Restart if modem disconnected added
- Section 9.5 Geofencing alarm added
- Section 9.6 PPS (Pulse per second) signal added
- Section 11.1 Radio Profiles compatibility updated
- The SW settings chapter moved to Chapter 5
- Chapter 5.1.2 added

- Minor fixes and improvements

V2022_06_01

- Section 10.2 Wi-Fi settings for Super-Modem added

V2022_05_20

- Section 2.4 The Maps – moved to chapter 7
- Section 3.6.3.1 How to flash Beacon mini-RX added
- Section 8.22 updated
- Chapter 12 updated
- Section 4.4 updated
- Section 8.6 updated
- Section 10.1 Radio Profiles compatibility added

V2022_05_13

- Section 5.2 DIP switch position added
- Information about Industrial Beacons 3 added

V2022_05_06

- Section 7.11 updated
- Section 2.3 updated
- Section 9.1 updated

V2022_04_26

- Section 4 - Software pack added

V2022_04_07

- Section 4 screenshots updated
- Section 6.7.3 added
- Section 6.7.4 added
- Section 6.12 updated
- Section 6.13 updated
- Section 6.9.1 updated
- Section 5.9.2 updated

V2022_04_05

- 3.1 section updated
- 3.2 section updated
- 3.4 section updated
- 3.5.3 section updated
- Information about Starter Set NIA-01-3D removed
- Section 4.3 pictures of a top view and side view changed to relevant
- Section 4 examples of 2D configuration added
- Information about Starter Set NIA-02-2D removed
- Information about Starter Set IA-01-2D removed
- Information about Starter Set IA-02-3D removed
- 5.1 section screenshot updated
- 5.4 section all screenshots updated

- 5.7 section screenshots updated
- 6.7.1 section updated
- 6.7.2 section screenshots updated
- Information about new frequencies added
- Section 11 updated
- Sections 3.6.4; 3.6.5; 3.6.6; 3.6.7 pinout picture from April 2022 added

V2022_02_23

- Screenshot and clarifications to section 7.2.2 added
- Unrelated information from section 9.11 removed
- Hyperlinks fixed
- Starter set product information updated
- 1.1 distance between beacons updated
- 3.2 section updated
- 3.4 section updated
- 9.11 section updated
- 11.1 section updated
- Minor fixes and improvements

V2021_08_12

- Omni-microphone soldering scheme added
- Omni-microphone setting description added

V2021_07_04

- Added Microphone settings chapter

V2021_06_20

- Added connection pictures for the Paired Beacons chapter
- Links fixed for interface manual

V2021_06_10

- “Paired microphones” chapter added.
- Turning on the microphone setting description added

V2021_06_04

- Super-Beacon 2 pinout picture updated

V2021_06_03

- Pairing beacon chapter and beacon pinout pictures updated

V2021_04_25

- Paired beacons chapter updated

V2021_02_09

- Minor fixes and improvements

V2021_01_28

- Architectures’ elements chapter described
- Architectures chapter improved
- Minor fixes and improvements

V2020_12_21

- FCC notice for Super-Beacon description added
- Minor fixes and improvements

V2020_12_14

- FCC notice for Modem HW v5.1 description added
- Minor fixes and improvements

V2020_12_04

- Starting up chapters improved
- Minor fixes and improvements

V2020_12_01

- Starting up chapters improved
- Submap’s settings chapter improved
- SW update chapter improved with DFU Programming descriptions
- Minor fixes and improvements

V2020_11_24

- Licenses chapter updated
- Different beacons’ colors chapter improved
- Minor fixes and improvements

V2020_11_11

- Player chapter improved
- Diagnostics messages chapter described
- SW update chapter added
- Paired beacons chapter improved
- Minor fixes and improvements

V2020_08_07

- Modem HW v5.1 described
- Minor fixes and improvements

V2020_07_23

- System elements chapter improved
- Industrial beacons’ transmitting/reception diagram described
- Minor fixes and improvements

V2020_07_15

- Mini-RX internal solderable pinouts
- Minor fixes and improvements

V2020_05_21

- Starting up Starter Set Super-MP-3D (IA) described
- Minor fixes and improvements

V2020_05_13

- Reducing update rate latency chapter improved
- Minor fixes and improvements

V2020_05_08

- Building big maps in the Inverse Architecture (IA) chapter described
- Minor fixes and improvements

V2020_04_24

- Dashboard Monitoring Mode described
- Super-Modem described
- Super-Modem SW update described

- Minor fixes and improvements

V2020_04_09

- Minor fixes and improvements

V2020_04_07

- Background color described
- Height input in Starting up chapters described
- Minor fixes and improvements

V2020_02_27

- Geofencing zones described
- IMU axis positioning for Super-Beacon described
- External microphones soldering scheme for Super-Beacon improved

V2020_02_21

- Minor fixes and improvements

V2020_02_14

- Architectures comparison table added
- Legend chapter improved
- Minor fixes and improvements
- Floorplan Help video added

V2020_01_17

- External microphones connection for Mini-RX and Super-Beacon described
- Minor fixes and improvements

V2019_12_10

- Appendixes chapter improved
- Minor fixes and improvements

V2019_12_03

- Appendixes chapter added (protocols)
- Minor fixes and improvements

V2019_11_18

- Mini-RX solderable pinouts described
- Industrial connectors pinouts improved
- Minor fixes and improvements

V2019_10_31

- Industrial Super-Beacon Metal-25kHz described
- Starting up chapters for every starter set described
- Super-Beacon and Super-Beacon outdoor described
- Improved photos
- Reception diagrams for HW v4.9 improved
- Oscilloscope chapter improved
- Minor fixes and improvements

V2019_07_02

- Troubleshooting improved
- Architecture comparison improved
- Minor fixes and improvements

V2019_06_25

- TDMA modes described
- Stationary beacons' colors described

- Minor fixes and improvements

V2019_06_13

- Delay tuning described
- Update rate tuning described
- Minor fixes and improvements

V2019_06_07

- F.A.Q. and Troubleshooting improved
- Architecture comparison improved
- Receiving and transmitting angles illustrations added (v4.9 chapter and Mini-RX chapter)
- The ceiling and mirroring buttons described

V2019_06_03

- TDMA described

V2019_05_28

- IMU axis positioning fixed
- IA details added
- Troubleshooting improvements
- Minor fixes and improvements

V2019_05_16

- Introduction of the Legend
- Added missing video on page 34
- Minor fixes and improvements

V2019_04_30

- DFU programming described
- Magnetic reset for Industrial beacons and DFU programming described
- Minor fixes

V2019_04_04

- Starting up the system description for different Starter Sets (NIA, Industrial NIA, and IA)
- Sending path to robot described

V2019_03_18

- New names for beacons: DSP => Mini-RX, Mini-beacon => Mini-TX, Beacon-TX-25-IMU-IP67-RS485 => Industrial-TX, Beacon-RX-IMU-IP67-RS485 => Industrial-RX
- Starting up the system description for different Starter Sets

V2019_02_05

- Licenses described
- Minor fixes and improvements

V2019_01_29

- Mini-RX Inverse SW flashing described
- Added new types of beacons
- Minor fixes and improvements

V2019_01_12

- Mini-RX beacon and Mini-TX described
- IMU axis described
- Minor fixes and improvements

V2018_12_02

- Major new feature – support for 250 beacons (mobile + stationary combined) and 250 submaps per modem

- New feature: user must set handover zones between submaps to guarantee handover quality for complex maps with multi-floor and similar
- New feature: The default wireless connection setting is now 153kbps (used to be 38kbps). Radio profile 153kbps provides a radio coverage range of nearly as much as 38kbps and an update rate almost as high as 500kbps, i.e., it is a middle ground between 38kbps and 500kbps, combining the best of both.
- Correction: USB streaming in power save mode improved
- Correction: The zero IMU button in the Dashboard is improved, while the button Reset IMU is removed completely
- Correction: ultrasound TX is not reset to 31kHz when the Default button is pressed. Now, several types of ultrasonic frequencies are supported, so 31kHz is not anymore the defaulted ultrasonic frequency for all beacons
- Improved: both energy saving and tracking quality with Power Saving mode enabled
- Improved: only beacons with a selected tick in the Dashboard lower menu will be accepted to the network – not any addresses. This improves the network's predictability when many beacons may not belong to the network. Their attempts to join the network will be blocked
- Improved: now, submaps support up to 4 beacons only. More than that – build another submap. Up to 250 beacons (mobile + stationary combined) and up to 250 submaps are supported per beacon
- Bug fix: improved map building with active hedgehog
- Bug fix: duplicated address might work incorrectly in some cases

V2018_11_08

- Real-time player feature described

V2018_08_30

- New SW features described
- New Dashboard view described

V2018_08_03

- Calibration of an accelerometer described
- F.A.Q. updated
- Troubleshooting guide described
- Refreshed links
- Player feature described
- IMU feature described
- Minor fixes

1. Executive Summary

Marvelmind Indoor Navigation System is an off-the-shelf indoor navigation system that provides precise (±2cm) location data to autonomous robots, vehicles (AGV), forklifts, and drones. It can also track moving objects via mobile beacons attached to them. Other applications include cranes, virtual/augmented reality (VR/AR) systems, helmets for construction workers or miners, etc. See more: Solutions.

The navigation system consists of a network of stationary ultrasonic beacons interconnected via a radio interface in a license-free band (915/868 MHz), one or more mobile beacons installed on objects to be tracked, and a modem or modems providing a gateway to the system from a PC or other computers. See more: Architectures.

Using the trilateration algorithm, a mobile beacon's location is calculated based on a propagation delay of ultrasonic pulses (Time-Of-Flight or TOF) between stationary and mobile beacons.

The system can build a map of stationary beacons automatically. In simple cases, no additional manual data input or any manual distance measurements are required. This map formed once can be frozen and stored in the modem's memory, and the system becomes fully active within 7 to 10 seconds after the modem is powered.

Fig. 1: Example of Starter Set based on Super-Beacons

Minimum configuration requirements to ensure optimal performance of the Marvelmind Indoor Navigation System:

- For 3D (X, Y, Z) tracking: an unobstructed line of sight (hearing) between a mobile beacon and 3 or more stationary beacons within 30 meters
- For 2D (X, Y) tracking - an unobstructed line of sight (hearing) between a mobile beacon and 2 or more stationary beacons within 30 meters

1.1. Key Capabilities:

Parameter	Technical Specifications
Distance between beacons	- Reaches up to 50 meters and up to 100 meters with horn under laboratory conditions (Mini-RX or Super-Beacon to Super-Beacon with RX4 only) - Recommended distance is 30 meters (Transducer4 on the first beacon is looking straight at the Transducer4 on the second beacon; other transducers are switched off)
Coverage area	- Reaches up to 1000m^2 with the Starter Set configurations - Coverage for larger territories is provided using submaps – like cells in cellular networks
Location precision	- Absolute: 1–3% of the distance to the beacons - Differential precision: **±2cm**
Location update rate	- 1/20Hz to 40Hz (Ultrasonic based only) - 100Hz with ultrasonic + IMU fusion enabled (Only for Beacons HW v4.9-IMU-Discontinued) - Can be set manually via Dashboard software - Depends on the distance between mobile and stationary beacons (shorter distance—higher update rate). See more - Depends on the number of mobile beacons (For Non-Inverse Architecture; for Inverse Architecture, there is no such dependency) - Depends on the radio profile (500kbps, 200kbps, 38kbps) - Slightly depends on the number of stationary beacons—dependence is not the same as for mobile beacons
Power supply	Internal: 1000mAh LiPo battery (Super-Beacon) - Battery lifetime: from 2 days to several months, depending on the mode of operations[1]
	External: micro-USB – recommended for permanent use
Weight	Mobile beacon (Super-Beacon) from the starter set: - 59 grams (including 1000mAh battery, Super-Beacon housing, and 50mm antenna)[2] - 27 grams (Super-Beacon, bare board w/o battery)
Beacon size	Size: 55x55x33mm (with 50mm antenna: 55x55x65mm) (Super-Beacon)[3]

[1,2,3] For other types of beacons, look to the comparison table

1.2. Legend

The legend chapter contains small icons and signs highlighting key text points.

- Important

- For experienced users

- Demo or Help video

- Useful link

2. Basics of the System

Here are examples of the Starter Sets:

2.1. What's in the Box

2.1.1. Starter Set Super-MP-3D:

- 4 x Stationary Super-Beacons with different frequences (19kHz, 22kHz, 25kHz, 28kHz, 31kHz, 34kHz, 37kHz, 45kHz). It can be used as IA, NIA, and MF NIA. See more in the architecture comparison.
- 1 x Mobile Super-Beacon
- 1 x Modem v5.1 supporting up to 250 beacons

2.1.2. Starter Set IA-04-2D-Badge:

- 2 x Super-Beacons – 915/868 MHz with different ultrasonic frequencies (f1 and f2 – usually 25kHz and 31kHz).
- 1 x Marvelmind Badge – 915/868 MHz as mobile beacon
- 1 x Modem HW v5.1 – 915/868 MHz as central controller of the system

*This is just an example of two starter sets.
You can see more options on our website: Products.

2.2. Indoor Navigation System Architectures

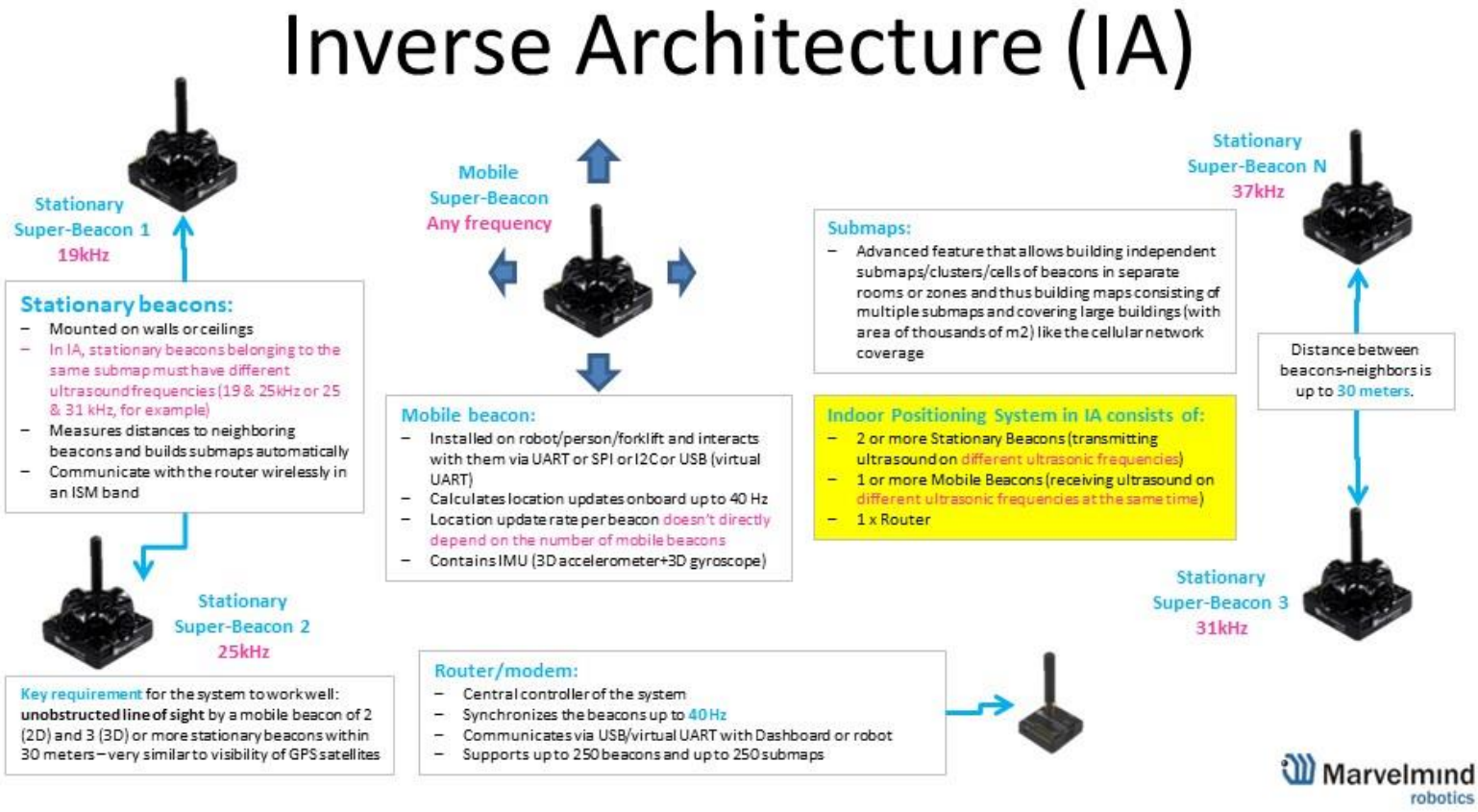
Marvelmind Indoor Navigation System provides high-precision (±2cm) indoor coordinates for autonomous robots and systems ("indoor GPS"). The scheme below briefly describes the system's key elements.

IA and NIA SW differ.
For IA, you should use stationary beacons with different frequencies.

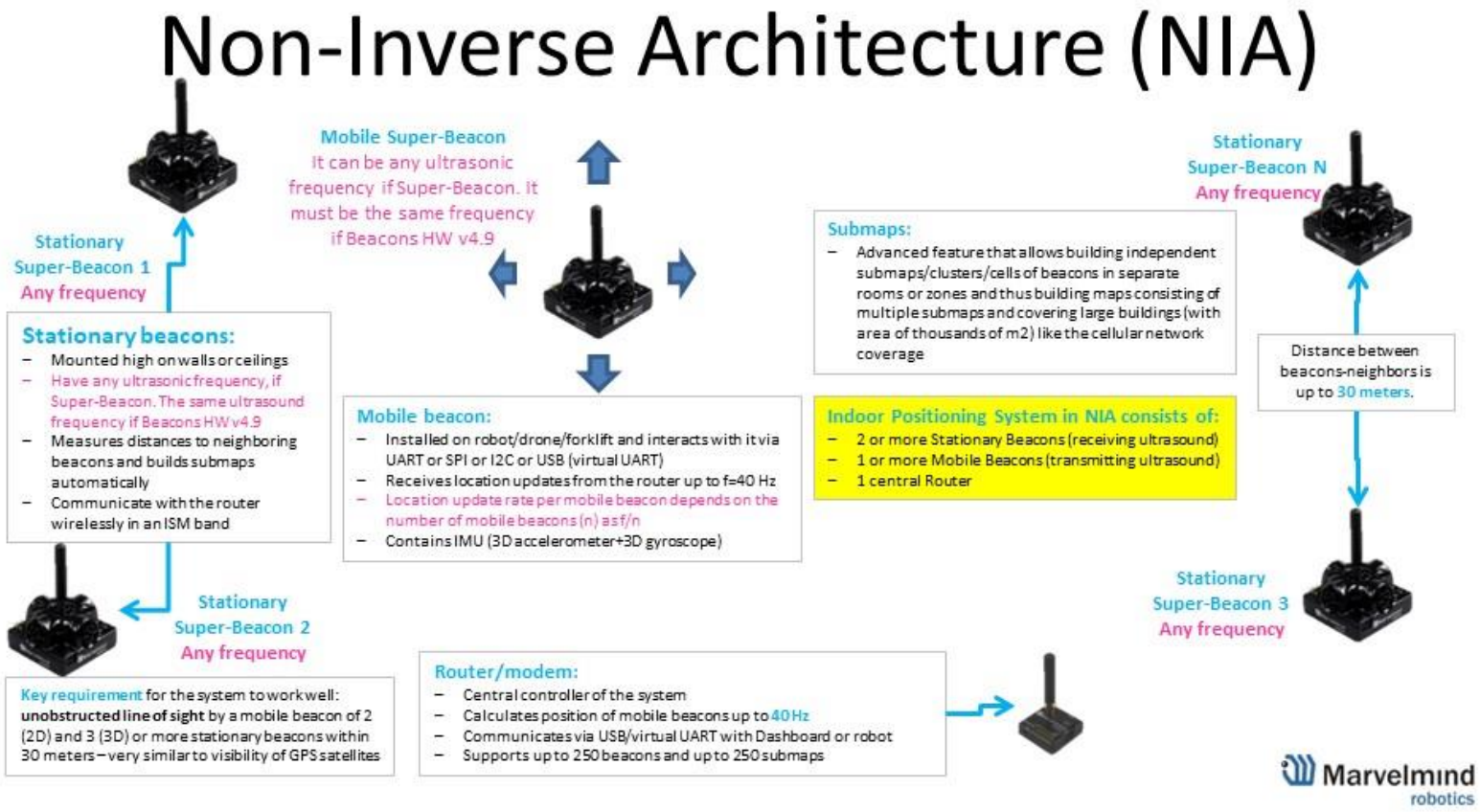
Below, you can see 3 types of architectures: Non-Inverse (NIA), Inverse (IA), and Multi-frequency NIA (MF NIA):

2.2.1. Inverse Architecture

For IA, you should use stationary beacons with different frequencies.

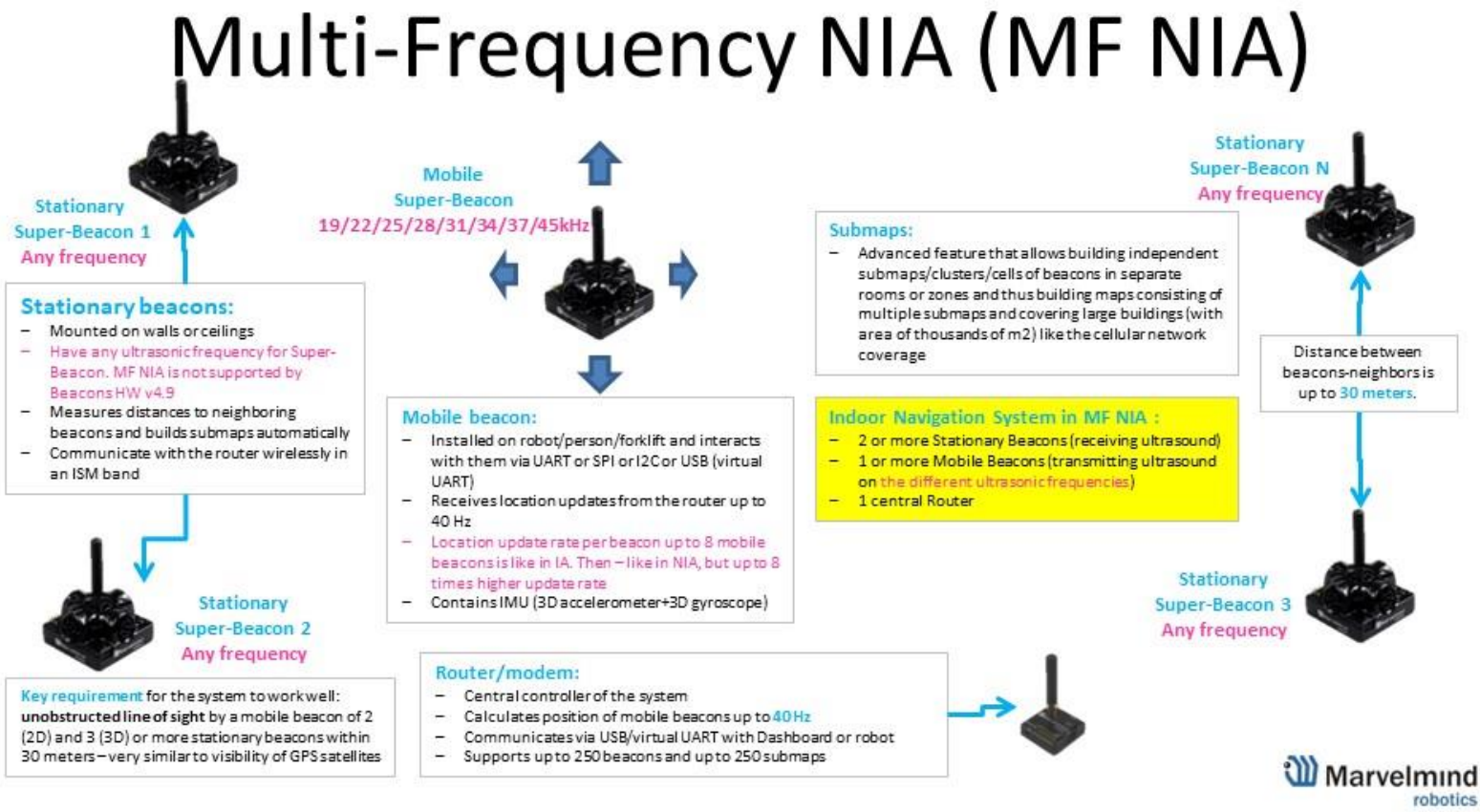


2.2.2. Non-Inverse Architecture (NIA)



2.2.3. Multi-Frequency NIA (MF NIA)

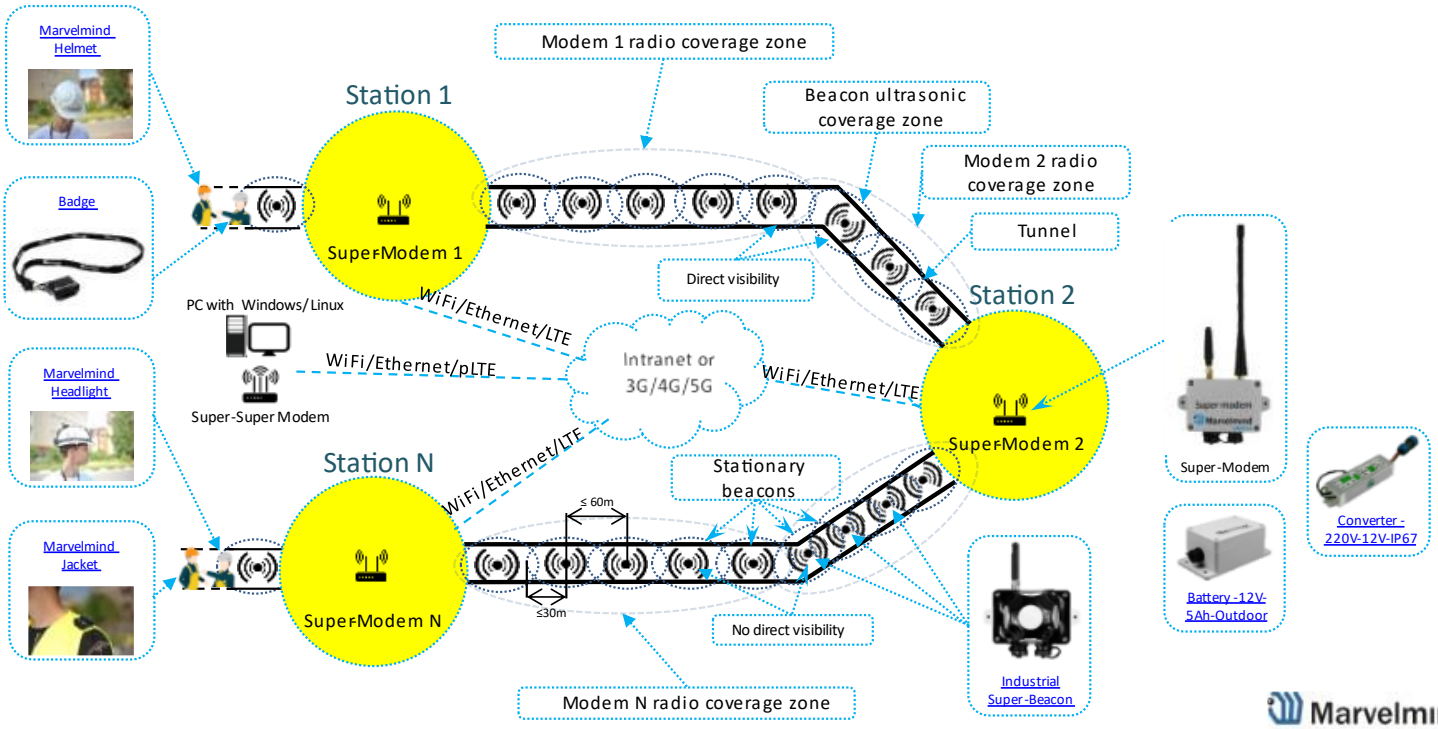
License • MMSW0004: MF NIA support is needed to use MF NIA



2.2.4. Multi-modem Architecture for Very Large Networks

Multi-modem architecture for very large networks

Tunnel safety example for underground tracking



4

2.2.5. Architectures Comparison Table

Architectures comparison

	Non-Inverse (NIA)	Inverse (IA)	Multi-Frequency NIA (MF NIA)	Multi-modem architecture
Typical usage	- 1-4 autonomous robots/drones - supports up to 250 beacons (stationary+mobile) - When mobile beacon shall be installed on a noisy drone/vehicle, but stationary beacons are in relatively quieter places	- Many mobile users (people, robots, VR) and when update rate per mobile is important - supports up to 250 beacons (stationary+mobile combined) - When mobile beacons are in quieter places	- 5-16 autonomous robots/drones - supports up to 250 beacons (stationary+mobile combined) - Effectively, MF NIA combines the best from both IA and NIA. But it is still "more NIA than IA", because the mobile beacons are emitting the ultrasound	- All three previous architectures are supported - When distance from some of the beacons to the modem is too big
Not recommended	- In applications, where emitting ultrasound of mobile beacon is undesirable	- For drones – because mobile beacons are receiving ultrasound. The range may be limited to just 2-5m. May be improved with future SW releases	- In applications, where emitting ultrasound of mobile beacon is undesirable	-
Accuracy	- ±2cm or better with more averaging	- ±2cm or better with more averaging	- ±2cm or better with more averaging	- ±2cm or better with more averaging
Update rate	- Depends on the number of mobile beacons (n) as f/n –TDMA is used - Slightly depends on the radio profile - Depends on the sizes of submaps - IMU fusion is HW and SW supported	- Does not depend on the number of mobile beacons, because they are receiving ultrasound at the same time - Slightly depends on the radio profile - (the same as NIA) - Depends on the sizes of submaps (the same as NIA) - IMU fusion is HW supported. SW support is coming	- Depends on the number of mobile beacons (n) for n>8 –TDMA is used, i.e. can provide up to 8 times higher update rate than NIA with the same number of mobiles. Up to 8 mobiles the update rate per mobile is equal to IA - The rest – like NIA	- Depends on the description for other architectures
Range	- Can cover as large territory as you wish using submaps - Up to 30m in real life and up to 50m in lab conditions within a single submap, i.e. stationary beacons shall be placed every 30m or closer (in 1D with horns – up to 120m)			
Map building	- Can build submaps automatically and manually	- Can build submaps automatically and manually	- Can build submaps automatically and manually	- Can build submaps automatically and manually

Version 2023_06_26

Marvelmind robotics

Here is a tutorial video about architectures:

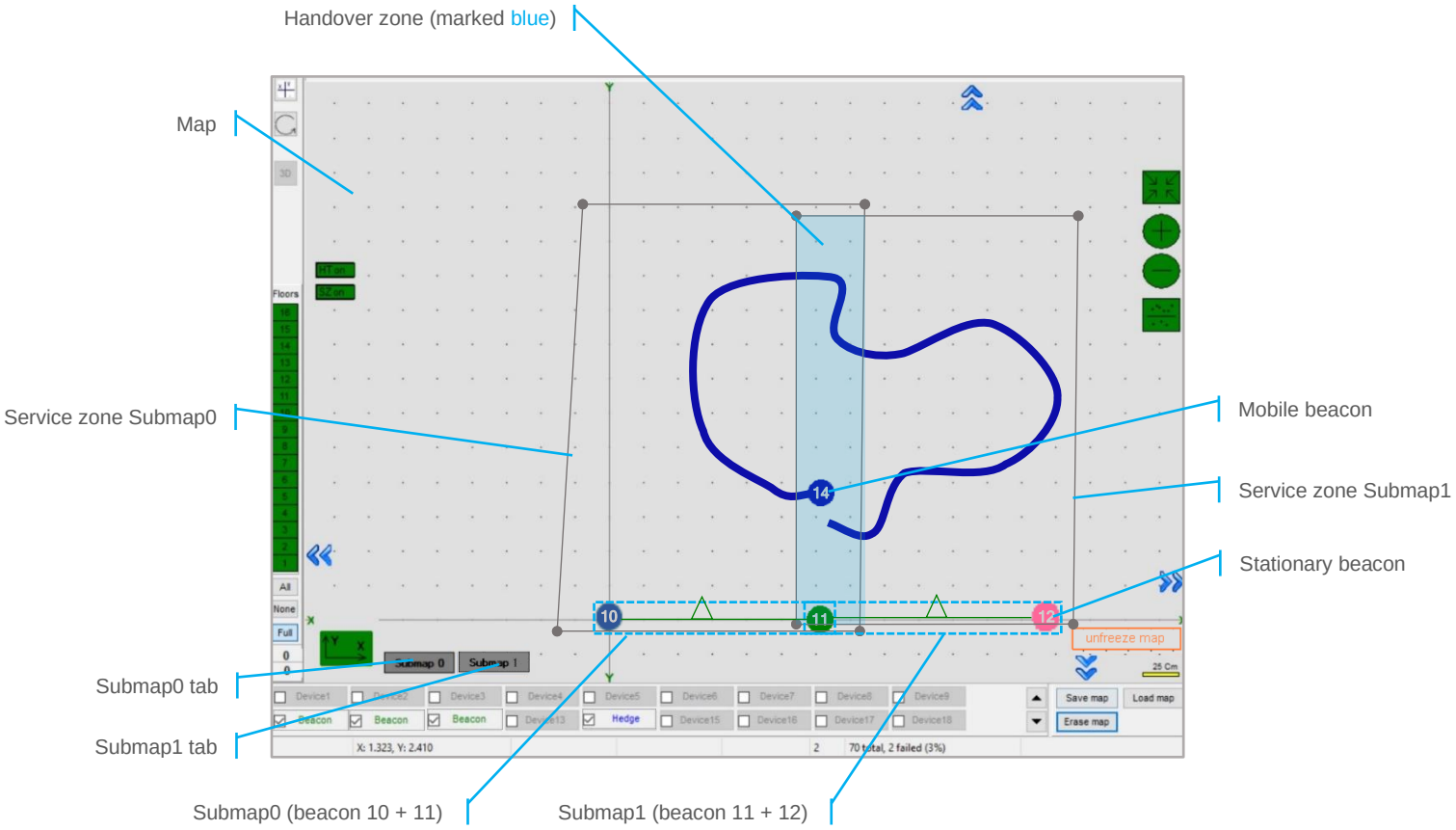
Help: Inverse Architectures (IA) vs. Non-Inverse Architectures (NIA)

NIA vs. IA vs. MF NIA - how to choose?

Marvelmind robotics

2.3. Architectures' Elements

A **map** is a system unit that includes **submaps, stationary beacons**, and **service zones**. Ultrasonic signals from the stationary beacons of this submap ensure the positioning of mobile beacons.



The main parameters of a submap are its **size, frequencies, and TDMA (Time Division Multiple Access) positions of stationary beacons, by which mobile beacons can not only be positioned** but also determine in which submap the mobile beacon is located.

Here is the main tutorial video about maps:

- Help: submaps, service zones, handover zones

Detailed explanation of complex map building:

- Building submaps: Part 1
- Building submaps: Part 2

2.4. Indoor “GPS” System Close-up and Internal View

Here, you can see what system elements look like.

- Super-Beacon:

- Modem HW v5.1:

- Super-Modem:

- Beacon Mini-RX:

- Beacon Mini-TX:

- Beacon Industrial-RX:

- Industrial Super-Beacon Metal-25kHz:

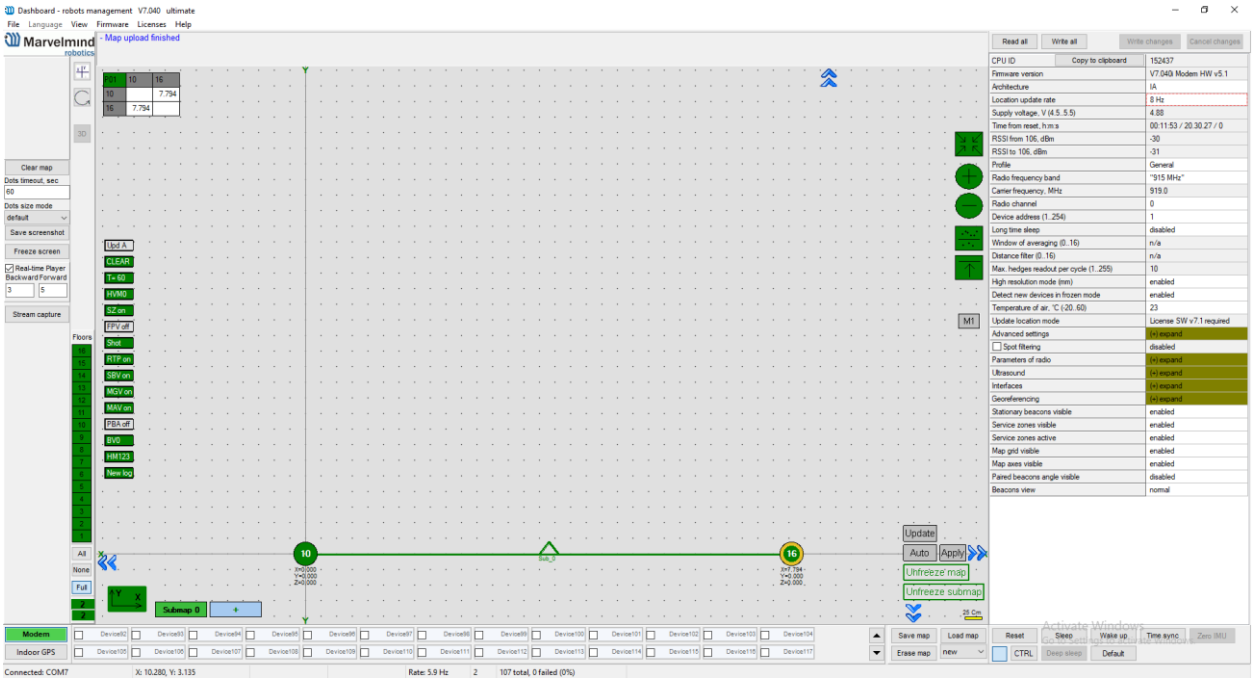
- Industrial Super-Beacon-Plastic:

3. System Elements

Here are represented core elements required for the stable working of the system:

3.1. Control System (Dashboard)

Dashboard is a Windows/Linux/Mac app that sets up and tunes the system and accesses tracking data.



- General app for SW update and initial setting up of the system
- Contains many tracking display features
- Very deep tuning and setting abilities
- All new features available in the Dashboard app

Minimum system requirements:

- OS: Windows 11 64 bit; Linux Ubuntu 18.04
- Processor: Intel Core i5-4200M or equivalent
- Memory: 4 GB RAM
- Display: 1920x1080 pixels
- Storage: 1 GB available space
- Additional Notes: USB 2.0 port

You can get data without the Dashboard; the whole system can work without it after setting it up. You don't need a computer, internet access, or cloud to run the system. All calculations are spread between the modem and the beacons.

3.2. Stationary Beacon

- Usually mounted on walls or ceilings above the robot with ultrasonic sensors facing down—to provide the robot's most robust unobstructed ultrasonic signal coverage. However, for automatic landing and indoor navigation of copters, for example, it is recommended to install a mobile beacon horizontally on the belly of the copter so that the beacon would be looking downwards

Fig.1: Super-Beacon as an example

- The position and orientation of the beacons should be chosen to provide maximum ultrasonic signal coverage. System efficacy strongly depends on the quality of the ultrasonic signal received by stationary beacons

- Stationary beacons emit and receive ultrasound during the map configuration period. In non-inverse architecture, they only work as receivers once the map is formed and frozen. In inverse architecture, they only work as transmitters.

- Stationary beacons have no exterior differences from mobile beacons

- The mobile and stationary beacons can be easily interchanged during configuration in the Dashboard

- There are 433MHz(out of production, get bug-fixing SW update only) and 868/915MHz versions available. A proprietary radio protocol is used for communication and synchronization. Other ISM bands are available upon request as well

- A stationary beacon can be equipped with a full-size 165mm antenna, which provides a more robust radio connection between the modem and beacons.

3.3. Mobile Beacon a.k.a. “Hedgehog”

- The mobile and stationary beacons can be easily interchanged by selecting in the Dashboard

- The mobile beacons are designed to be placed on a robotic vehicle, copter/drone, AGV, or helmet to trace its location. Formally speaking, the location of the mobile beacon is traced—not the robot itself. Since the sizes and the location of the central point of the mobile beacon and the robot are different, the difference is taken into account in the robot’s software (SW)

- It is recommended to place the mobile beacon horizontally to provide optimal ultrasonic coverage in the upper hemisphere

Fig.1: Super-Beacon as an example

- Its sensors must not be covered with anything that can reduce the strength of the ultrasonic signal. For example, the system won’t work well if one puts the mobile beacon in a plastic box

- The beacon’s coordinates are updated according to the rate set on the Dashboard

- The system may contain one or several mobile beacons. The current implementation relies on a time-division multiple access approach and refers only to NIA. Thus, if two mobile beacons are activated, they share the same system bandwidth. It means that if the 16 Hz update rate is selected in the Dashboard and there are 2 mobile beacons in the system, each beacon’s location will be updated with the rate of 16Hz/2 ~ 8Hz. If there are 3 mobile beacons => 16Hz/3 ~ 5Hz, etc. For 4 and more mobile beacons, we recommend using Inverse Architecture. See more in the architecture comparison. To increase the update rate, see the location update rate boost.

- Location data is obtained either from the “hedgehog” via USB (virtual UART), UART, SPI, or from the modem via USB (virtual UART). More information on interfaces can be found here (Mini-TX Beacons do not have pinouts, only over micro USB. This doesn’t refer to Mini-TX 2)

- Data from the beacon sent in a streaming format identical to that of GPS (NMEA 0183)

- There are 433MHz(out of production, get bug-fixing SW update only) and 868/915MHz versions available. Proprietary radio protocol is used for communication and synchronization

- The “hedgehog” has been successfully integrated with Windows PC, Linux machines, Raspberry Pi, Arduino boards, Intel boards, etc.

3.4. Modem

- The modem is the central controller of the system. It must always be powered when the Navigation System is working. An active USB hub or even a regular cellular phone USB power supply is recommended for that purpose. A USB power bank can also be used

- The modem is also used to set up the system, monitor it, and interact with the Dashboard

- It can be placed anywhere within radio coverage for permanent radio connection with all beacons—usually in a radius of up to 100 meters with antennas from the Starter Set

- Radio coverage was further extended to a few hundred meters by using a lower bitrate of 38kbps and full-size (165mm for a 433 and 915MHz band) antennas, which have been tested to provide up to 400m in ideal conditions

Fig.1: HW v5.1 Modem as an example

- There are 433MHz (only for HW v4.9, out of production, get bug-fixing SW update only) and 915MHz versions available

- A proprietary radio protocol used for communication and synchronization between modem and beacons

3.5. Different Types of Modems

There are three types of Marvelmind modems:

- Modem HW v5.1 – newest and primarily used version of modem.
- Modem HW v 4.9 – old version of Modem HW v5.1. Out of production, get bug-fixing SW update only
- Super-Modem - is a superior version of the Modem HW v5.1 with advanced capabilities and interfaces

3.5.1. Super-Modem

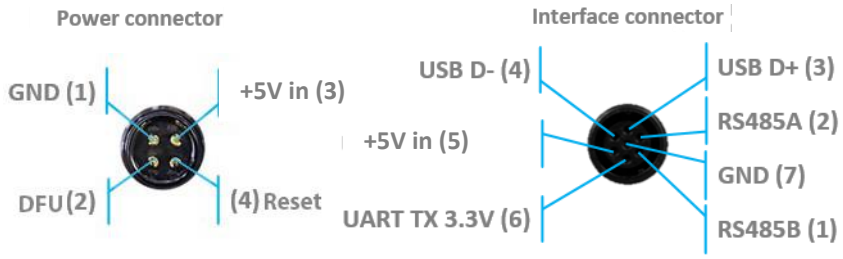
Super-Modem is a superior version of the Modem HW v5.1 with advanced capabilities.

Fig.2: Super-Modem's contents of delivery

- Super-modem supports all the basic features of the Modem HW v5.1 and can be connected over USB to the Dashboard for system tuning and control (Do not forget to power the Super-Modem via a Power connector)
- UDP streaming over Wi-Fi is supported. In the future, remote control of the modem and the whole system via TCP-IP will be supported too
- Bluetooth (HW enabled but not yet supported in SW)
- >1000x more RAM and >1000x Flash memory than Modem HW v4.9
- Full-size bendable antenna by default
- Higher ingress protection - up to IP67 (optional)
- Super-Modem's HW supports Super-Modem and Super-Super-Modem functionality for Multi-Modem architecture:

  https://marvelmind.com/pics/marvelmind_presentation.pdf
- Designed for outdoor and industrial applications
- External bendable antennas with SMA connector for extended radio range included

- Currently, it supports a license-free 915MHz ISM band (for example, US, Japan, Korea) and a license-free SRD band 868MHz (EU, Russia). Future 433MHz HW variants may come in some months, but there is no firm schedule yet. You can place orders for 433MHz. When enough orders are collected, we will produce the 433MHz version as well
- Supports all types of beacons working in the 915MHz band (among them: Super-Beacons, all Industrial beacons, Mini-RX, Beacons HW v4.9, Helmets, Badges, Jackets, Watches, etc.)
- Two IP67 external connectors included (like Industrial beacons):



- The same mounting holes as for Industrial beacons
- No battery inside – external power supply (+5V) required (for example, Converter-AC-5V-IP67). External battery is not practical for long-term due to relatively high and constant power consumption of 1.5-2W
- The new version of Super-Modem (from June 2023) supports ONLY a **+5V power supply**. Please don't use a +12V power supply converter for this version; it will burn the beacon!
- For optional IP67 version – extended working temperature range: -40C…+50C (provided by design – not tested, not certified)
- Embedded reset switch and DFU switch – magnetic control or external pins on IP67
- Supports IA, NIA, and MF NIA. Can be easily switched between the modes in the Dashboard
- Radio range to beacons – up to a few hundred meters in the open space area. Wi-Fi – a few tens of meters in the open space

3.5.2. Modem HW v5.1

Modem HW v5.1 is a superior version of the Modem HW v4.9.

Modem HW v5.1 looks almost the same as Modem HW v4.9. To distinguish it, check the white sticker on the bottom.

Fig.1: Modem HW v5.1

Modem HW v5.1 and Modem HW v4.9 brief comparison:

- Modem HW v5.1 has more memory
- Modem HW v5.1 has a higher radio range
- Modem HW v5.1 more sensitive
- Modem HW v5.1 has TELEC T-108 Japan certification
- All new features come to the new Modem HW v5.1
- FCC NOTICE:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna

Increase the separation between the equipment and the receiver

Connect the equipment to an outlet on a circuit different from that to which the receiver is connected

Consult the dealer or an experienced radio/TV technician for help

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) This device must accept any interference received, including interference that may cause undesired operation.

The equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body.

3.5.3. Modem HW v4.9 (Superseded by the Modem HW v5.1)

Modem HW v4.9 has balanced features and performance.

Since Modem HW v5.1 was released, Modem HW v4.9 will only get bug-fixing SW updates.

Fig.1: Modem HW v4.9

- The modem is also used to set up the system, monitor it, and interact with the Dashboard
- It can be placed anywhere within radio coverage for permanent radio connection with all beacons—usually in a radius of up to 100 meters with antennas from the Starter Set
- Radio coverage is further extended to a few hundred meters by using a lower bitrate of 38kbps and full-size (165mm for a 433MHz band) antennas, which have been tested to provide up to 400m in ideal conditions
- There are 433MHz and 915MHz versions available
- A proprietary radio protocol used for communication and synchronization between modem and beacons

3.6. Different Types of Beacons

There are many types of beacons. Each is used in different ways, depending on your case and preferences.

- Mini-RX — can receive ultrasound and is mainly used as a mobile beacon. It could be made in Outdoor modification.
- Mini-TX — for ultrasound transmitting only. Because of its small size, it is suitable for copter and tracking.
- Super-Beacon – can receive and transmit ultrasound, using in most cases. It could be made in Outdoor modification.
- Industrial-RX – suitable for massive manufacturing and outdoor installation. It has no sensors and works in NIA architecture as a stationary beacon or mobile beacon in IA architecture.
- Industrial Super-Beacon— a fully functional Super–Beacon that can work as a mobile and stationary beacon. It is suitable for massive manufacturing and outdoor installation.

Here you can see more details about the different types of beacons.

3.6.1. Super-Beacon

The Super-Beacon is a dual-use beacon – it can both receive and transmit ultrasonic pulses.

The Super-Beacon Beacon can be used in the Non-Inverse Architecture (NIA) and the Inverse Architecture (IA): Architecture comparison.

It supports a license-free 915MHz ISM band (US) and a license-free SRD band of 868MHz (EU). Support of the 433MHz ISM band (EU) comes with a larger order.

Key features:

- The Super-Beacon has a separate receiving part with a single wide-beam microphone and sharp DSP filters (like Mini-RX or Industrial-RX has). Thus, it is more sensitive than Beacon HW v4.9, more resistant to external noise, and easier to set because you don't have to care about turning on and off ultrasonic sensors to optimize coverage vs. sensitivity
- The Super-Beacon can receive any ultrasonic frequency from the bands: 19kHz, 22kHz, 25kHz, 28kHz, 31kHz, 34kHz, 37kHz, 45kHz. The filter can be selected in the Dashboard. At the same time, the ultrasonic frequency of Beacon HW v4.9 is HW-defined by ultrasonic sensors and can't be changed
- The Super-Beacon can receive several ultrasonic frequencies at once. That is used in the Inverse Architecture. See the comparison
- The Super-Beacon has several-times improved battery lifetime in TX mode as compared with Beacon HW v4.9
- The Super-Beacon can work with regular Beacons HW v4.9 and Mini-RX and Industrial-RX in any combination as a part of a Starter Set or a part of navigation systems. In all cases, beacons shall use the same radio band

Super-Beacon also has an outdoor (IP54) version, protected from dust and water.

Demo video: Demo: IP56 testing of Super-Beacon-IPxx

Figure 1: Outdoor version (IP54)

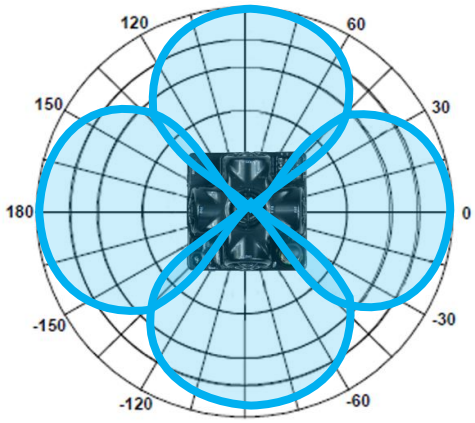


Figure 2: Transmitting diagram (with ultrasound transmitters)

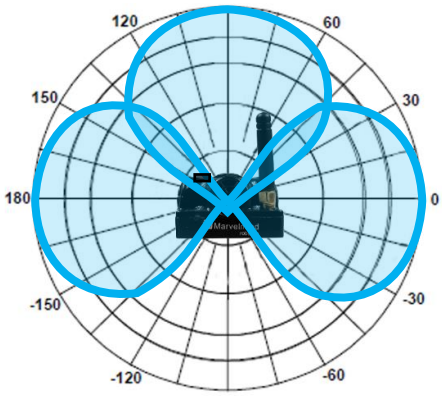


Figure 3: Transmitting diagram (with ultrasound transmitters)

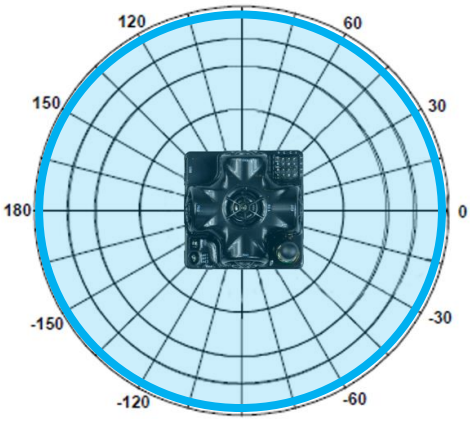


Figure 4: Receiving diagram (with digital microphone)

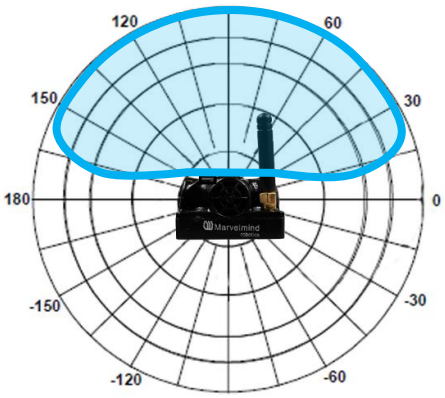


Figure 5: Receiving diagram (with digital microphone)

FCC NOTICE:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna*
- *Increase the separation between the equipment and the receiver*
- *Connect the equipment to an outlet on a circuit different from that to which the receiver is connected*
- *Consult the dealer or an experienced radio/TV technician for help*

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) This device must accept any interference received, including interference that may cause undesired operation.

The equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body.

3.6.1.1. Omni and External Microphones Extension

This modification of the Super-Beacon allows you to bring the receiving microphone to any place on your robot or clothing. Due to this, the microphone body itself will not interfere and will not be visible. It allows you to create more accurate implantation.

It is possible to connect External Microphone-IP67 or Omni-Microphone-IP67

It is also possible to use 2 External Microphones to calculate the direction or to improve and increase the reception area.

Omni-Microphone-IP67 wire length is 1m; it connects to a 4x4 pinout in the default configuration.

The external microphone's length is 25cm (default), but it may be expanded up to 1m (optional). Check out the product page.

Be careful: You should have soldering skills to solder External Microphone on board

Figure 1: Super-Beacon with one External Microphone connected

Figure 2: Super-Beacon with two External Microphones connected

Figure 3: Super-Beacon with Omni-microphone connected

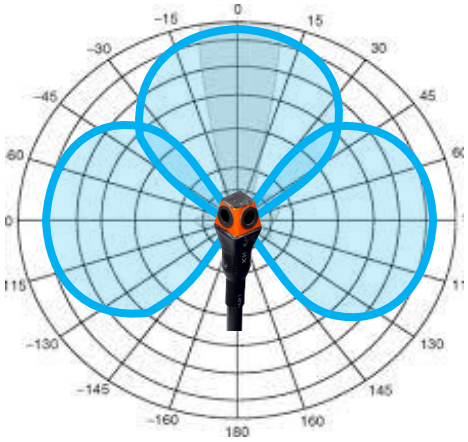


Figure 4: Receiving diagram (with Omni-Mic-IP67)

3.6.1.2. Omni-Microphone Schemes

If you don't want to use a 4x4 pinout to connect Omni, you can solder it using this scheme.

Be careful: You should have soldering skills to solder Omni Microphone on board.

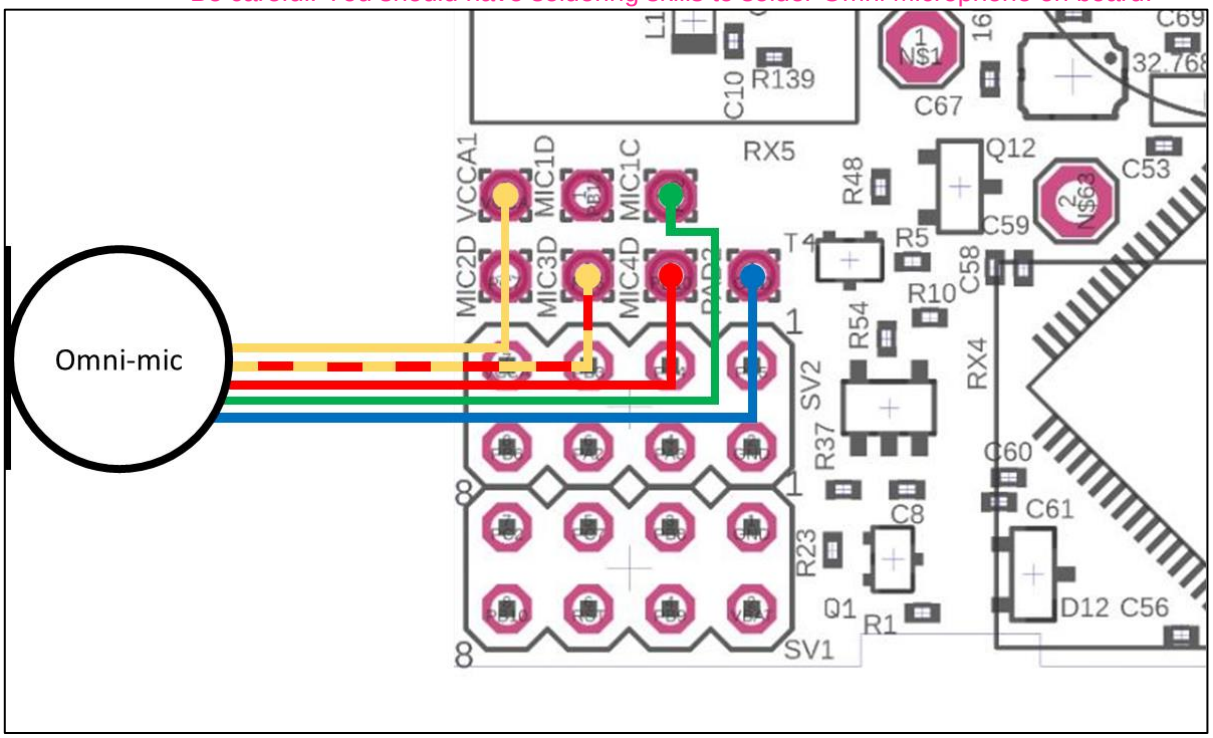


Figure 4: Omni-Microphone connection for Super-Beacon

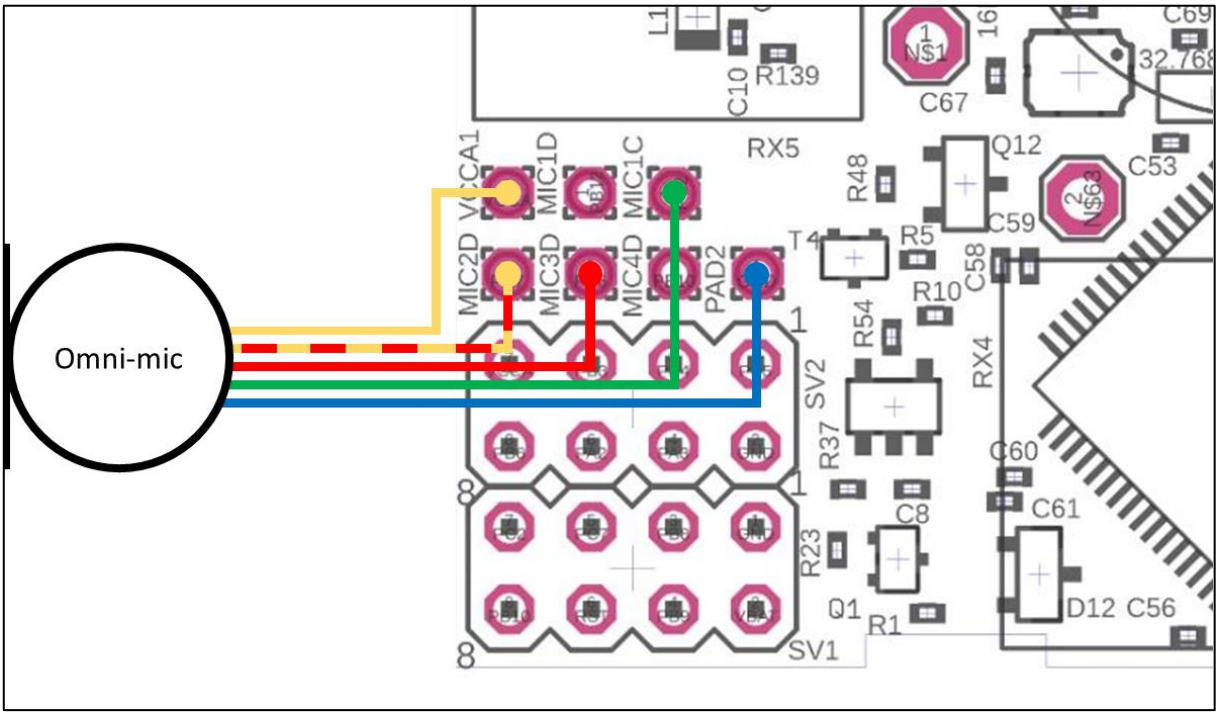


Figure 5: Omni-Microphone connection for Super-Beacon-2 and Super-Beacon-3

3.6.1.3. External Microphones Schemes:

There can be some beacons (from one of the batches) with mixed default microphone wires' colors.

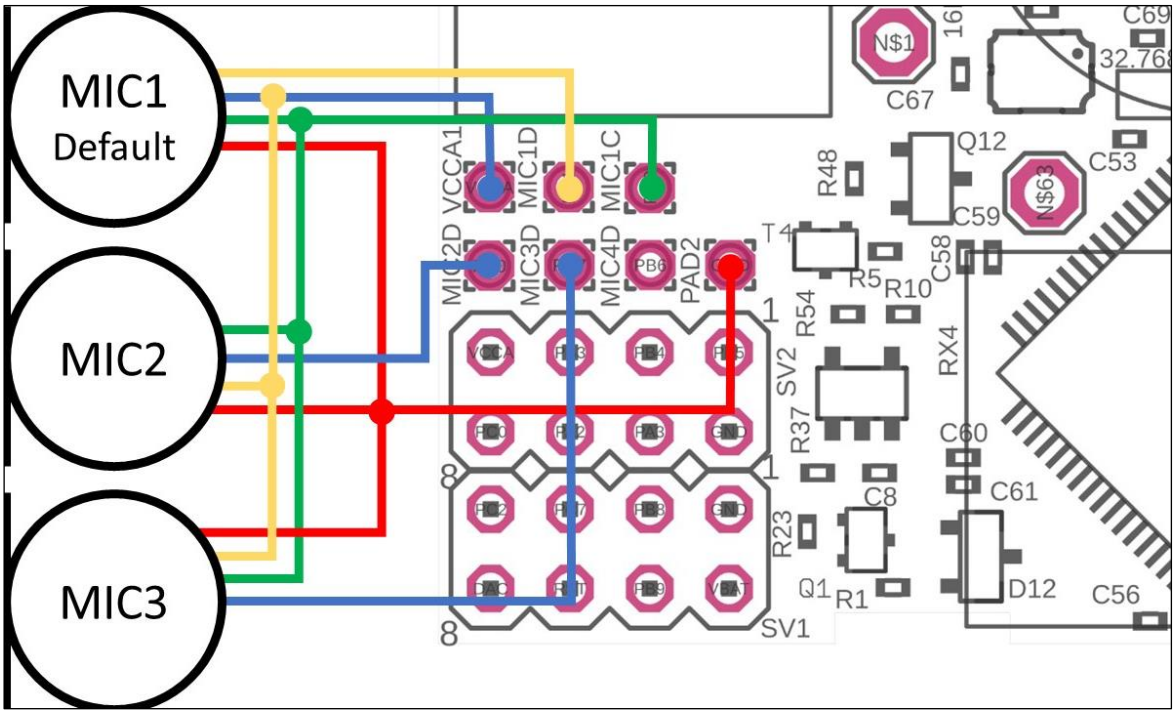


Figure 6: Connection for the beacon with switched blue and yellow wires

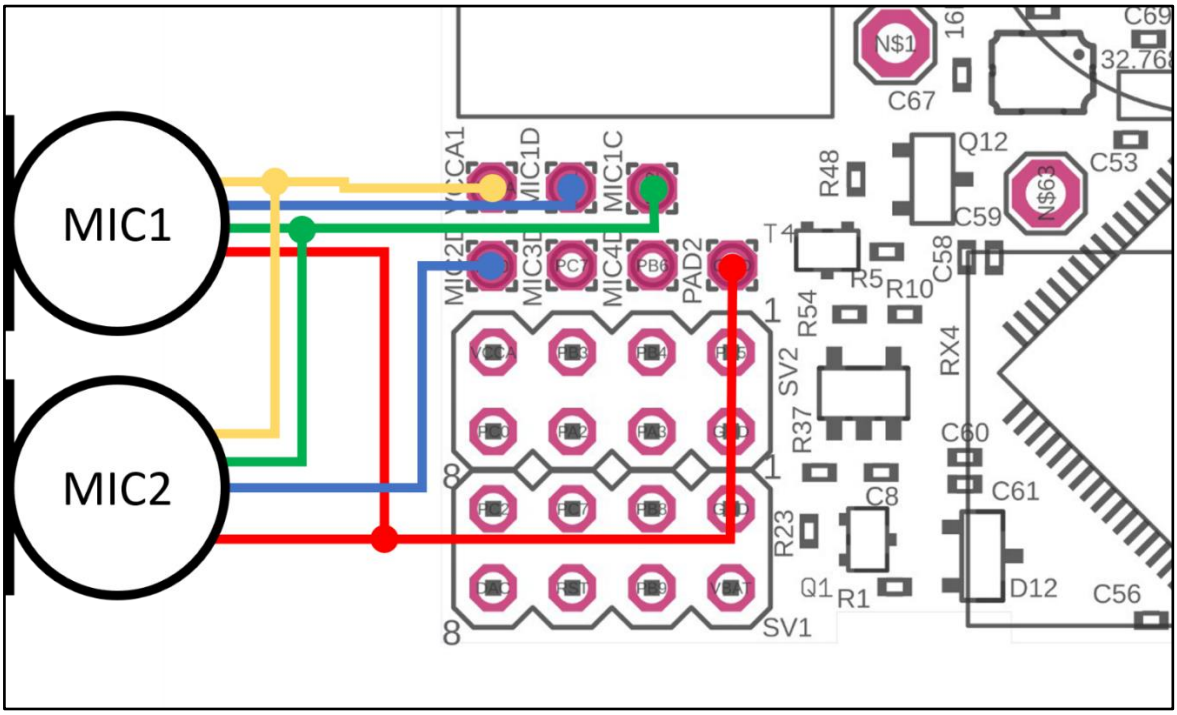


Figure 7: One External Microphone connection

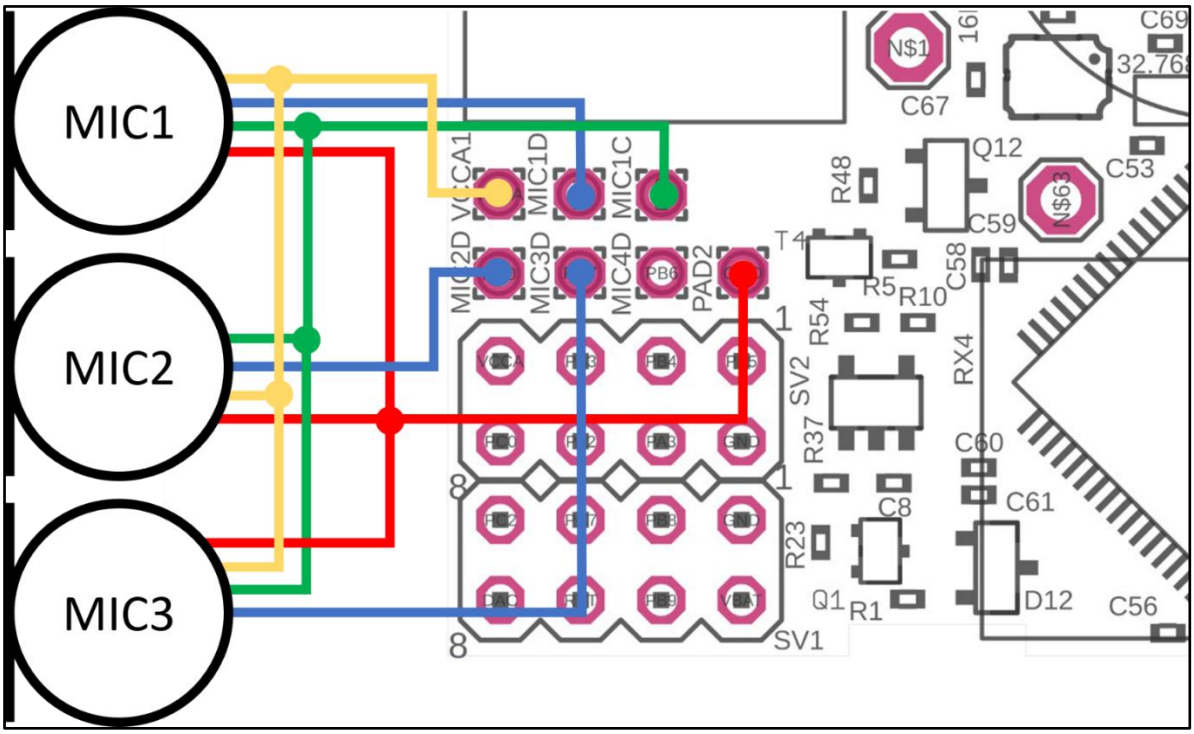


Figure 8: Two External Microphone connections

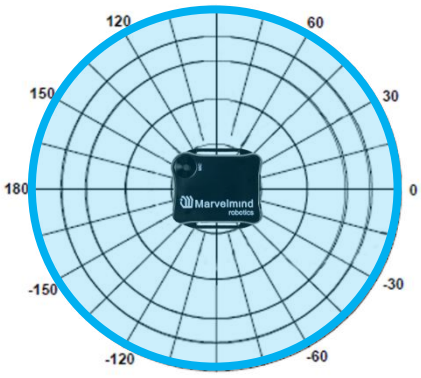
3.6.2. Beacon Mini-RX

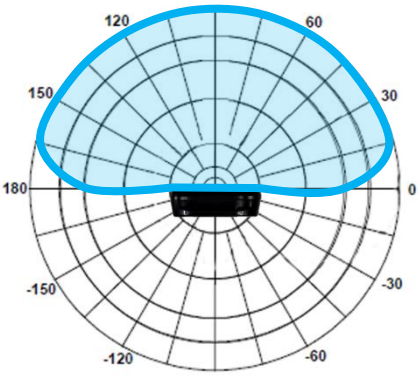
The Beacon Mini-RX can be used in the Inverse Architecture (IA) as a mobile beacon and in the Non-Inverse Architecture (NIA) and in the Multi-frequency Non-Inverse Architecture (MF NIA) as a stationary beacon: NIA, IA, and MF NIA comparison.

In the majority of cases, Mini-RX is used along with one or more external microphones because they provide the best possibility for the line of sight between the mobile beacon (Mini-RX + external microphones) and stationary beacons.

- Mini-RX is an RX-only beacon, i.e., it can receive, but it cannot transmit an ultrasonic signal
- The Mini-RX beacon can receive any ultrasonic frequency from the following bands or all at once: 19kHz, 22kHz, 25kHz, 28kHz, 31kHz, 34kHz, 37kHz, and 45kHz. That is used in Inverse Architecture. See the comparison: NIA, IA, and MF NIA comparison. The filter can be selected in the Dashboard
- The Mini-RX Beacon is significantly smaller and lighter than Super-Beacon. It is it's the main advantage
- It can play the role of a stationary beacon when imputing coordinates manually (in NIA and MF NIA)
- It can play the role of a mobile beacon (in an IA system)
- It has a digital microphone, which is more sensitive than regular sensors
- Supports 868/915MHz radio license-free ISM/SRD bands
- Can be water-protected
- Mini-RX is at the heart of Marvelmind Helmet, Jacket, Headlight, and Watch
- It has 360° reception angle (horizontally) and 120° reception angle (vertically)

Reception diagram. The digital microphone's reception angle is about 360° (horizontally) and 180° (vertically) (if used without housing) and 360°x120° with the housing.



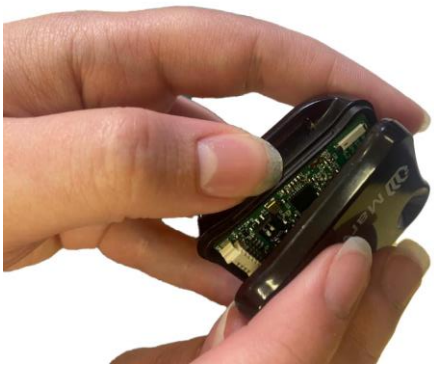
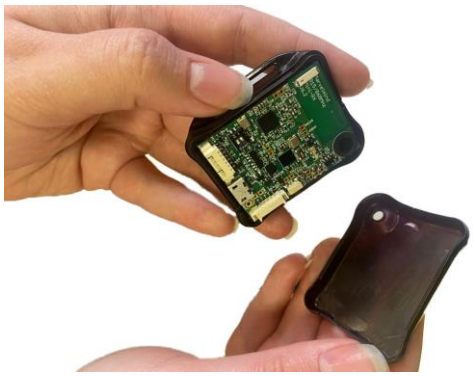


Mini-RX beacon may be over-discharged. In that case, do the following:

Please turn off the beacon with DIP switches and charge it for 1 hour. Then turn the beacon on, flash the latest SW via DFU Programming, and charge it for 1 hour again

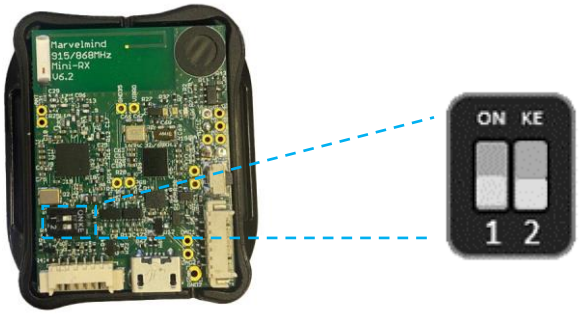
3.6.2.1. How to Flash Beacon Mini-RX

When you receive Beacon Mini-RX, it is turned off. Open it to access the DIP switch.

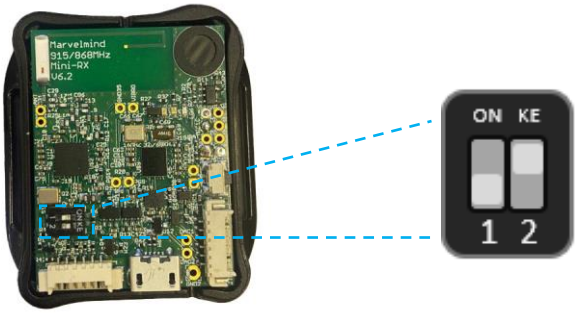
Put the DIP switch to the needed position:

- Only charging the device is possible when the DIP switch is in this position.



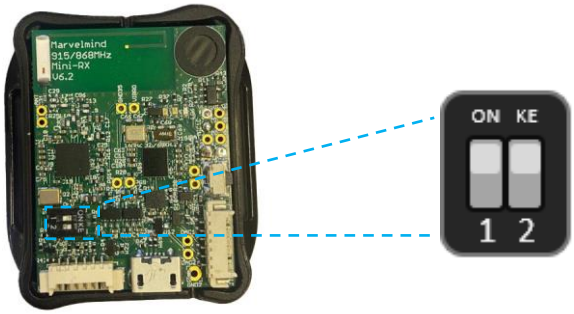
Put DIP switch to this position:

- To turn on the beacon
- For HEX programming (via Dashboard)



Put DIP switch to this position:

- For DFU programing (via: DfuSe v3.0.5 or DfuSe v3.0.6)



3.6.2.2. External Microphone Extension for Mini-RX

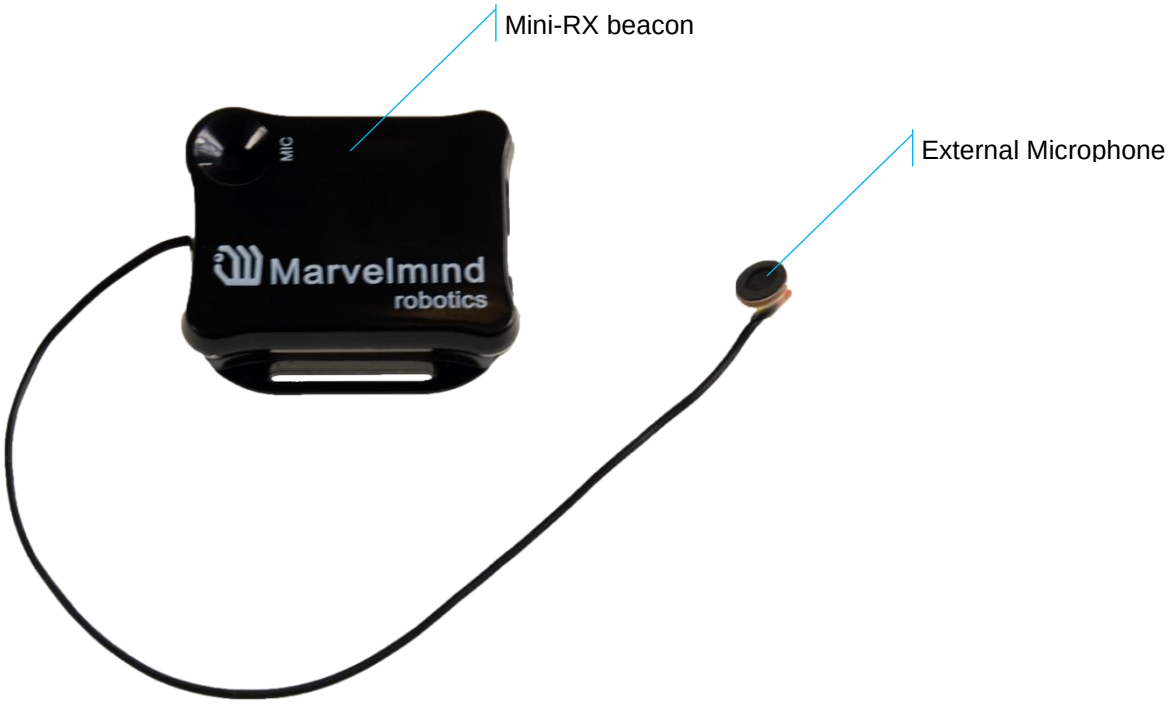
This modification of the Mini-RX beacon allows you to bring the receiving microphone to any place on the robot or clothing. Due to this, the microphone body itself will not interfere and will not be visible. It allows you to create more accurate implantation.

It is also possible to use 2 external microphones to calculate the direction or to improve and increase the reception area.

The length is 25cm (default) and may be expanded to 1m (optional). Check out the product page.

At maximum, Mini-RX supports **up to four microphones**: either 3 + 1 including the internal one or 4 external microphones, if the internal one is unsoldered. Such configuration – with four external microphones – is used, for example, in Marvelmind Jacket.

Be careful: You should have soldering skills to solder external microphone on board.



3.6.2.3. Dual Microphone Modification:

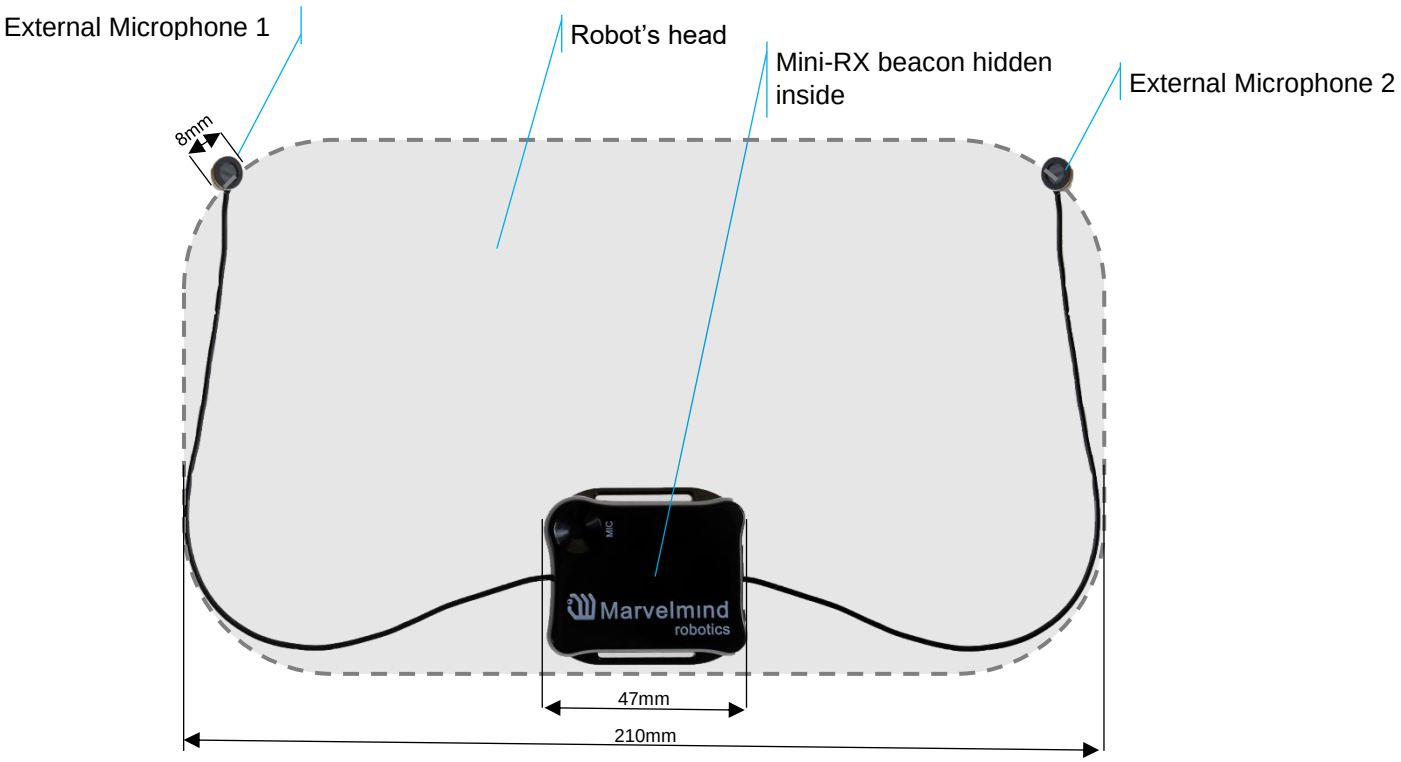


Figure 1: One external microphone with housing

Figure 2: Two external microphones with housing

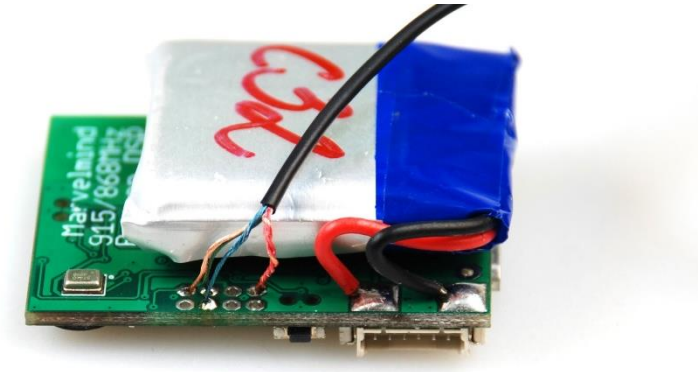


Figure 3: One external microphone soldering

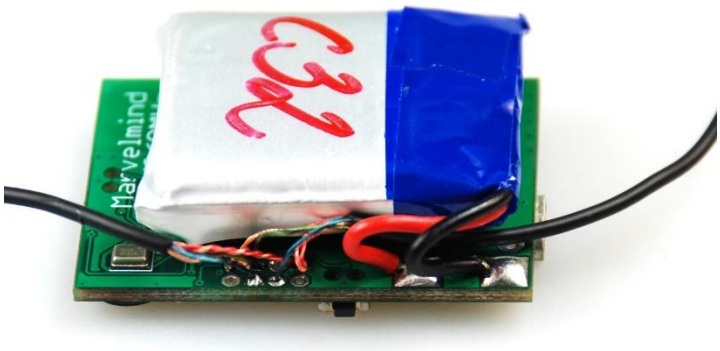


Figure 4: Two external microphones soldering

3.6.2.4. External Microphones Schemes:

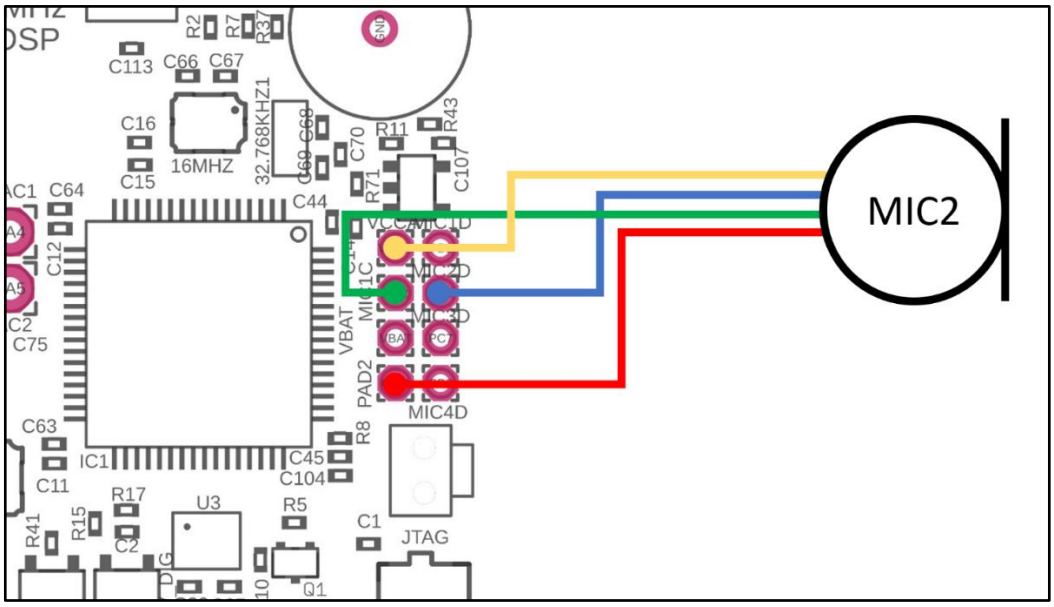


Figure 5: One External Microphone connection

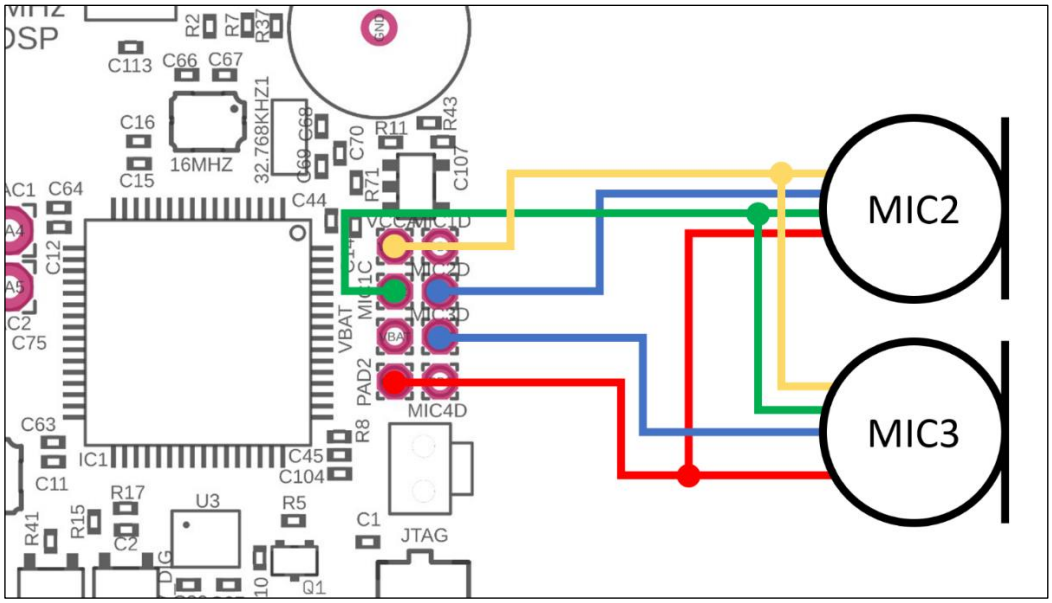


Figure 6: Two External Microphones connection

Figure 7: Two External Microphones final view

Figure 8: Two External Microphones Final View

3.6.3. Beacon Mini-TX

The Mini-TX is a TX-only beacon, i.e., it can transmit but cannot receive ultrasound.

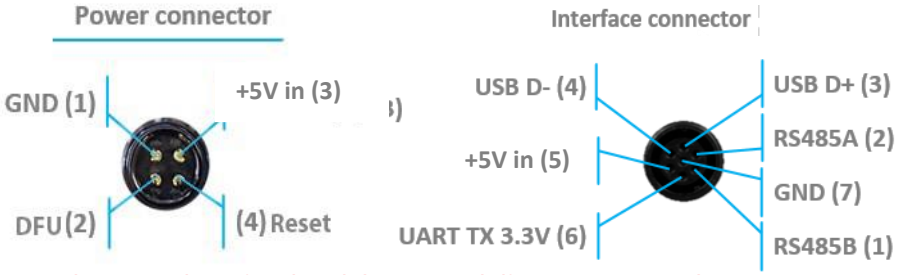
Comparison to Super-Beacon:

- Smaller size and lighter: 47x42x15mm & 25g vs. 55x55x33mm & 62g (or 55x55x64mm with antenna)
- TX only, i.e., Mini-TX can only transmit ultrasonic and cannot receive. Super-Beacon is dual use: it can receive and transmit ultrasonic
- Only has 31kHz version
- Battery – 250mAh vs. 1000mAh in a regular beacon. But Mini-TX has a new, more efficient ultrasonic TX module; thus, battery lifetime in TX mode is even superior to the Beacon HW v4.9
- Tested battery lifetime with 8Hz – 96h. With a lower update rate – nearly proportionally longer. Very efficient ultrasonic TX module
- Mini-TX has only USB (virtual UART) output – no additional pins. This doesn't refer to Mini-TX 2.
- Mini-TXs have embedded IMU – newer and better, it has a 3D accelerometer and 3D gyroscope, but no magnetometer (which we do not recommend using indoors anyway, due to magnetic field distortion)
- Embedded antenna – smaller size, but smaller radio coverage ~50m with regular Modem HW v5.1 as compared with ~100m of Super-Beacon with Modem HW v5.1
- Ultrasonic range is virtually on par with regular Super-Beacon – up to 30m with Super-Beacon as RX beacon. At the same time, for example, a combination of Mini-RX RX beacon + Mini-TX TX provides better coverage and a stronger signal than Super-Beacon + Super-Beacon
- This HW is for the 868/915MHz band only, i.e. 433MHz is not supported and not planned

3.6.4. Beacon Industrial-TX-Metal

Do not disassemble the Industrial beacons. Otherwise, the warranty will be lost

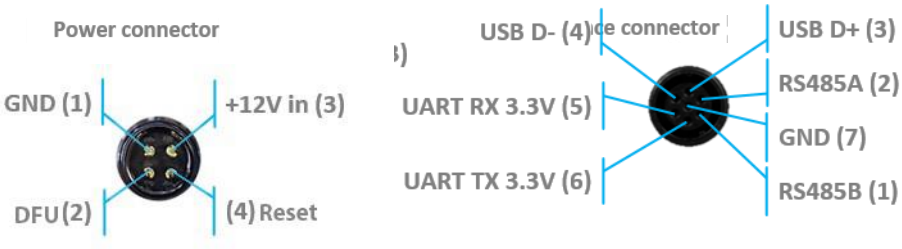
- TX-only beacon – can transmit ultrasonic, but can't receive it
- Electronics is IP67 protected
- Special IP67-protected 25kHz transducers
- External antenna with SMA connector for extended radio range
- Corresponding IP67 connectors (male part) included
- No battery inside
- Extended working temperature range from -40°C to +50°C (not tested, provided by design)
- Embedded reset switch and DFU switch – magnetic control
- Two IP67 external connectors:
- Modification (After June 2022) for versions 2 and 3



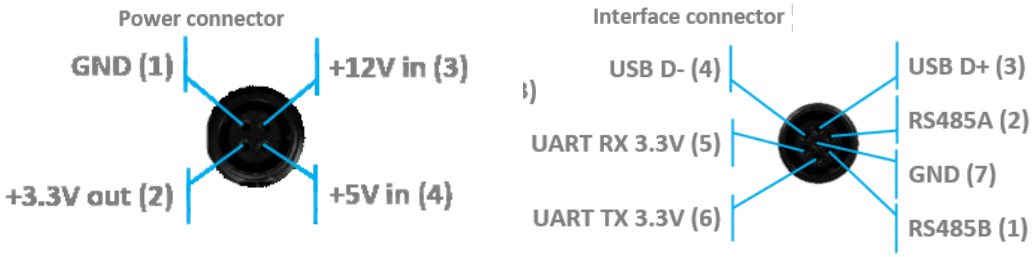
Version 2 and 3 of Industrial-TX-Metal (from June 2022) **support a +5V power supply ONLY**. Don't use a +12V power supply converter for this version, it will burn the beacon!

This version doesn't have UART RX, but it is now possible to use the Interface connector as a power supply.

- RS485 modification pinouts (After Sep.2019)

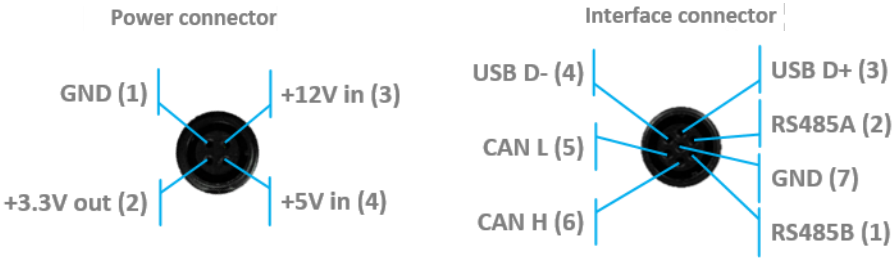


- RS485 modification pinouts (Before Sep.2019)

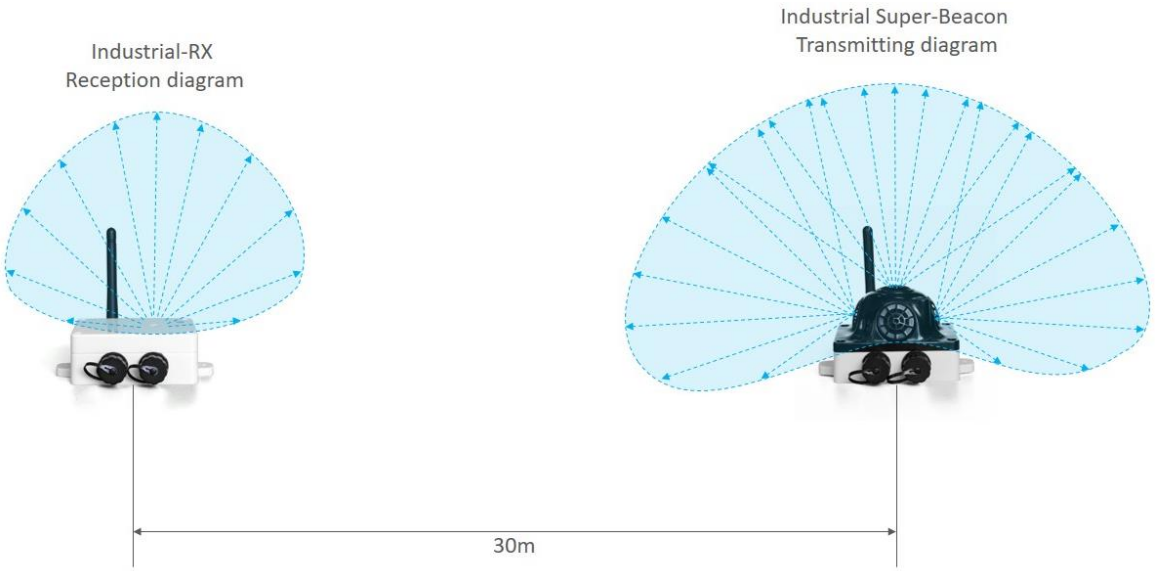


Marvelmind robotics

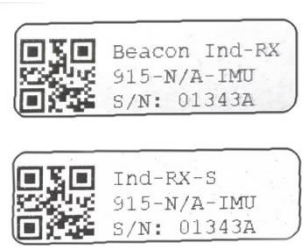
- CAN modification pinouts



- Can work with any Mini-RX beacon or Super-Beacon
- Most of all, designed to work together with Outdoor versions of Mini-RX beacons and heavy outdoor Industrial-TX and Industrial-RX beacons (radio bands must match)
- Up to 30m with Beacon Mini-RX
- Optional external Converter-220V-12V-IP67 **(except version from April 2022, it supports only +5V power supply)**
- Wide transmitting diagram



Determine carefully the version of your Industrial beacons: they may be built before September 2019 and after September 2019. If it is a beacon from the late batch, you must use Industrial Super-beacon SW. If you have beacons from the early batch, use Industrial-RX or Industrial-TX SW. Stickers' differences: Later batch — Ind-RX-S or Ind-TX-S. Early batch – Beacon Ind-RX or Beacon Ind-TX.



Versions 2 and 3 of Industrial-TX-Metal (from June 2022) support ONLY +5V power supply. Don't use a +12V power supply converter for this version, it will burn the beacon!

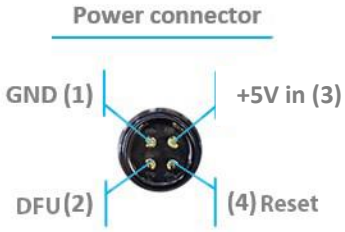
This version doesn't have UART RX, but it is now possible to use the Interface connector as a power supply.

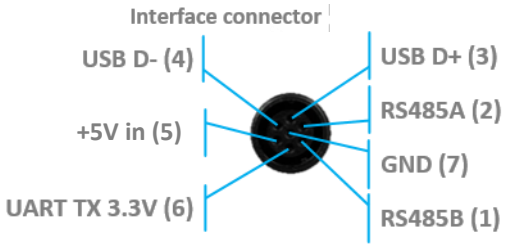
3.6.5. Beacon Industrial-RX

Do not disassemble the Industrial beacons. Otherwise, the warranty will be lost.

- RX-only beacon – can receive ultrasonic, but can't transmit it
- Electronics is IP67 protected
- Special IP67 membrane for ultrasonic sensor
- External antenna with SMA connector for extended radio range
- Corresponding IP67 connectors (male part) included

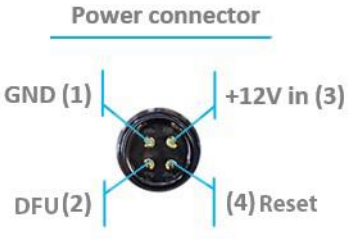
- No battery inside by default – external power bank or external power supply (+12V or +5V). But an optional variant with an internal battery is possible **(except the version from April 2022, which supports only a +5V power supply)**
- Two IP67 external connectors:
- Modification (After April 2022)

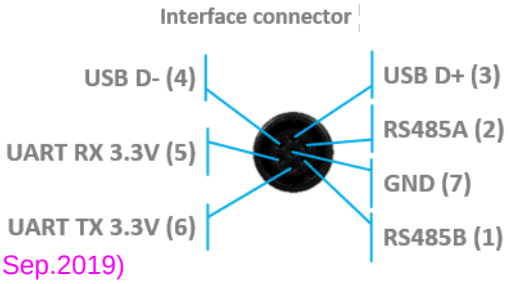




Version 3 of Industrial RX (from April 2022) **supports ONLY a +5V power supply. Don't use a +12V power supply converter for this version;** it will burn the beacon!

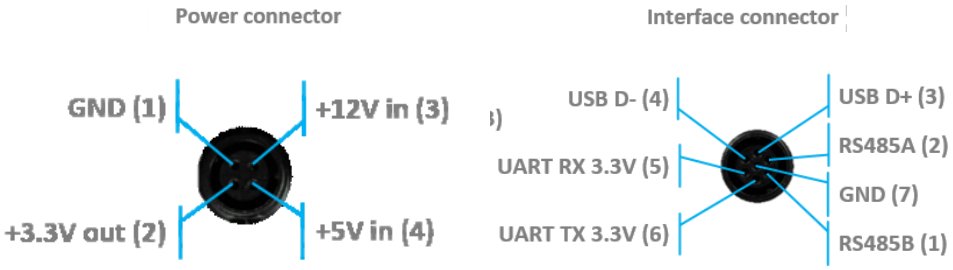
This version doesn't have UART RX, but it is now possible to use the Interface connector as a power supply.





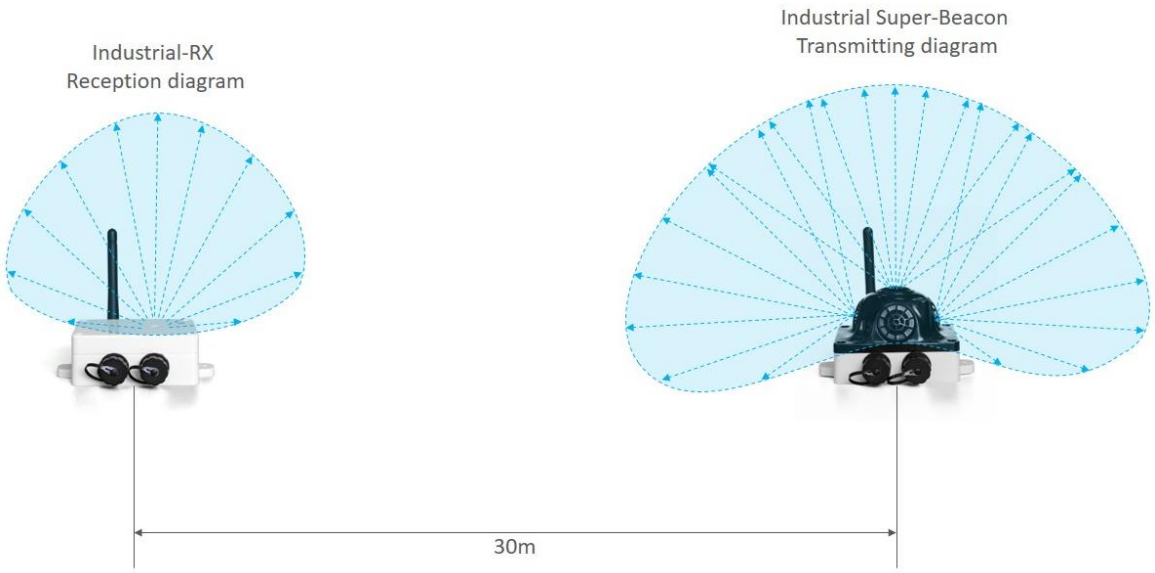
- RS485 modification pinouts (After Sep.2019)

- RS485 modification pinouts (Before Sep.2019)



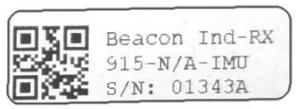
- CAN modification pinouts

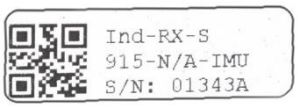
- Extended working temperature range from -40°C to +50°C (not tested, provided by design) – only for the version without battery
- Embedded reset switch and DFU switch – magnetic control
- Supports a wide range of ultrasonic frequencies: 19/22/25/28/31/34/37/45kHz
- Most of all, designed to work together with Outdoor versions of Mini-RX beacons and heavy outdoor Industrial-TX and Industrial-RX beacons (radio bands must match)
- Optional external Converter-220V-12V-IP67 **(except version from April 2022, it supports only +5V power supply)**
- Optional external Converter-AC-5V-IP67 for versions 2 and 3
- Wide reception diagram



Uploading Beacon's Industrial-RX or Beacon's Industrial-TX SW to Industrial Super-beacon may permanently damage the Industrial Super-beacon board.

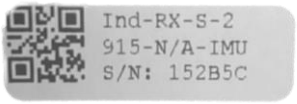
Determine carefully the version of your Industrial beacons: they may be built before September 2019 and after September 2019. If it is a beacon from the late batch, you must use Industrial Super-beacon SW. If you have beacons from the early batch, use Industrial-RX or Industrial-TX SW. Stickers' differences: Later batch — Ind-RX-S or Ind-TX-S. Early batch – Beacon Ind-RX or Beacon Ind-TX.

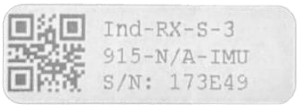




Versions 2 and 3 of Industrial-TX-Metal (from June 2022) support ONLY +5V power supply. Don't use a +12V power supply converter for this version; it will burn the beacon!

This version doesn't have UART RX, but it is now possible to use the Interface connector as a power supply.



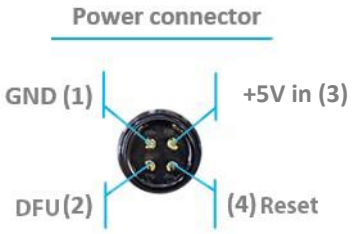


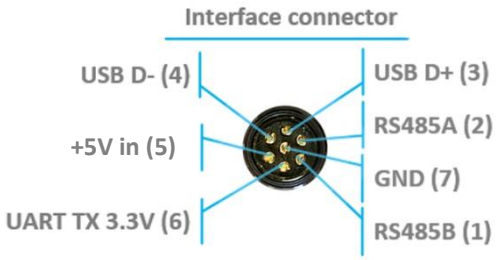
3.6.6. Industrial Super-Beacon Metal-25kHz

Do not disassemble the Industrial beacons. Otherwise, the warranty will be lost.

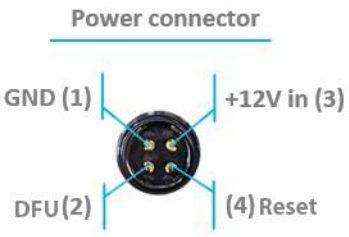
- Supports dual-use – RX and TX beacon. It can transmit on its native ultrasonic frequency (25kHz) and receive on any ultrasonic frequency via an embedded RX sensor – like Industrial-RX or Mini-RX does. Effectively, the Industrial Super-Beacons combine inside an Industrial-TX and Industrial-RX. Additionally, the beacon supports both AI and NIA architectures. Thus, it is called Industrial Super-Beacon

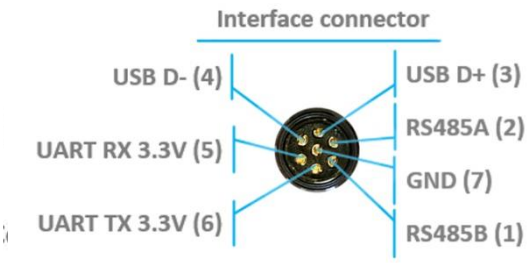
- Electronics is IP67 protected
- Special IP67-protected 25-kHz transducers
- External antenna with SMA connector for extended radio range
- Corresponding IP67 connectors (male part) included
- No battery inside
- Extended working temperature range from -40°C to +50°C (not tested, provided by design)
- Embedded reset switch and DFU switch – magnetic control
- Two IP67 external connectors:
- Modification (After April 2022)





- Version 3 of Industrial RX (from April 2022) **supports ONLY +5V power supply**. Don't use +12V power supply converter for this version, it will burn the beacon!
- This version doesn't have UART RX, but now is possible to use Interface connector as a power supply.
  - RS485 modification pinouts





- Can work together with modems with corresponding radio (radio bands must match)
- Can work with any Mini-RX beacon or Super-Beacon

- Most of all designed to work together with Outdoor versions of Mini-RX beacons and heavy outdoor Industrial-TX and Industrial-RX beacons (radio bands must match)
- Up to 30m with Beacon Mini-RX
- Optional external Converter-220V-12V-IP67 **(except version from April 2022, it supports only +5V power supply)**

Uploading Beacon Industrial's (Not super) DFU software to Industrial Super-Beacon hardware make permanently damage for Industrial Super-Beacon board. Be double attentive with update

Version 2 and 3 of Industrial-TX-Metal (from June 2022) **supports ONLY +5V power supply**. Don't use +12V power supply converter for this version, it will burn the beacon!

This version doesn't have UART RX, but now is possible to use Interface connector as a power supply.

3.6.7. Beacon HW v4.9 (Superseded by the Super-Beacon)

Beacon HW v4.9 can be used in both the Non-Inverse Architecture (NIA) and in the Inverse Architecture (IA): NIA and IA comparison

Reception diagram. Each sensor has about 90° reception angle:

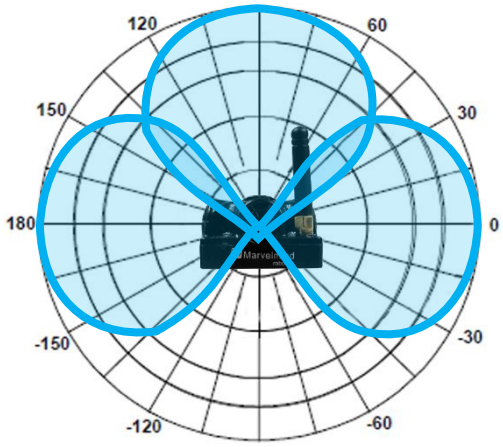


Figure 1: Transmitting diagram (with sensors)

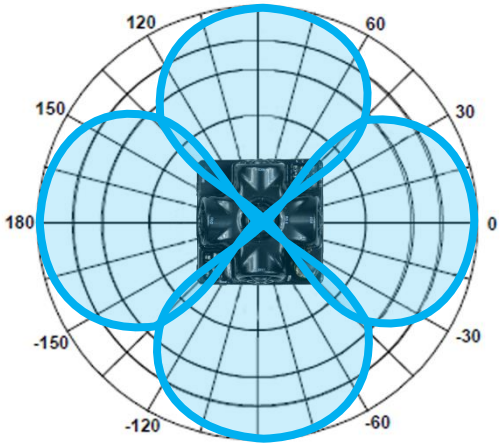


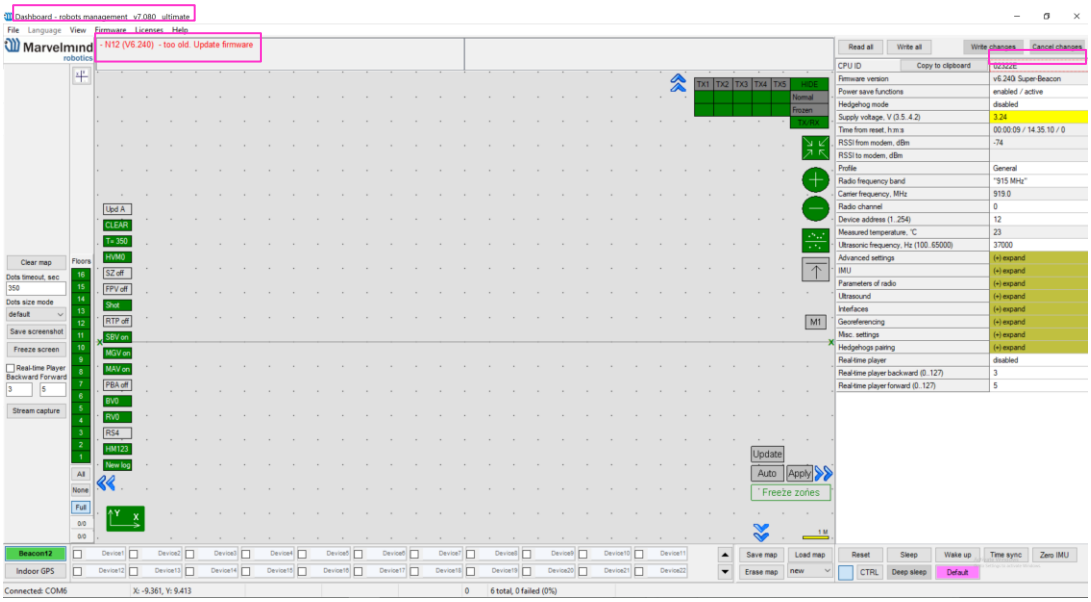
Figure 2: Transmitting diagram (with sensors)

4. Software Pack

In this chapter you can find out how to use our SW pack.

Always remember:

- All devices must be flashed from the same SW Pack
- Don’t look at the dates in the name of the file, they can be different, pay attention only to the name of the device.
- If the device was flashed with an older firmware version than Dashboard, this will be displayed in the diagnostic message window:



Changes in files in the Marvelmind SW pack (from SW version 7.200):

The SW files for beacons/modems that don’t require an update with the new release won’t be replaced with the latest files in the new SW pack. However, the Dashboard will assign them the new version number based on the newly introduced SW version compatibility table. Thus, the files physically remain the same. Still, if they are compatible with the latest SW pack, the Dashboard will automatically substitute their older SW version number with the latest SW version number.

It is done to detect and avoid the most common mistake by users—an attempt to run incompatible SW versions of beacons, modems, or Dashboards obtained from different SW packs, i.e., not updating the beacons/modems to the latest SW version from the same SW pack upon getting the equipment from Marvelmind Robotics.

Changes in the naming of SW versions and licenses (from SW version 7.200):

Optional SW features brought by MMSW0005 are now marked with an L at the end of the release name. For example, v7.200 – only base SW features are enabled – by default. Purchasing the MMSW0005 license activates optional features, and the SW version changes to v7.200L

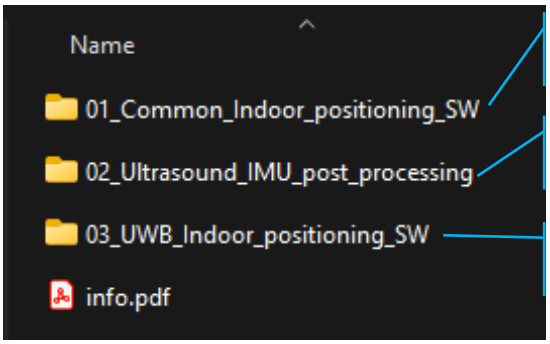
Naming example IA vs. NIA: v7.200 and v7.200L – SW for NIA and MF NIA, v7.200i and v7.200Li – SW for IA

If some beacons/modems don’t have the MMSW0005 license, their addresses are listed in the upper part of the Dashboard – information window.

4.1. Download and Open

4.1.1. Go to our website https://marvelmind.com/ => https://marvelmind.com/download/ and download the latest Marvelmind SW pack

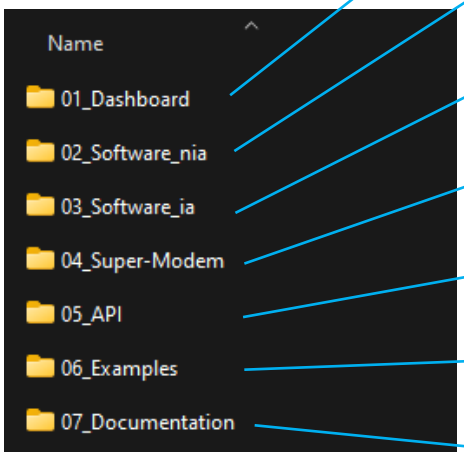
4.1.2. Unzip the pack and open a folder



Folder with software for a modem and beacons for IA and NIA

Folder with software for a modem and beacons for IA and NIA (MMSW0009 license)

Folder with software for a modem and beacons for UWB system



Folder with Dashboard software

Folder with software for a modem and beacons for non-inverse architecture (NIA)

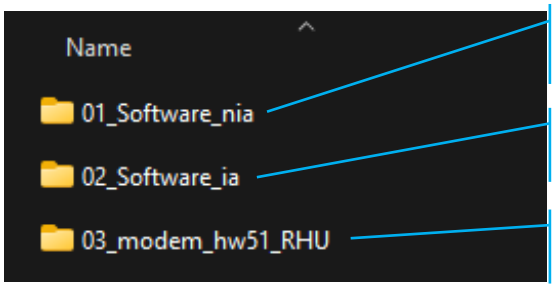
Folder with software for a modem and beacons for inverse architecture (IA)

Folder with software for a Super-Modem (same software for both NIA and IA).

Folder with Marvelmind API library and C example

Folder with misc. sample code

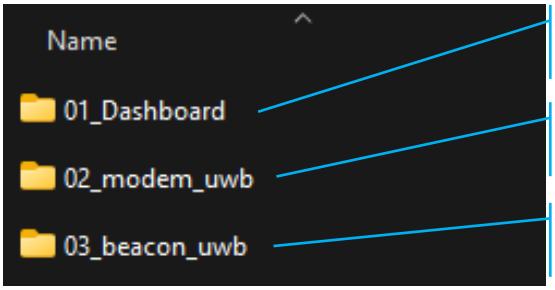
Folder with documentation



Folder with software for beacons for non-inverse architecture (NIA)

Folder with software for beacons for inverse architecture (IA)

Folder with software for an RHU Modem (same software for both NIA and IA).



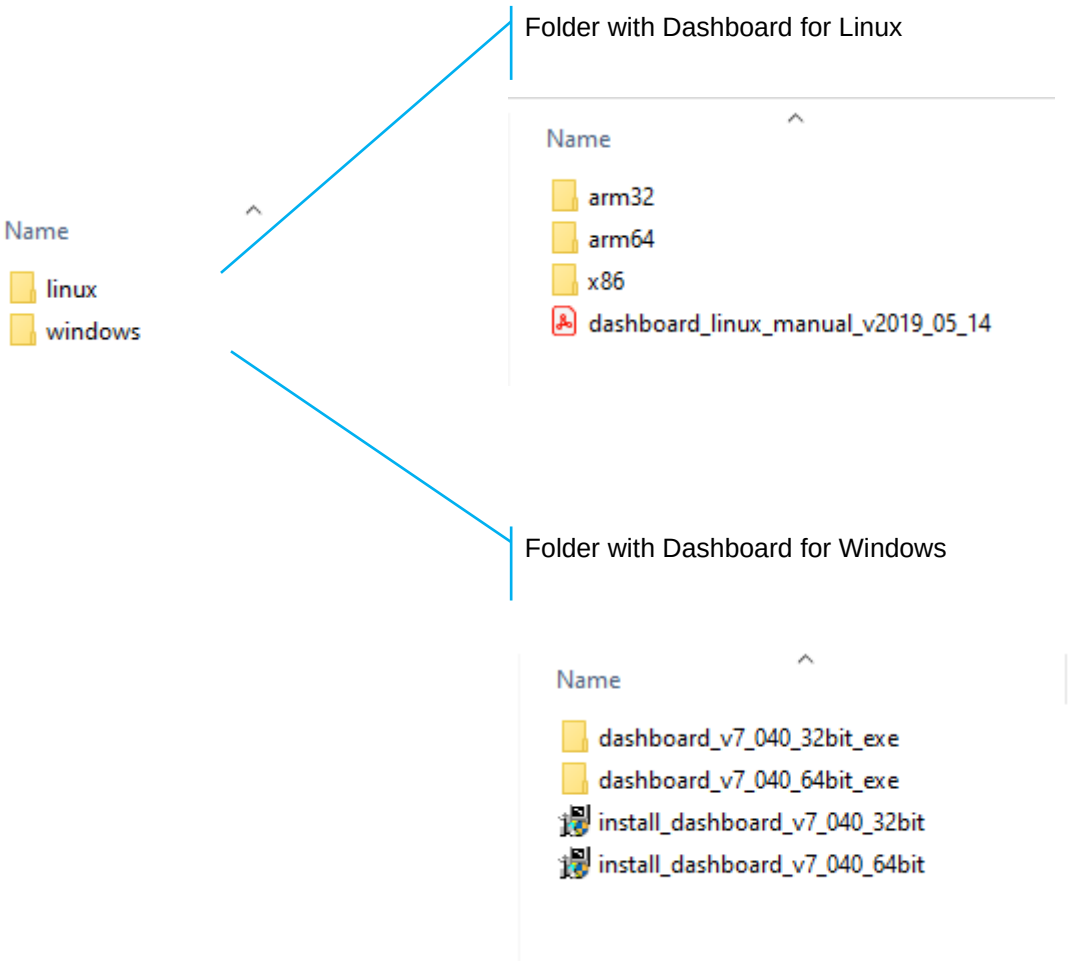
Folder with Dashboard

Folder with software for a modem for UWB

Folder with software for a beacon for UWB

4.2. Dashboard Folder

In this folder you can find all modifications of Dashboard.

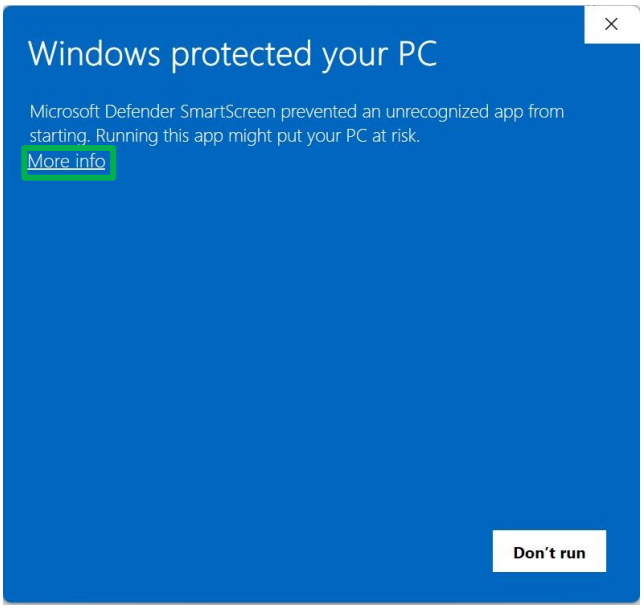


4.2.1. “Windows Protected Your PC” Error

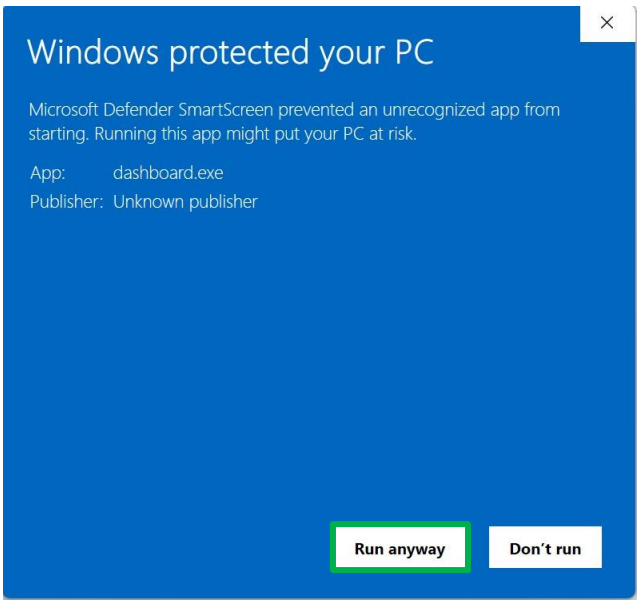
Sometimes, the new SW is uploaded before the certification for Marvelmind is received. In this case, Windows can prompt you with a warning window.

Here are the instructions on what to do:

1. Click “More info”



2. Click “Run anyway”

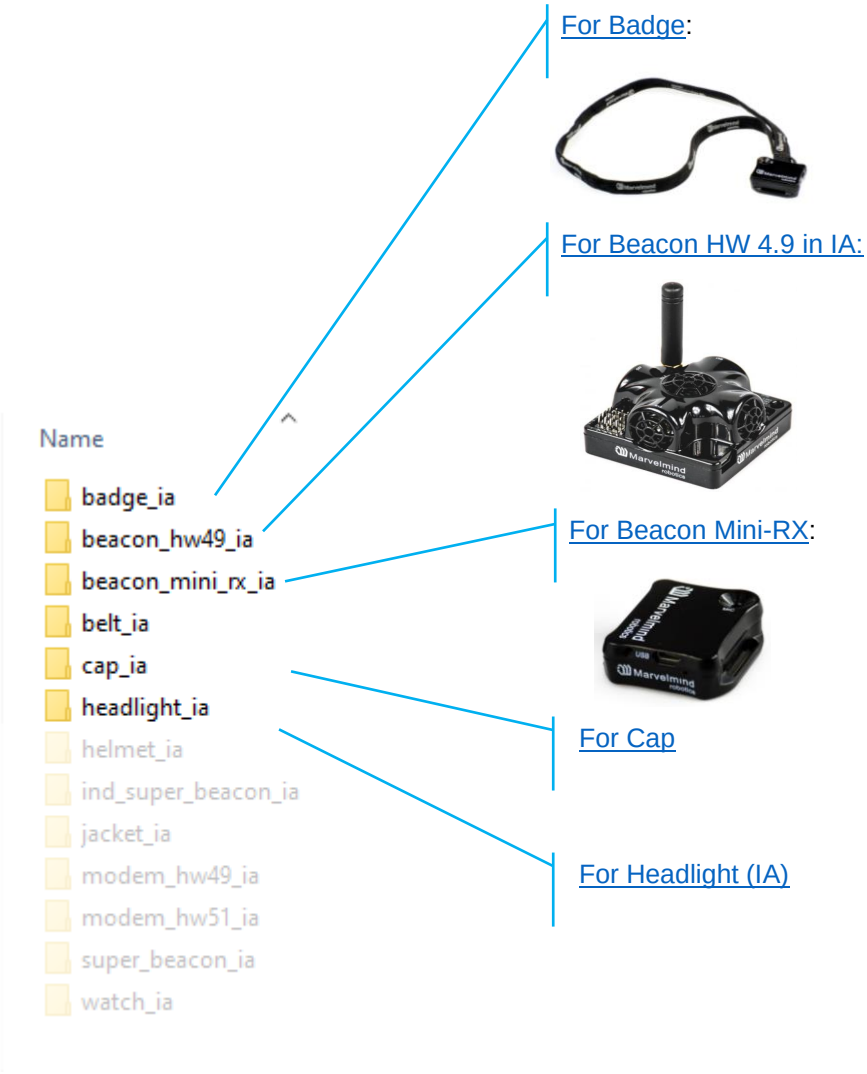


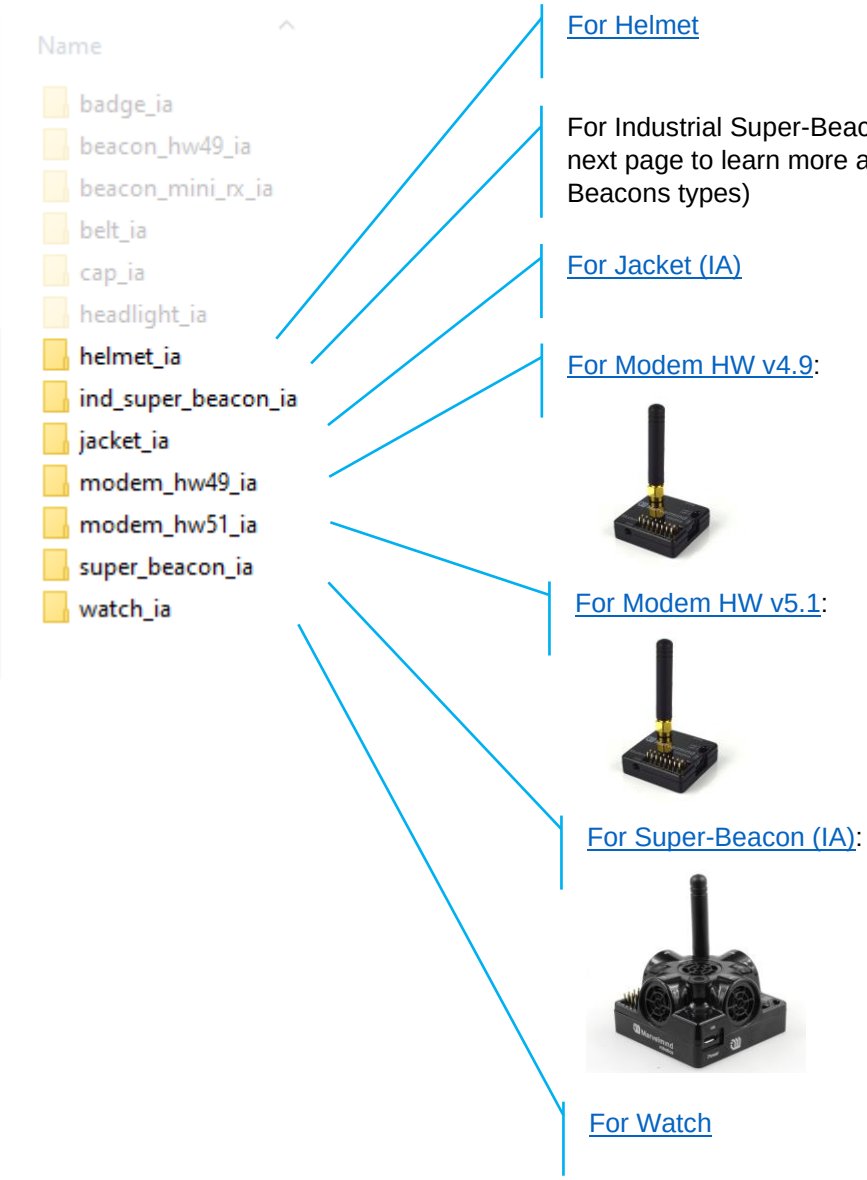
No worries about this window. All versions of Dashboards are tested and checked before publishing SW pack, but certification is not received yet. This sometimes happens and we fix it as soon as possible.

4.3. Software IA Folder

In this folder you can find all software to flash devices to build a map in Inverse Architecture. Use this folder to flash sets:

1) Starter Set IA-04-2D-Badge
2) Starter Set Super-MP-3D in Inverse Architecture




Name
badge_ia
beacon_hw49_ia
beacon_mini_rx_ia
belt_ia
cap_ia
headlight_ia
helmet_ia
ind_super_beacon_ia
jacket_ia
modem_hw49_ia
modem_hw51_ia
super_beacon_ia
watch_ia
For Helmet
For Industrial Super-Beacons* (watch the next page to learn more about Industrial-Beacons types)
For Jacket (IA)
For Modem HW v4.9:
For Modem HW v5.1:
For Super-Beacon (IA):
For Watch

4.3.1. Types of Industrial-Super-Beacons:

1) Beacon Industrial-RX:

2) Industrial Super-Beacon Metal-25kHz:

3) Industrial Super-Beacon-Plastic:

4.4. Software NIA Folder

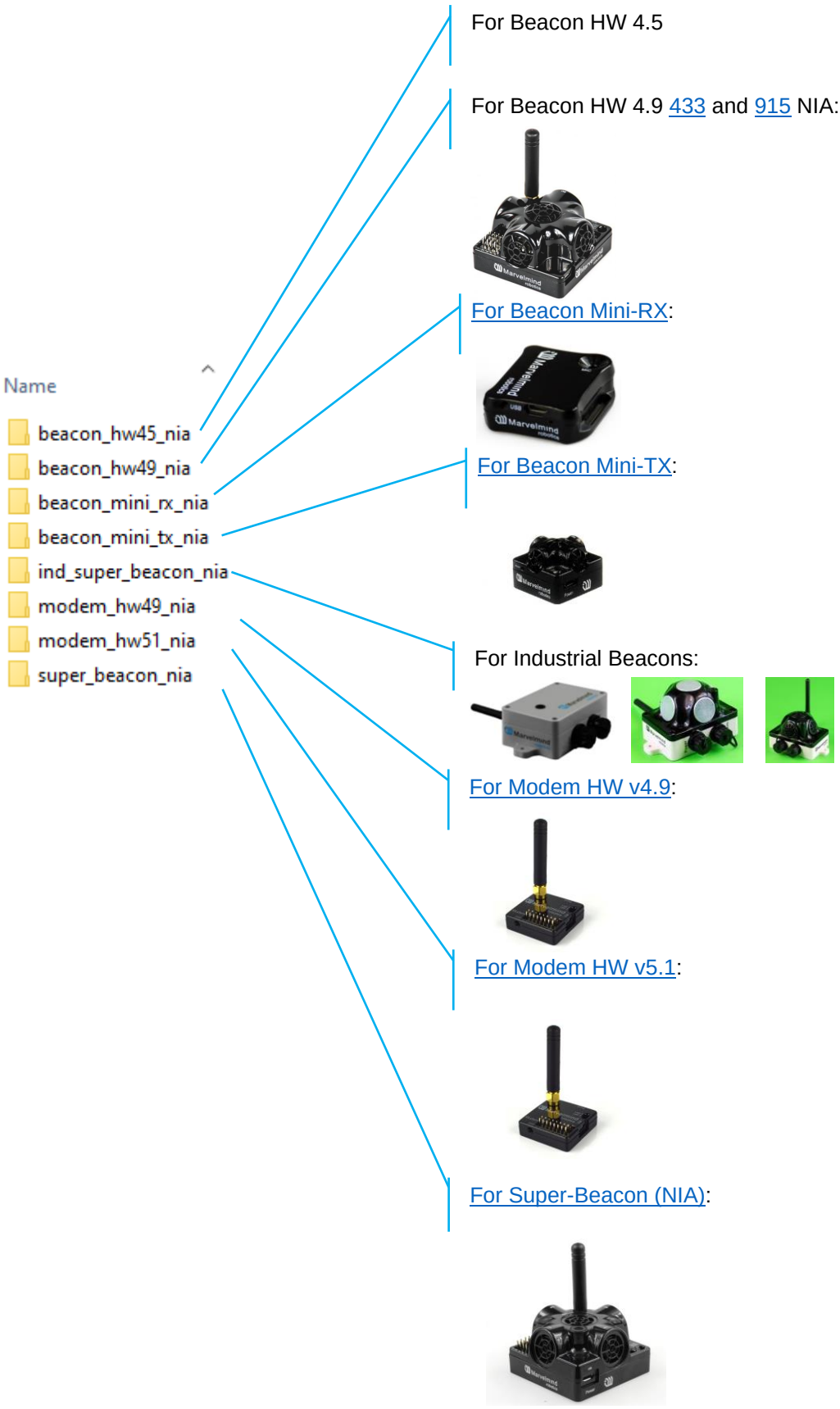
In this folder you can find all software to flash devices to build a map in Non-Inverse Architecture. Use this folder to flash sets:

1) Starter Set HW v4.9-NIA:

2) Starter Set NIA-SmallDrone:

3) Starter Set Industrial-NIA-01:

4) Starter Set Super-MP-3D in NIA:


Name
beacon_hw45_nia
beacon_hw49_nia
beacon_mini_rx_nia
beacon_mini_tx_nia
ind_super_beacon_nia
modem_hw49_nia
modem_hw51_nia
super_beacon_nia
For Beacon HW 4.5
For Beacon HW 4.9 433 and 915 NIA:
For Beacon Mini-RX:
For Beacon Mini-TX:
For Industrial Beacons:
For Modem HW v4.9:
For Modem HW v5.1:
For Super-Beacon (NIA):

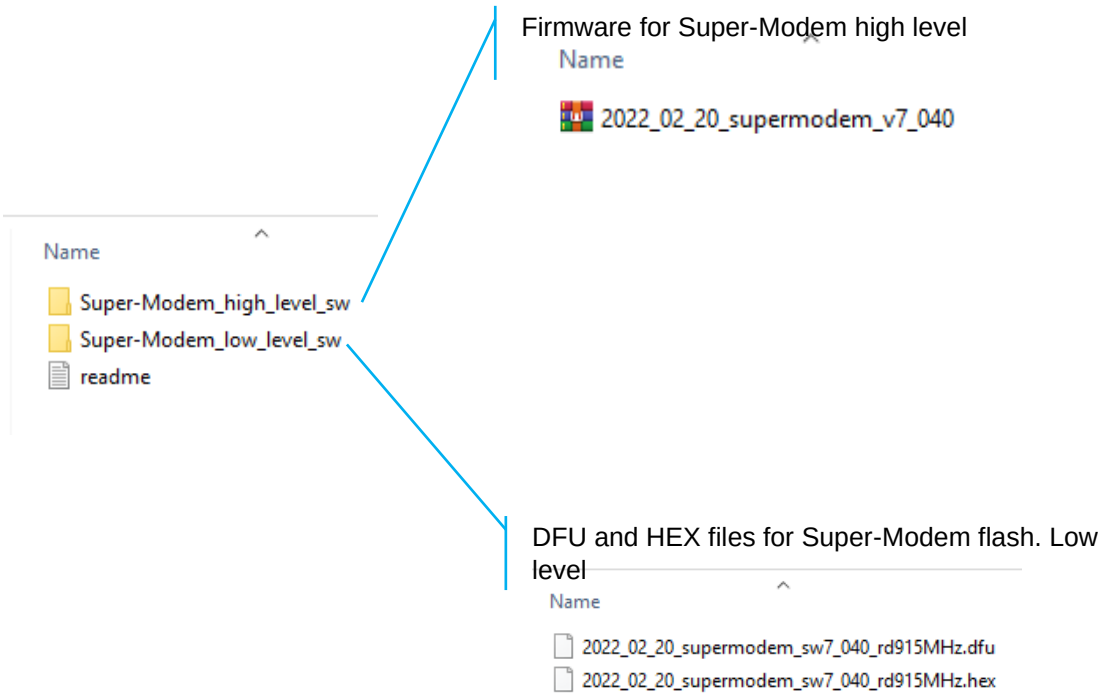
4.5. Super-Modem Folder

Folder with Super-Modem software (same software for both NIA and IA).

Warning! If your current Super-Modem software version is less than 7.000, you need to reflash the micro-SD card inside the Super-Modem for an update. The Super-Modem micro-SD card image is supplied in a separate archive because it is large.

After SW release v7.040, you can flash Super-Modem via Dashboard. Flash both levels – high and low.

Please refer to the downloads page and download SW for Super-Modem



Marvelmind robotics

5. SW Settings Descriptions

5.1. Super-Modem's SW Update and Configuration Description

5.1.1. Super-Modem's SW Update

Do not disassemble the Super-Modem before you check the SW version installed. First, check if the SW version of your Super-Modem is up to date (the latest version is on the Marvelmind Downloads page). If not, update the software as described below.

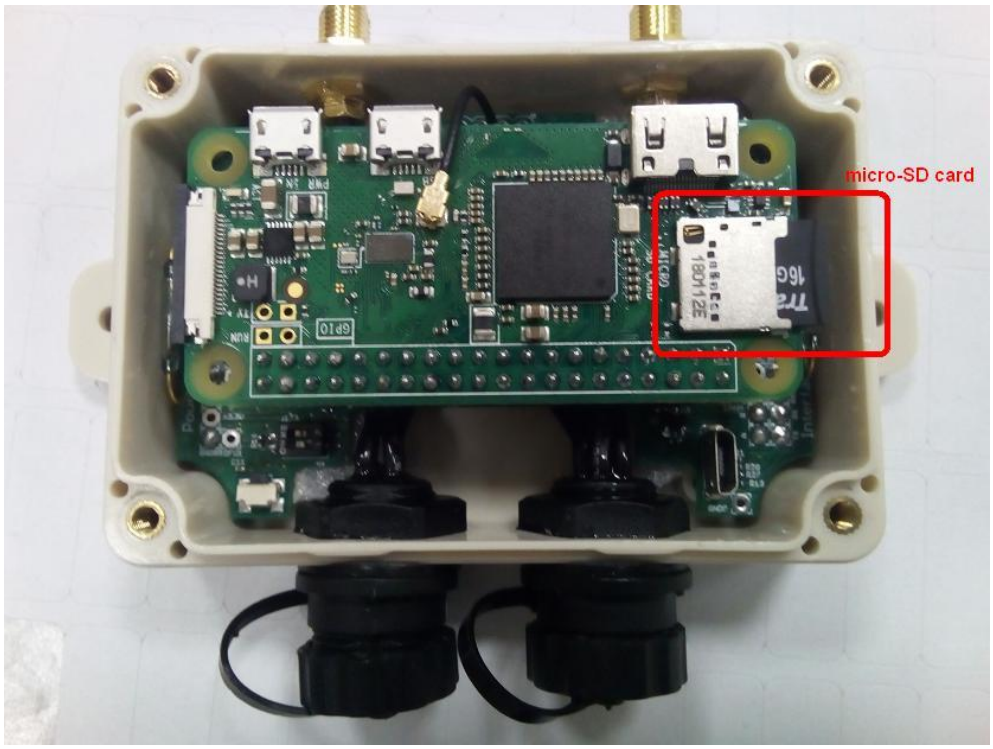
Marvelmind Super-Modem software consists of two parts:

- Low-level firmware
- High-level software for integrated Raspberry Pi single-board computer

Low-level firmware is included in the general software package with all Marvelmind software in the 'Super-Modem' folder. Like other firmware in the package, this firmware can be updated via Dashboard (hex file) or via DFU (pdf file). Please refer to the Operating Manual for details on updating software via Dashboard or DFU.

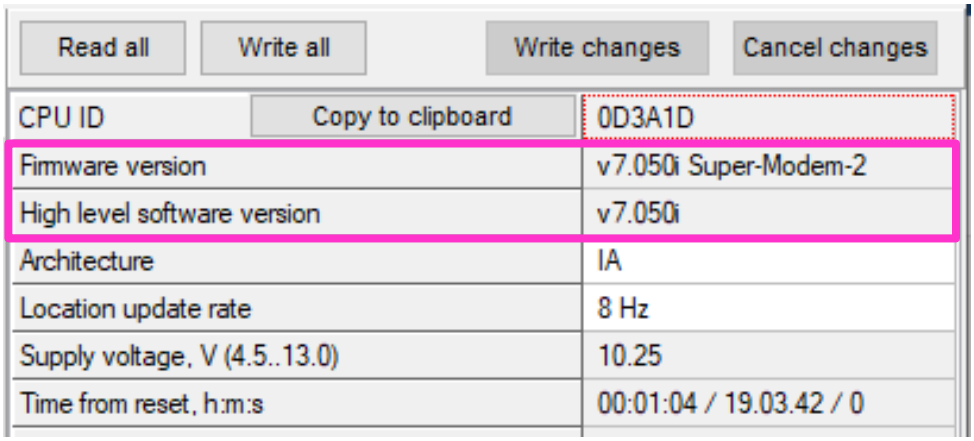
High-level software is located on a microSD card inserted in the Raspberry Pi single-board computer inside a Super-Modem. To update this software, you should write the image of the microSD card with updated software on it. You can download the image on the Downloads page. The image is placed in an archive separately from the general software package because it is large (about 1.5 - 2 GB).

Micro-SD card location

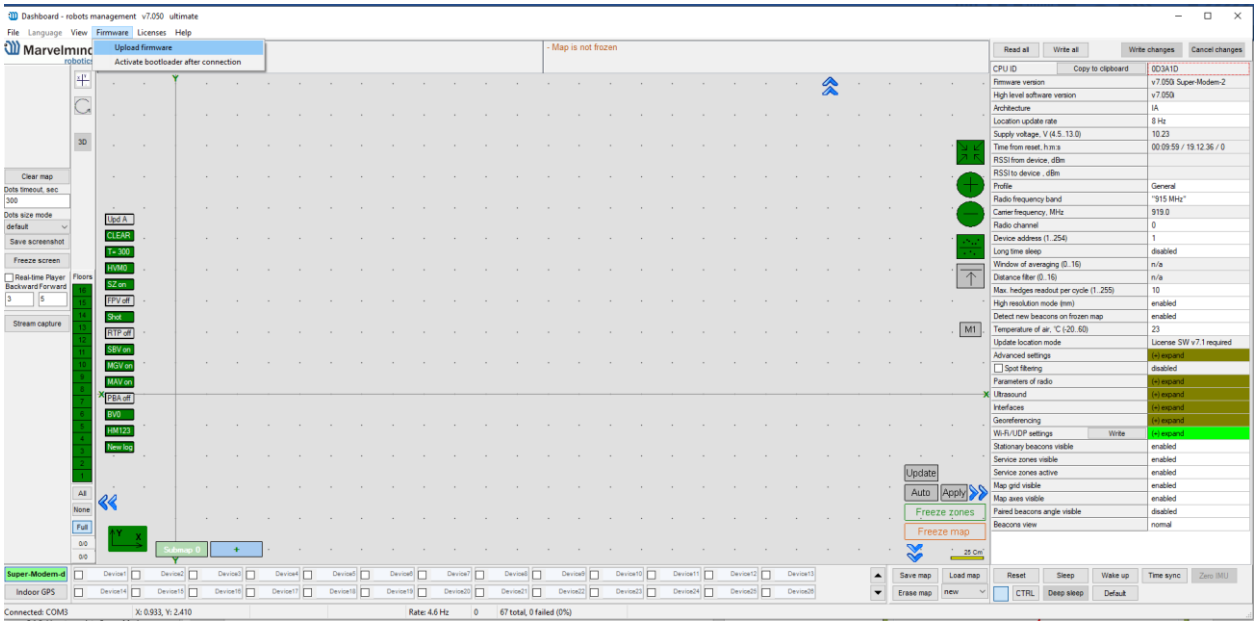


5.1.2. How to Update Super-Modem (for SW Version from v7.000)

In the latest versions of SW, it's possible to flash Super-Modem without dissembling.



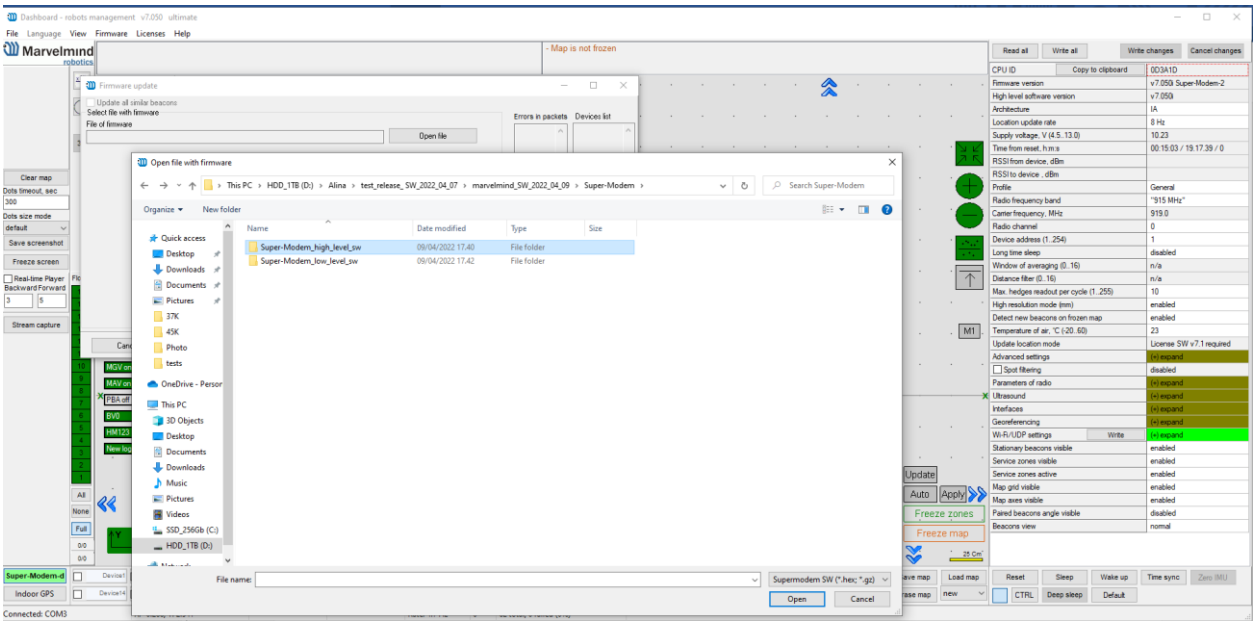
5.1.2.1. Connect the power supply to the Super-Modem and connect the Super-Modem to the PC via USB. Wait for 1 minute till it appears in Dashboard



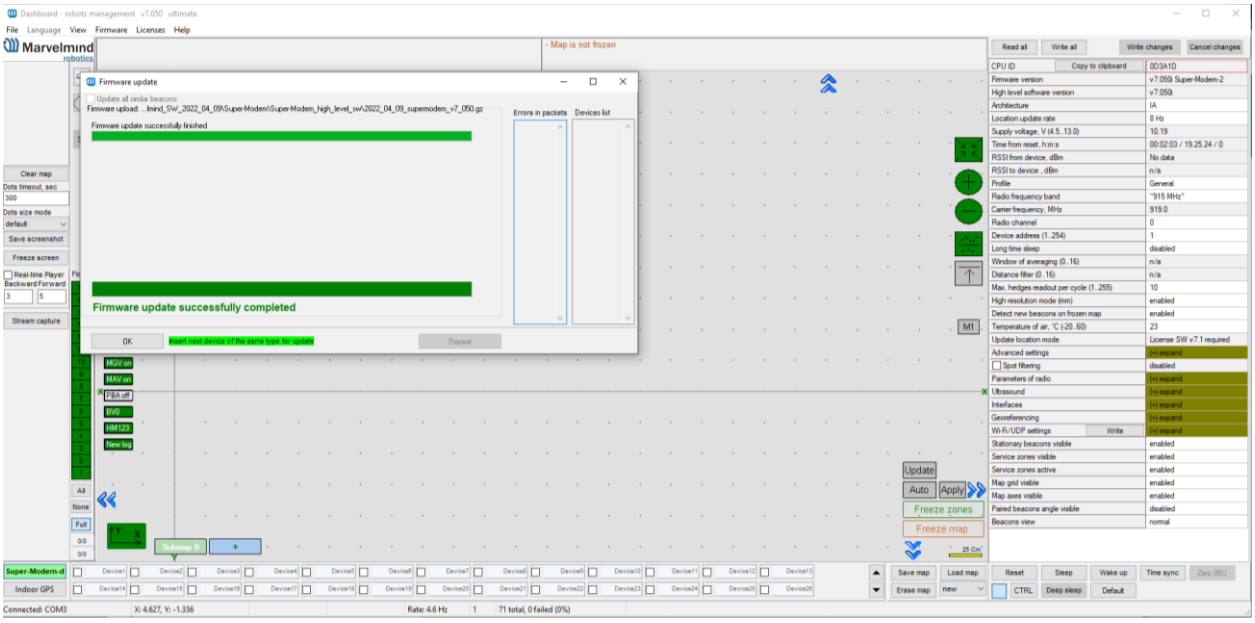
5.1.2.2. There are two Firmware versions: low–level (Firmware version) and high-level (high-level software version). Both should be flashed from the same pack.

5.1.2.3. Go to Firmware => Upload firmware

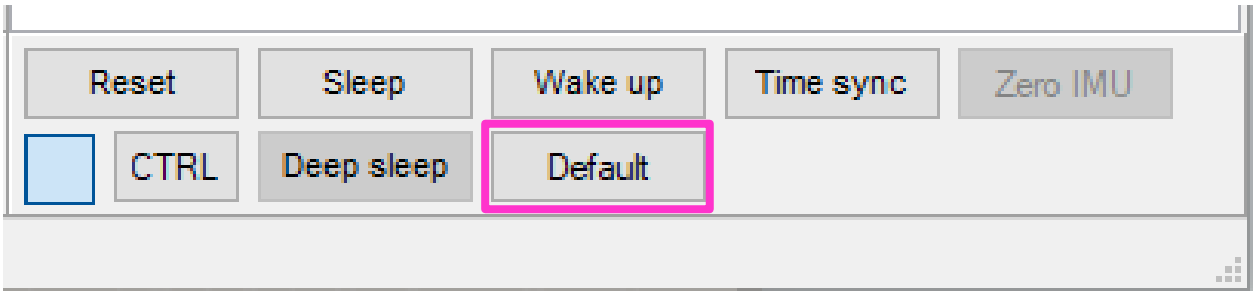
5.1.2.4. Update high-level SW (from folder Super-Modem_high_level SW)



5.1.2.5. When high-level flashing is done, use the file from folder Super-Modem_low_level_SW



5.1.2.6. Press the Default button after flashing both levels.



5.1.2.7. Firmware update completed.

5.1.3. How to Update Super-Modem's SW (for SW Version Older than v7.000):

Do not disassemble the Super-Modem before you check the SW version installed. First, check if the SW version of your Super-Modem is up to date (The latest version is on the Downloads page). If not – update the software as described below.

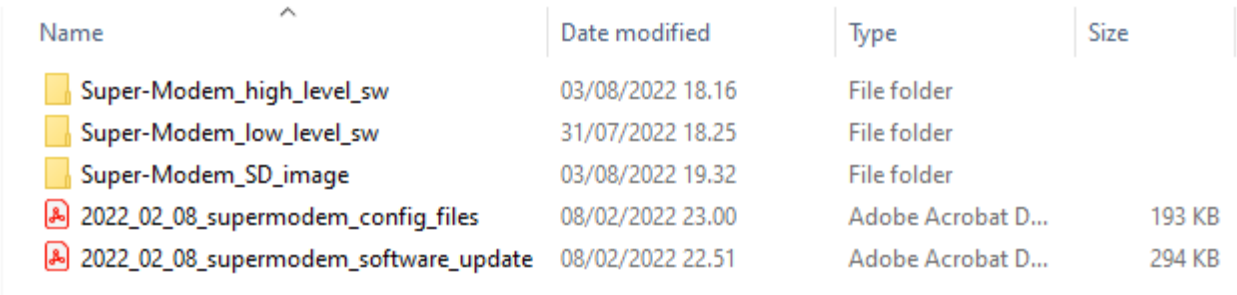
Follow the steps below to update Super-Modem's SW.

5.1.3.1. Open Super-Modem enclosure

5.1.3.2. Eject the micro-SD card (Super-Modem should not be powered at this time)

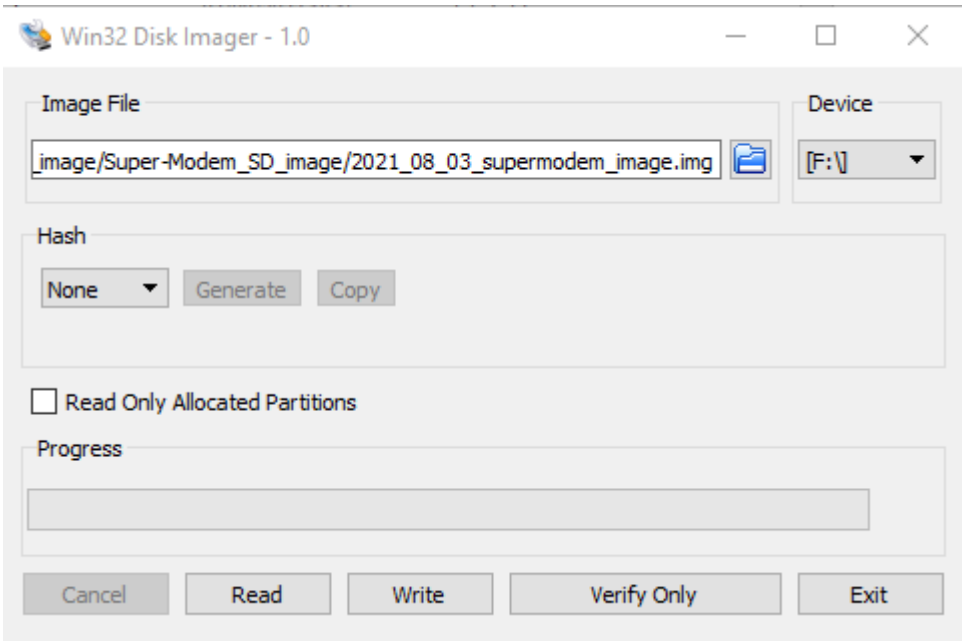
5.1.3.3. Insert micro-SD card into any MS Windows computer via card reader

5.1.3.4. Download and unpack the archive with the image of updated software



5.1.3.5. Install and run the Win32 disk imager program (supplied in the archive with the image)

5.1.3.6. Open the image file and write to the micro-SD card (see screenshot below)

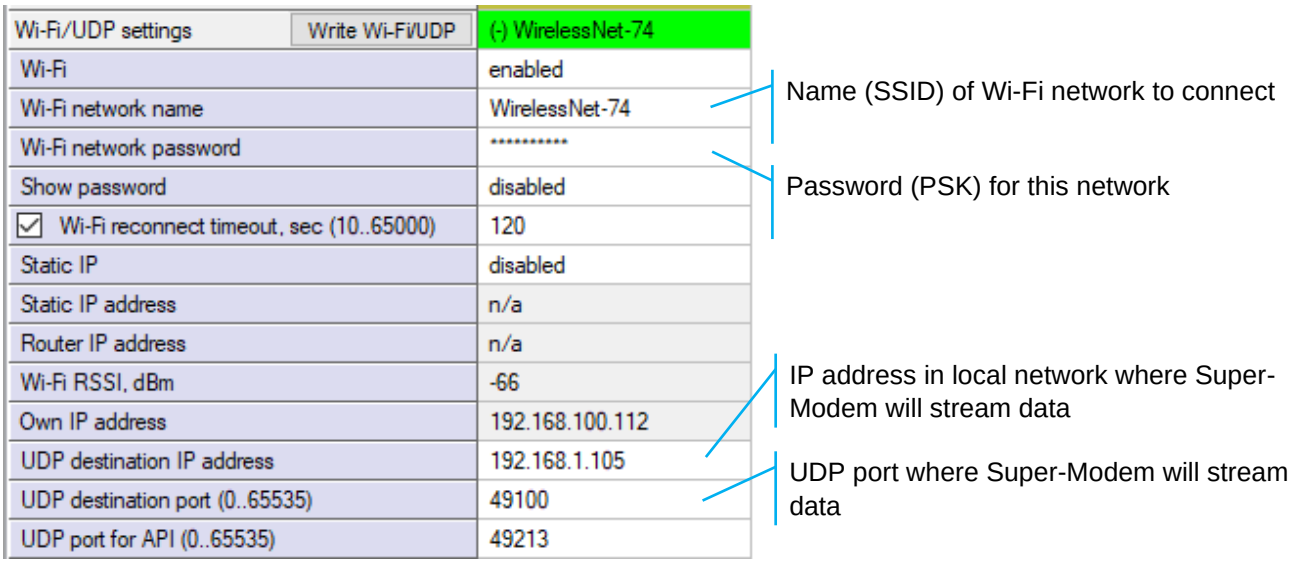


5.1.3.7. Eject the micro-SD card from the computer and insert it back into Super-Modem

5.1.3.8. Close Super-Modem enclosure

5.1.4. Super-Modem's Configuration

Marvelmind Super-Modem contains a Raspberry Pi single-board computer with corresponding software. Settings can be modified via the configuration menu in the Dashboard.



If you need more information about API streaming here.

5.2. SW Update (USB/Radio/DFU)

This chapter describes three general ways of updating SW: regular, using a USB or Radio connection, and SW update for special cases (if the SW version gap is very big or regular SW updates do not work): DFU Programming.

5.2.1. SW Update via USB

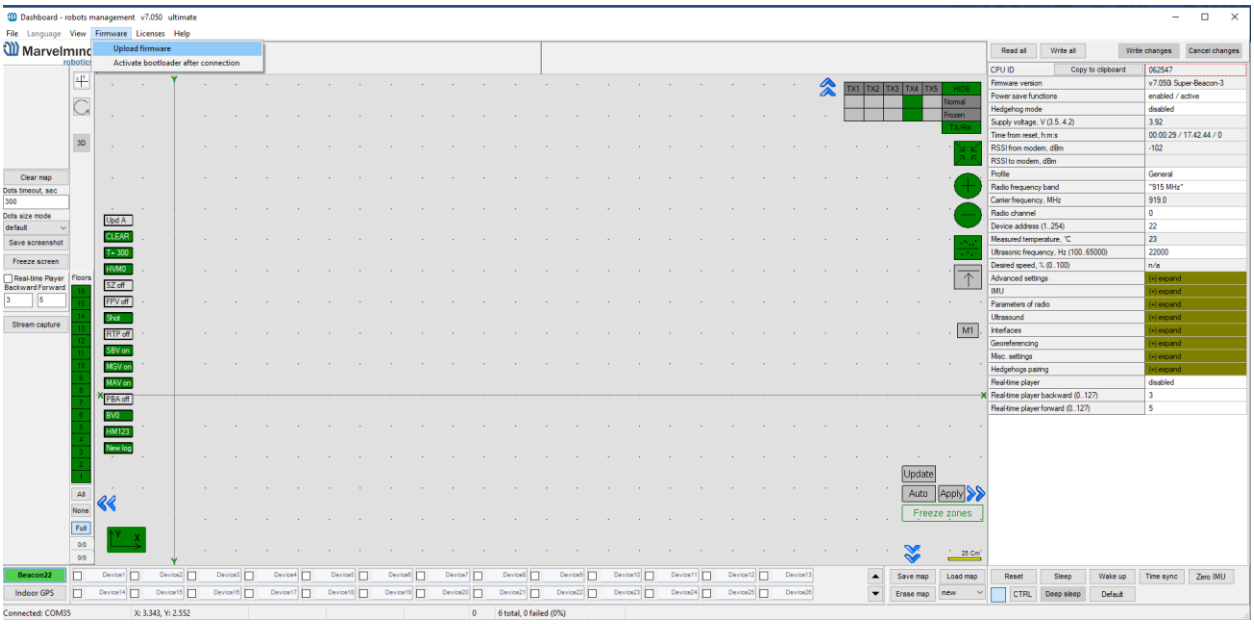
Usually, the SW update via USB is used the first time the system is started up. It allows you to update to the actual SW version very quickly before the system deployment.

Pros: Quick SW update per beacon.

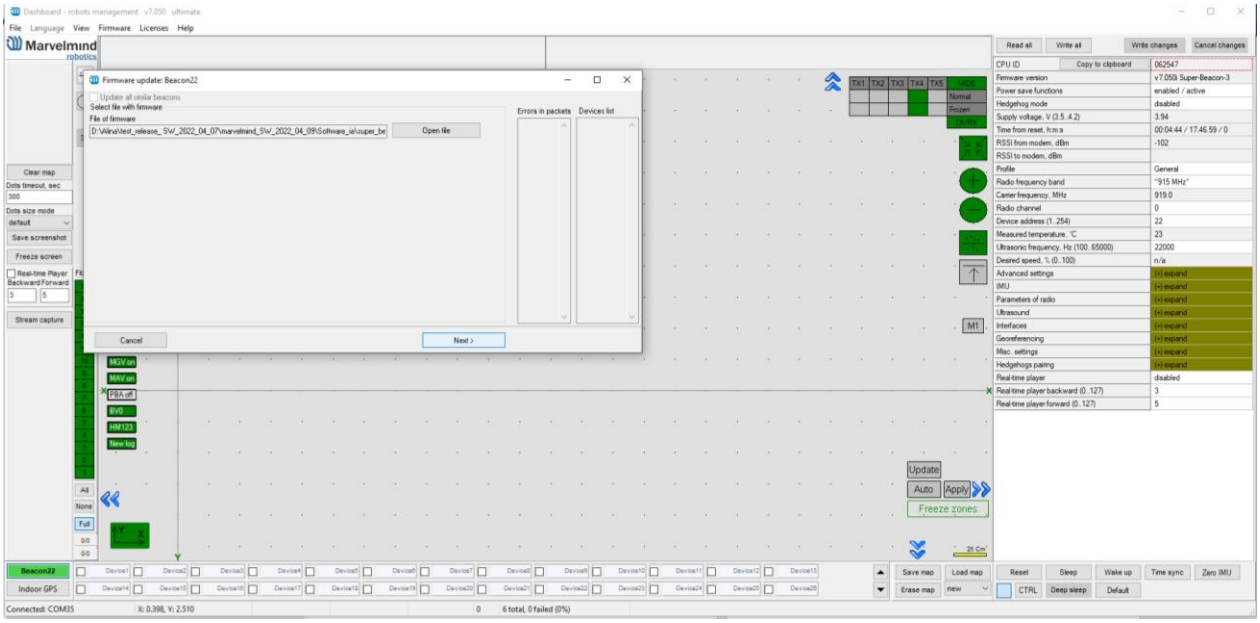
Cons: All the devices should be connected to the PC via a USB cable. If you already deployed the system, you would need to unmount it.

How to:

- Launch the Dashboard
- Make sure that the beacon is on
- Connect the beacon to your PC via a USB cable
- When the beacon is connected to the Dashboard, go to **“Firmware” → “Upload firmware”**



- **Choose a .hex SW file for your device** (Be careful with IA and NIA architectures, do not mix them)
- Click **“Next”**



- Wait until the beacon update finishes

Note: Press the Default button for every beacon after the SW update

- Repeat for all your beacons

Be careful: The default button will apply full default settings to this beacon, except its address. If you had some custom Radio settings before, it would be changed to 153kbps Radio profile, 0 Radio channel

5.2.2. SW Update via Radio

Usually, the SW update via USB is used the first time the system is started up. It allows you to update to the actual SW version very quickly before system deployment.

Pros: Allows you to keep your system in its place and update SW remotely

Cons: Not as fast as USB SW update

How to:

- Launch the Dashboard
- Make sure that the modem is connected to the Dashboard (via USB)
- Ensure that you can see your beacons via radio in the Dashboard
- Click on the beacon you want to update (In the bottom devices' list)
- go to **"Firmware"** → **"Upload firmware"** → **Choose the .hex SW file for your device** (Be careful with IA and NIA architectures, do not mix them)
- Click **"Next"**
- Wait until the beacon update finishes
    - Repeat for all your beacons
        - Note: with an additional license, you can enable simultaneous updates of multiple beacons (stationary and mobile)

5.2.3. SW Update via DFU Programming

Not applicable to “Outdoor” versions of initially non-outdoor versions

Usually, SW updates happen using regular USB or Radio SW updates. But if you haven’t updated your system for a long time (and get a big SW version gap) or are faced with some unexpected troubles, please do the DFU Programming SW update. This chapter describes DFU updates for different types of devices.

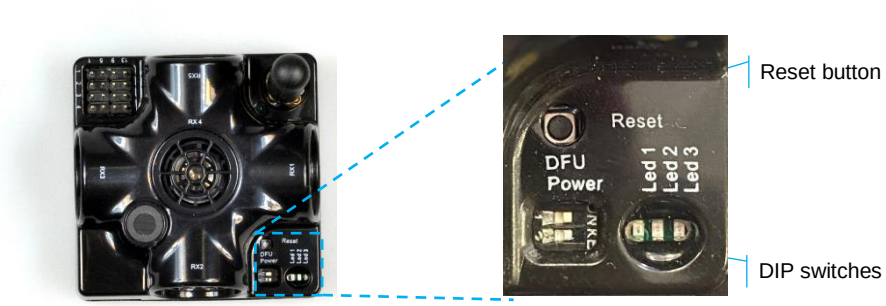
Pros: The Ultimatum SW update erases all glitches, settings, etc. It allows the beacon to be revived if “everything goes bad.”

Cons: It is more complicated than a regular SW update and clears all settings. Save the map file to avoid losing your map.

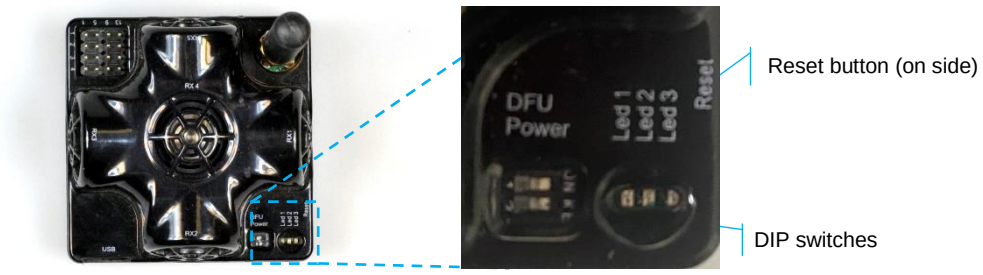
To do DFU programming, you must know where the hardware reset button and DIP switches are placed.

5.2.3.1. Reset Button and DIP Switch Placement

- Super-Beacon:

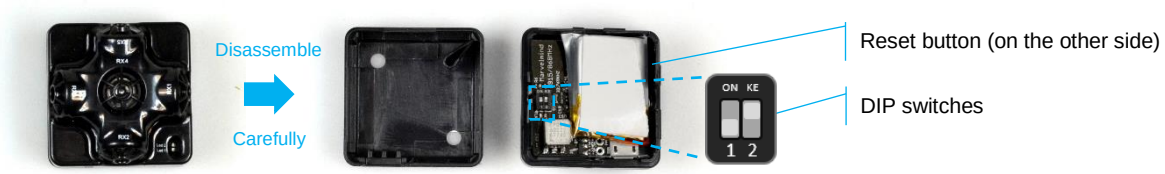


- HW v4.9 Beacon:



- Mini-RX beacon:

- Mini-TX beacon:

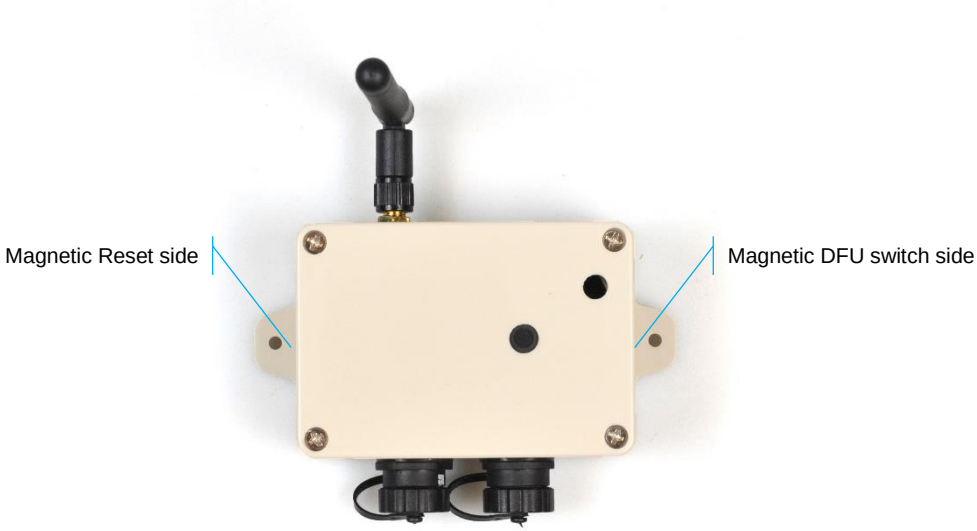


Industrial beacons have no switches and reset buttons, but they have magnetic DFU switches and magnetic Reset buttons:

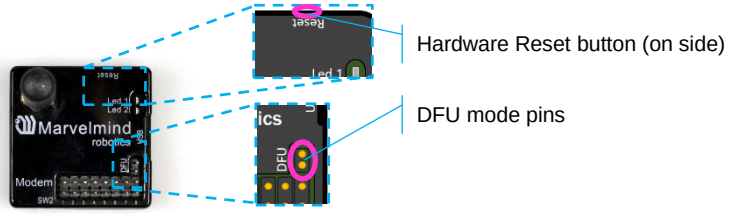
- Industrial Super-Beacon-Plastic:

- Industrial Super-Beacon Metal-25kHz:

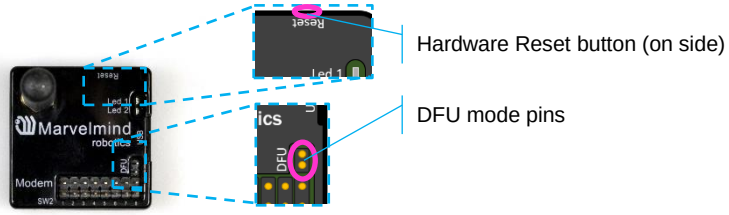
- Beacon Industrial-RX:



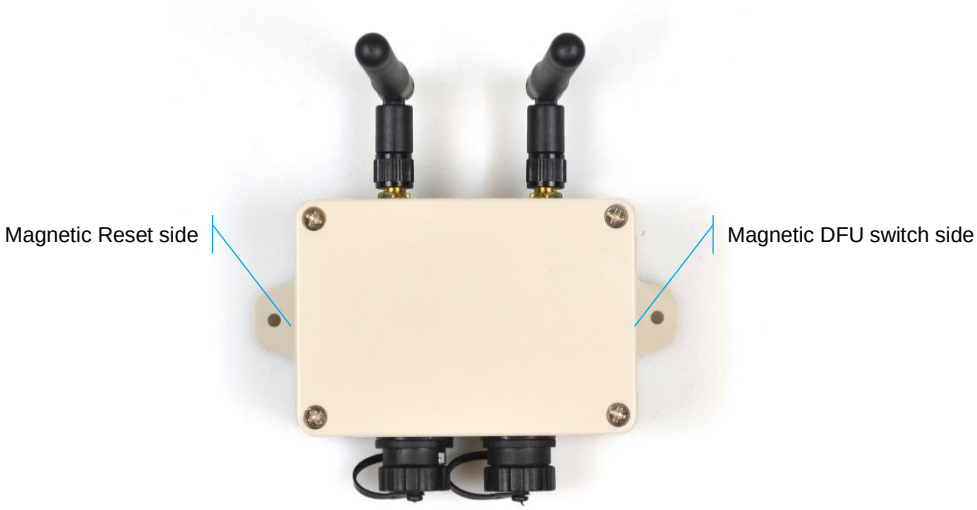
- How to enter DFU mode and reset different types of Modems:
- Modem HW v5.1:



- Modem HW v4.9:



- Super-Modem:



5.2.3.2. DFU Programming Process:

1. Enter the device into DFU Mode:

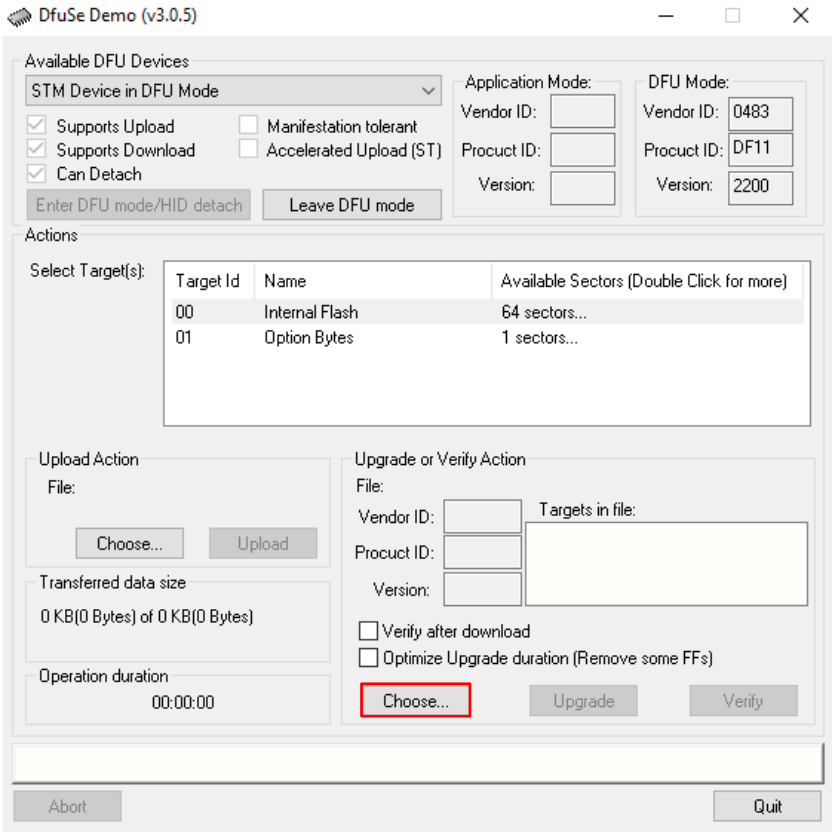
   - For regular and non-industrial versions of beacons – switch DIP switches into positions shown on the picture (both up) and press the Reset button – the device will go into DFU mode
   - For Industrial versions of beacon and Super-Modem – attach one magnet to the DFU switch side and attach for 1 second the second magnet to the Reset side of the device – the device will go into DFU mode (Do not forget to power Industrial versions of beacons and Super-Modem – they do not have an internal battery)
   - For Modem HW v5.1 and Modem HW v4.9 – short DFU mode pins and press the Reset button – the device will go into DFU mode

2. Connect the device via USB to your PC (Remember to power the Industrial versions of beacons and Super-Modem—they do not have an internal battery).

   - Run DfuSe (Choose whichever works best for your Windows: DfuSe v.3.0.5. or DfuSe v3.0.6.)

3. In the upper left corner of the DfuSe program, you will see a device connected in DFU mode (if not, reenter the device into DFU mode).

4. Choose the DFU file for the beacon.



5. Click the **UPGRADE** button.

6. After a few seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW you selected.

7. Exit from the DFU mode:

- For regular and non-industrial versions of beacons – switch DIP switches into positions shown on the picture (Left – down, right – up) and press the Reset button – the device will exit from DFU mode
- For Industrial versions of beacon and Super-Modem – remove one from the DFU switch side and attach for 1 second the second magnet to the Reset side of the device – the device will exit from DFU mode
- For Modem HW v5.1 and Modem HW v4.9 – remove the circuit plug DFU mode pins and press the Reset button – the device will exit DFU mode

8. Start the Dashboard. Leave the device connected to the PC via USB (Do not forget to power the Industrial versions of beacon and Super-Modem—they do not have an internal battery). The device should appear in the Dashboard.

9. Check SW on the beacon afterward.

10. Everything should be OK with SW now. DFU programming is complete.

5.2.3.3. DFU Troubleshooting

If you experience difficulties in DFU programming, please try the following:

- Change the USB cable
- Install a different DfuSe version (whichever works best with your Windows). Here you will find different versions of DfuSe: DfuSe v3.0.5 or DfuSe v3.0.6
- Use a different computer with a different version of Windows or another operating system

For more information check DFU update troubleshooting manual.

6. Setting up the System

6.1. Introduction

Our system supports Non-Inverse Architecture, Inverse Architecture, and MF NIA. However, we strongly recommend starting from NIA in a 2D configuration (2 stationary beacons and 1 mobile beacon). Once you achieve perfect results in NIA, you can set up the system in IA.

Check:

8 basic steps from unpacking to autonomous drive/flight

Step-by-step guide on how to build complex maps

Detailed explanation of complex map building:

Building submaps: Part 1

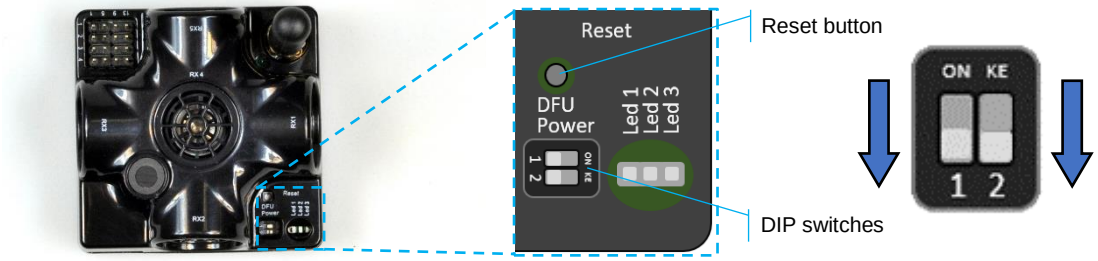
Building submaps: Part 2

6.2. DIP Switch Positions

This chapter shows different DIP switcher positions of devices in the example of a Super-Beacon.

6.2.1. DIP Switch Position for OFF Beacon

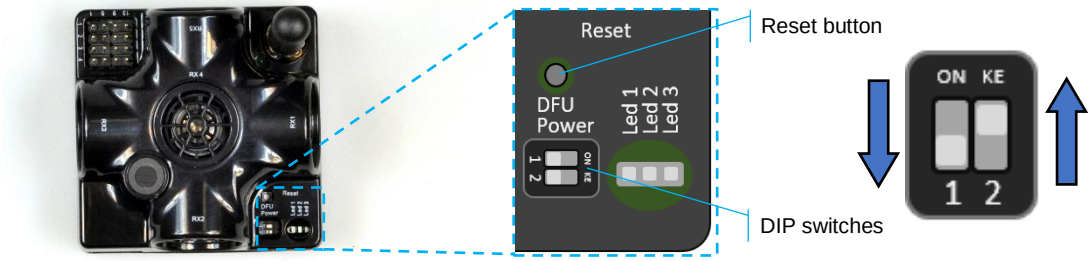
Only charging the device is possible when the DIP switch is in this position.



6.2.2. DIP Switch Position for Work and HEX Programming

Put DIP switch to this position:

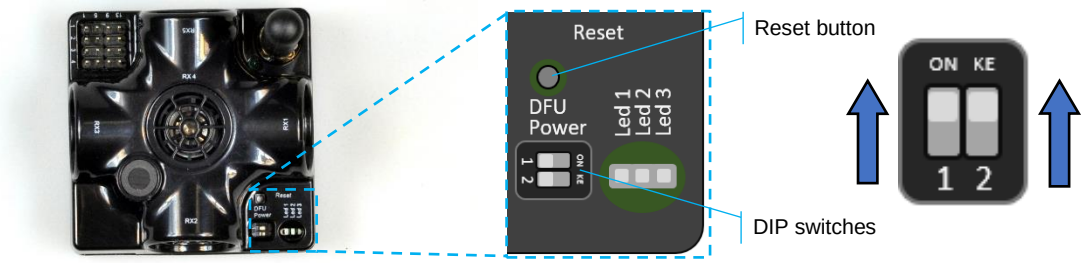
- To turn on the beacon
- For HEX programming (via Dashboard)



6.2.3. DIP Switch Position for DFU Programming

Put DIP switch to this position:

- For DFU programing (via: DfuSe v3.0.5 or DfuSe v3.0.6)



Put the DIP switch in position for work and restart the beacon after DFU programming.

6.3. Starter Set Super-MP-3D (NIA, IA, and MF NIA)

The steps below describe the first time you set up the system in NIA.

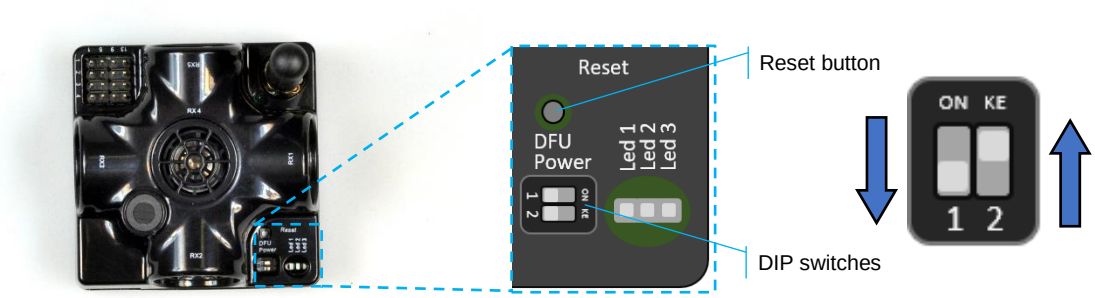
Super-Beacons and Modem HW v5.1 required.

This Set can be used in IA and NIA. Use NIA Software for Non-Inverse Architecture and IA Software for Inverse Architecture.

6.3.1. Unpack the system. Look at a similar unpacking video of HW v4.9. The videos have specific differences, but the basics are the same: Unpacking Marvelmind Precise (+-2cm) Indoor "GPS."

6.3.2. Charge all the beacons using a USB cable. Complete charging takes about 1-2 hours

6.3.3. Turn the beacons on: Place DIP switches as shown in the picture below



6.3.4. Download SW Pack

6.3.5. Update all the beacons (HEX programming):

6.3.6. Run the Dashboard and update the SW for all beacons and modem using Dashboard => Firmware => Choose the file => Program

6.3.7. If you see the message “Not found modem connection to a computer through USB” in the Dashboard or your PC does not recognize beacons/modem, it usually means that the STM32 driver is not installed. To install the driver, download it with the link at the top window in the Dashboard and run the installation file, then click on the link under and install the driver

6.3.8. Ensure that:

- You are programming the modem's SW to the modem and the beacon's SW to the beacon.
- You are using SW for Super-beacon, if you have Super-Beacon, etc. You have the SW from the same SW pack, i.e., the Dashboard SW, modem SW, and beacon SW must be from the same SW pack. Don't mix SW releases.

6.3.9. If SW flashed SUCCESSFULLY, MOVE DIRECTLY TO 6.3.13. If you have some problems with HEX programming, use DFU programming:

6.3.9.1. DFU programming or SW uploading is used when HEX SW uploading in the Dashboard cannot be used. For example, when you are updating from a very old SW version or when the SW includes significant changes to the system and the only possible way to update the SW is via DFU programming

6.3.9.2. After the DFU SW upgrade, future SW upgrades can be done in a regular manner via the Dashboard

6.3.9.3. To start programming, move the beacon's DIP switch to the DFU programming mode, as described in the paragraph on DIP switch modes

6.3.9.4. Download the latest SW package, unzip it, and select the proper version of the SW for your HW and frequency variant. Remember that for DFU programming, you should use DFU SW (DfuSe), not Dashboard's .hex file

6.3.9.5. Download DfuSe

6.3.9.6. Here you will find different versions of DfuSe. v3.0.5 or v3.0.6, whichever works the best for your Windows: DfuSe v3.0.5 or DfuSe v3.0.6

6.3.9.7. DFU Programming:

6.3.9.8. Put DIP switch into ***Power* = ON, *DFU* = ON**

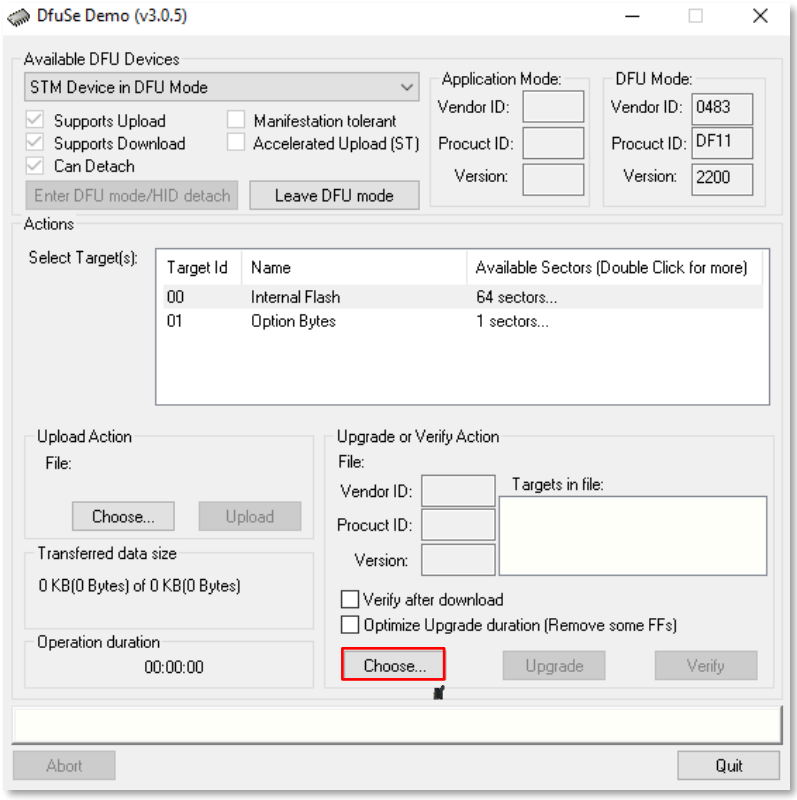
6.3.9.9. Connect the beacon via USB to your PC

6.3.9.10. Run DfuSe

6.3.9.11. Press the RESET button on your beacon

6.3.9.12. In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode

6.3.9.13. Choose the DFU driver (file) for the beacon



6.3.9.14. Click the **UPGRADE** button

6.3.9.15. After a couple of seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW you selected

6.3.9.16. Move the DIP switch into ***Power* = ON**, ***DFU* = OFF**

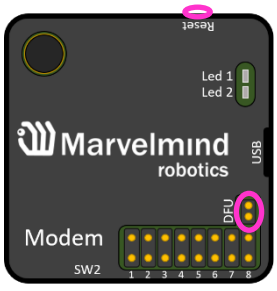
6.3.9.17. Start the Dashboard and press the **RESET** button on the beacon

6.3.9.18. Check SW on the beacon afterwards

Everything should be OK with SW now. DFU programming is complete

Follow the same scenario for the modem:

6.3.9.19. Short the circuit pins, as shown in the picture, and press the **Reset** button



6.3.9.20. The modem will go to DFU mode. Press the **UPGRADE** button in the DfuSe program

6.3.9.21. After a few seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen immediately. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different one

6.3.9.22. Disconnect the short circuit

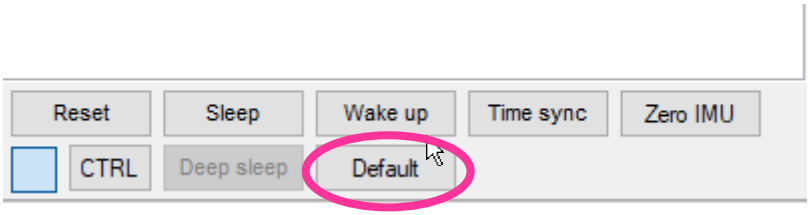
6.3.9.23. Start the Dashboard and press the **RESET** button

6.3.10. If you experience difficulties in DFU programming, please try the following:

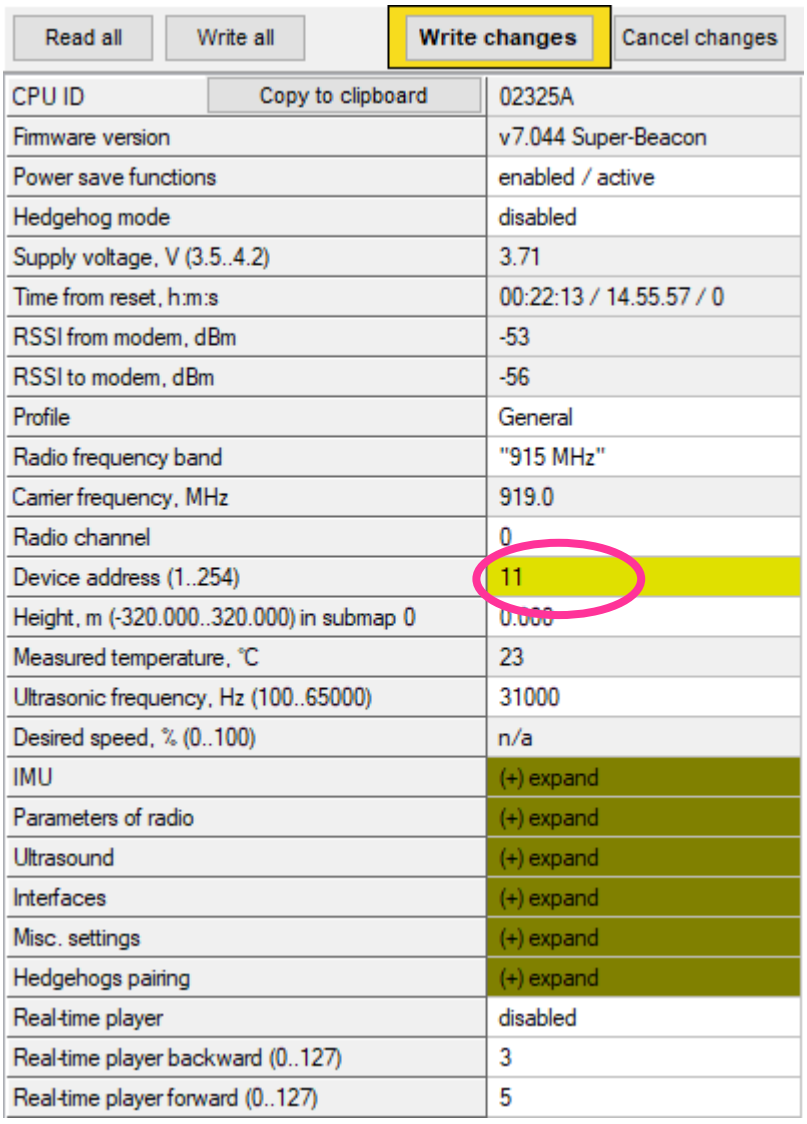
- Use a different computer with a different version of Windows or another operating system
- Install a different DfuSe version (whichever works best with your Windows)
- Use a different USB cable

6.3.11. If you have uploaded the latest firmware for all the boards, you can start to activate the system:

6.3.12. While the beacon or modem is connected to the Dashboard, click the DEFAULT button to upload the default settings. Do this after each SW upgrade for all devices!



6.3.13. Write down the beacon's address for future use or change the address at your convenience. Enter the device address and press ENTER - press the Write changes button. Beacons' addresses should not be repeated.

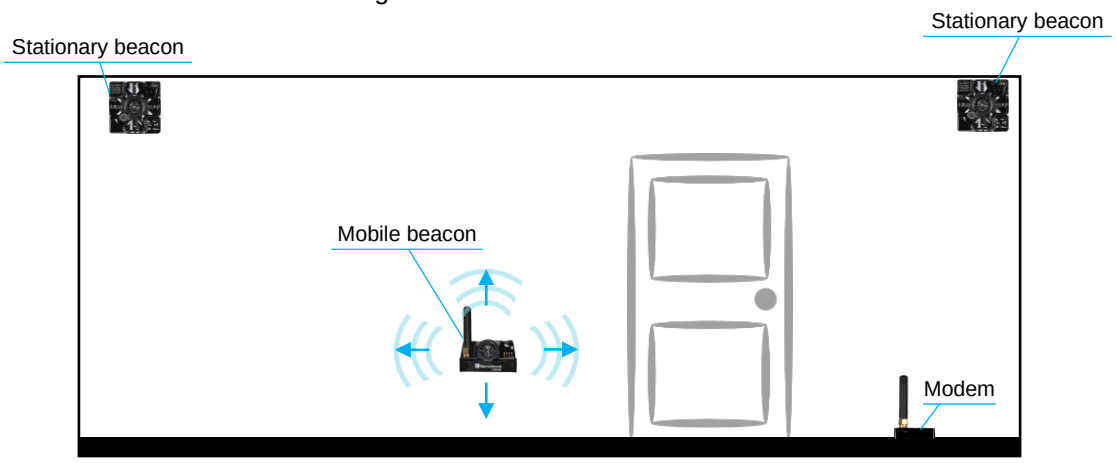


6.3.14. Press the RESET button on your beacons and modem after programming

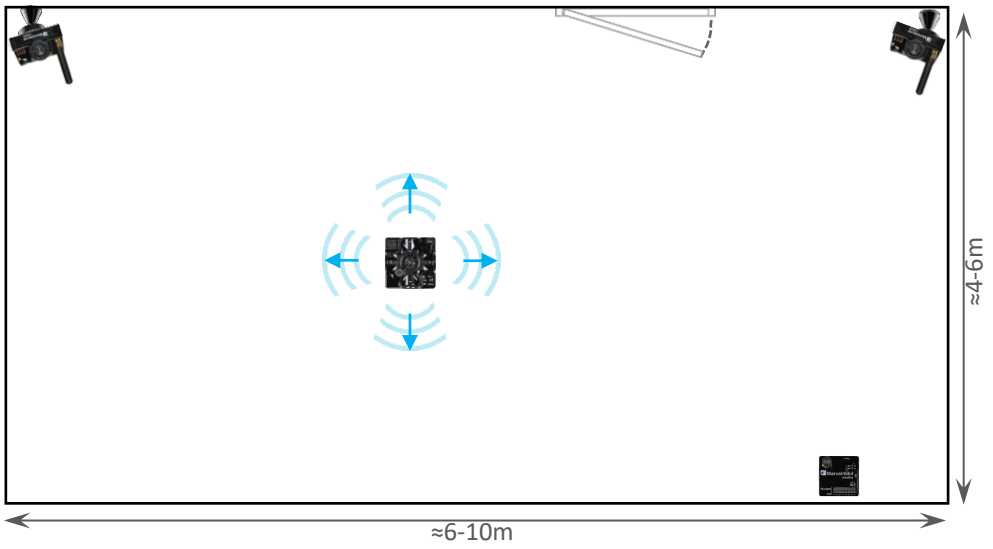
6.3.15. After programming devices with the latest software, the modem and beacons are ready for use

6.3.16. Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon's height for future changes in the settings. The help video on installation can be found here - Help: how to place beacons

Side view of 2D configuration:



Top view of 2D configuration:



More information about the placement can be found in the Placement Manual

6.3.17. Connect the modem via USB to a Windows PC with the Dashboard installed

6.3.18. Run the Dashboard. In the left corner of the Dashboard, the modem should be shown as connected

6.3.19. Wake up all beacons by pressing the correct addresses on the Dashboard panel

Only 4 stationary beacons may be in 1 submap. If you wake up more beacons, create a new submap for them, or it won't be displayed on the map and in the table of distances.

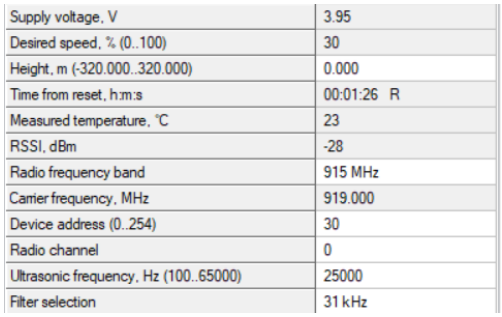
6.3.20. It may take up to 7-10 seconds for the beacons to wake up

6.3.21. Notice that if the modem is not active and is not powered, the beacons will go into sleep mode automatically after 1 minute

6.3.22. If this is the first time you wake up the beacons, the system may run the frequency search. If this step does not work, disconnect the modem and connect the beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to ensure the radio settings are the default.

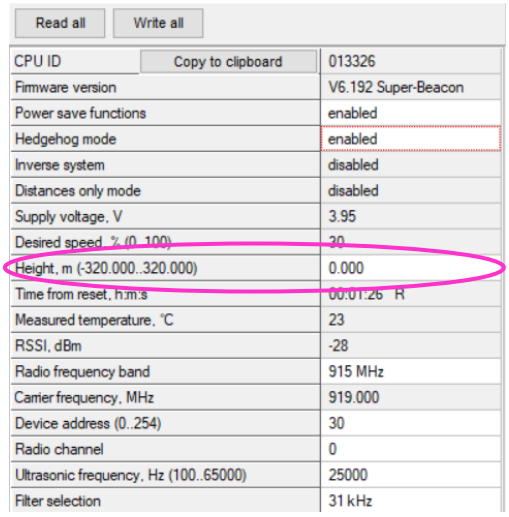
6.3.23. Check that the radio settings on the modem and the radio settings on the beacon are the same

6.3.24. Now you can check RSSI, voltage, ultrasonic filter settings, etc., on the panel in the right corner of the Dashboard



Supply voltage, V	3.95
Desired speed, % (0..100)	30
Height, m (-320.000..320.000)	0.000
Time from reset, h:m:s	00:01:26 R
Measured temperature, °C	23
RSSI, dBm	-28
Radio frequency band	915 MHz
Carrier frequency, MHz	919.000
Device address (0..254)	30
Radio channel	0
Ultrasonic frequency, Hz (100..65000)	25000
Filter selection	31 kHz

6.3.25. Enter the height of stationary beacons. Choose beacon in the list and enter the height value



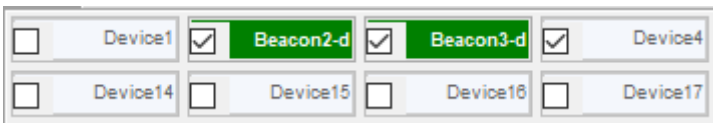
Read all | Write all

CPU ID	Copy to clipboard	013326
Firmware version		V6.192 Super-Beacon
Power save functions		enabled
Hedgehog mode		enabled
Inverse system		disabled
Distances only mode		disabled
Supply voltage, V		3.95
Desired speed, % (0..100)		30
Height, m (-320.000..320.000)		0.000
Time from reset, h:m:s		00:01:26 R
Measured temperature, °C		23
RSSI, dBm		-28
Radio frequency band		915 MHz
Carrier frequency, MHz		919.000
Device address (0..254)		30
Radio channel		0
Ultrasonic frequency, Hz (100..65000)		25000
Filter selection		31 kHz

Enter the height for the mobile beacon if you are using a 2D mode

6.3.26. One modem in the current version supports 250 beacons (mobile + stationary combined). You may need to scroll to find their addresses if you do not see some of your connected beacons on the map.

6.3.27. Double-click on the device both to put it into sleep mode and to wake it up



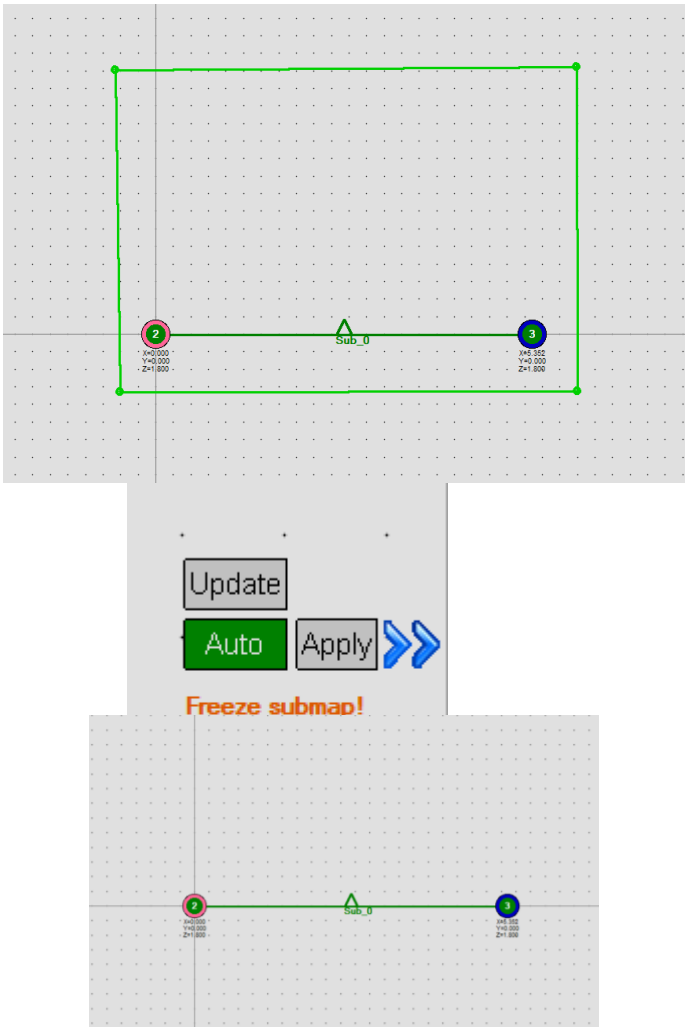
Marvelmind robotics

6.3.28. The map will form and zoom in automatically

6.3.29. If the map does not form well, check the table of distances in the left corner of the Dashboard. The cells must be colored in white; it means the distances between stationary beacons are measured correctly.

6.3.30. If you see some empty cells or marked yellow/red in the table, it indicates that distances between some beacons are measured inconsistently or not at all. Try to re-position them because there is usually an obstruction of some sort between the beacons. If you have any problems – check the Table of distances chapter

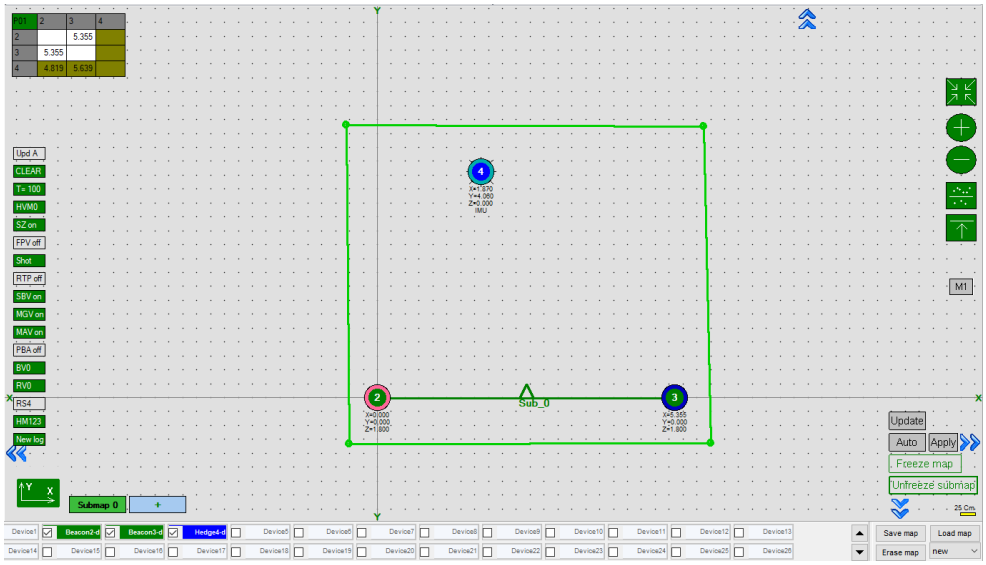
6.3.31. Make a service zone by clicking on the map with **Shift + Left Mouse Button**. See the Submaps chapter for more details



6.3.32. Freeze the Submap by clicking the button. Stationary beacons will stop measuring relative distances and will be ready to measure the distance from the mobile beacon(s)

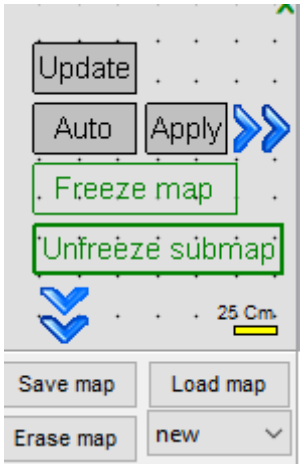
P01	2	3
2		5.374
3	5.330	

6.3.33. Turn on and wake up the mobile beacon by following the same steps as with the stationary beacon. More details are in our video.

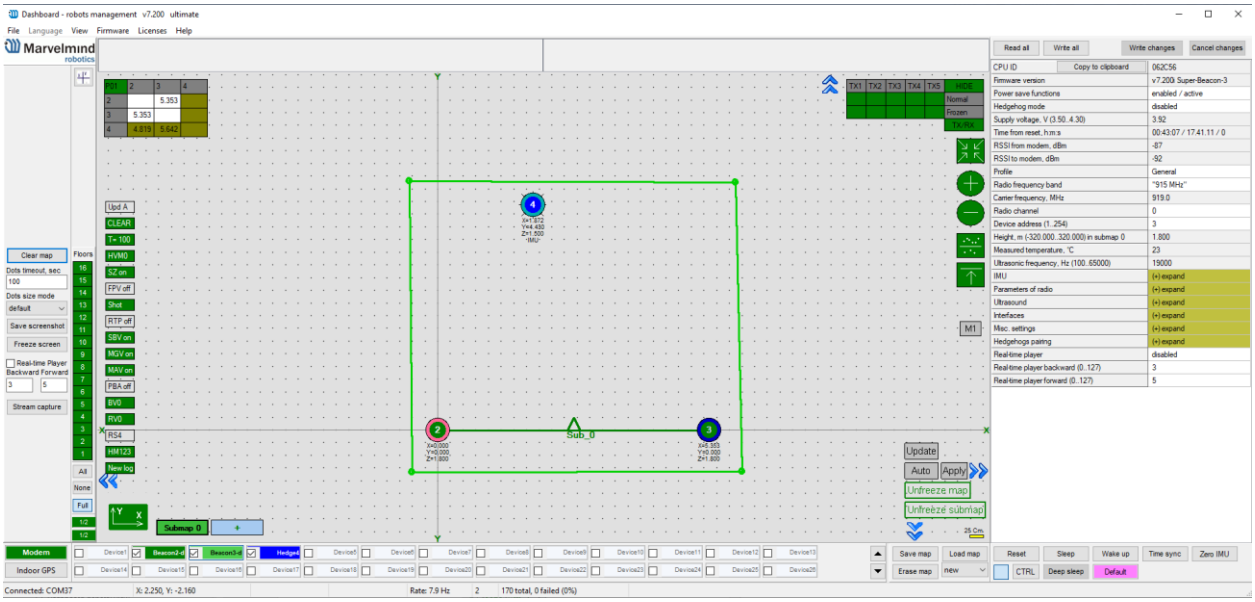


6.3.34. If you see on the devices' panel in the Dashboard that the beacon is colored orange, it means there are some differences in some of the settings between beacons. For example, some sensors may be off, and some ultrasonic or radio settings may be different. You can manually change the sensors' settings by clicking on the panel in the upper right corner of the Dashboard to change the cells from gray to green to turn on the sensor. It is recommended that the default settings on all beacons and the modem are used if this is your first time using the system.

6.3.35. If everything looks good and the table of distance is colored white, freeze the submap and the map.



6.3.36. The system is now fully operational.



6.3.37. You can upload a picture/map of your room in the Dashboard. You can use a different picture for every floor. Go to Loading the floorplan (Help video)

6.4. Starter Set HW v4.9

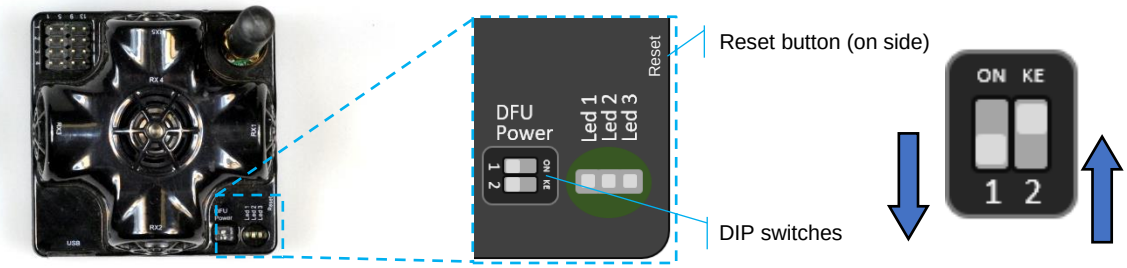
The steps below describe the first time you set up the system in NIA. Beacons HW v4.9 with the same frequencies and Modem HW v4.9 required.

This is Non-Inverse Architecture. Use NIA Software ONLY

6.4.1. Unpack the system. Watch the help video

6.4.2. Charge all the beacons using a USB cable. Full charging takes about 1-2 hours

6.4.3. Turn the beacons on: Place DIP switches as shown in the picture below



6.4.4. Download SW Pack

6.4.5. Update all the beacons (HEX programming):

- Run the Dashboard and update the SW for all beacons and modem using Dashboard => Firmware => Choose the file => Program
- If you see the message “Not found modem connection to a computer through USB” in the Dashboard or your PC does not recognize beacons/modem, it usually means that the STM32 driver is not installed. To install the driver, download it with the link at the top window in the Dashboard and run the installation file, then click on the link under and install the driver

Ensure that:

- You are programming the modem’s SW to the modem and the beacon’s SW to the beacon

- You are using SW for HW v4.9 if you have HW v4.9 and have the SW from the same SW pack, i.e., the Dashboard SW, modem SW, and beacon SW must be from the same SW pack. Don't mix SW releases!

If SW flashed SUCCESSFULLY, MOVE DIRECTLY TO 4.2.6. If you have some problems with HEX programming, use DFU programming:

DFU programming or SW uploading is used when HEX SW uploading in the Dashboard cannot be used. For example, when you are updating from a very old SW version or when the SW includes significant changes to the system, the only possible way to update the SW is via DFU programming.

6.4.5.1. After the DFU SW upgrade, future SW upgrades can be done regularly via the Dashboard

6.4.5.2. To start programming, move the beacon's DIP switch to the DFU programming mode, as described in the paragraph on DIP switch modes

6.4.5.3. Download the latest SW package, unzip it, and select the proper version of the SW for your HW and frequency variant. Remember that for DFU programming, you should use DFU SW (DfuSe), not Dashboard's .hex file

6.4.5.4. Download DfuSe

6.4.5.5. Here you will find different versions of DfuSe. v3.0.5 or v3.0.6, whichever works the best for your Windows: DfuSe v3.0.5 or DfuSe v3.0.6

6.4.5.6. DFU Programming:

6.4.5.7. Put DIP switch into ***Power* = ON**, ***DFU* = ON**

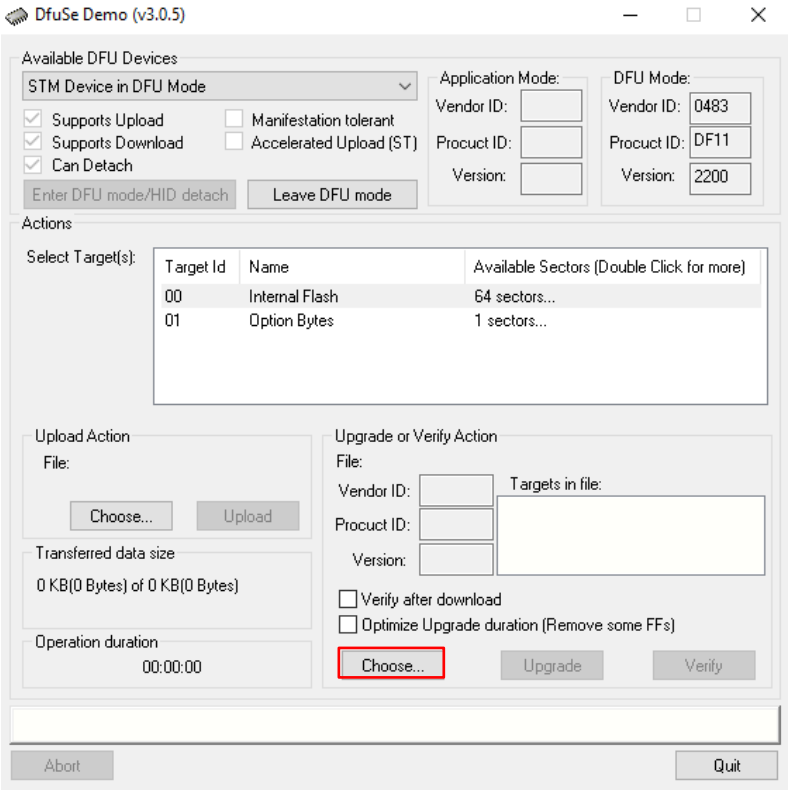
6.4.5.8. Connect the beacon via USB to your PC

6.4.5.9. Run DfuSe

6.4.5.10. Press the **RESET** button on your beacon

6.4.5.11. In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode

6.4.5.12. Choose the DFU driver (file) for the beacon



6.4.5.13. Click the **UPGRADE** button

6.4.5.14. After a few seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW you selected

6.4.5.15. Move the DIP switch into ***Power (2)*** **= ON**, ***DFU (1)*** **= OFF**

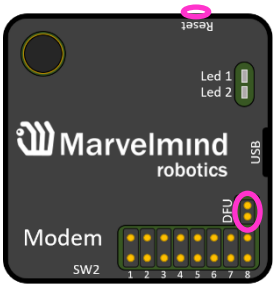
6.4.5.16. Start the Dashboard and press the **RESET** button on the beacon

6.4.5.17. Check SW on the beacon afterwards

6.4.5.18. Everything should be OK with SW now. DFU programming is complete

Follow the same scenario for the modem:

6.4.5.19. Short the circuit pins, as shown in the picture



6.4.5.20. Press the **Reset** button

6.4.5.21. The modem will go to DFU mode. Press the **UPGRADE** button in the DfuSe program

6.4.5.22. After a few seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen immediately. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different one

6.4.5.23. Disconnect the short circuit

6.4.5.24. Start the Dashboard and press the **RESET** button

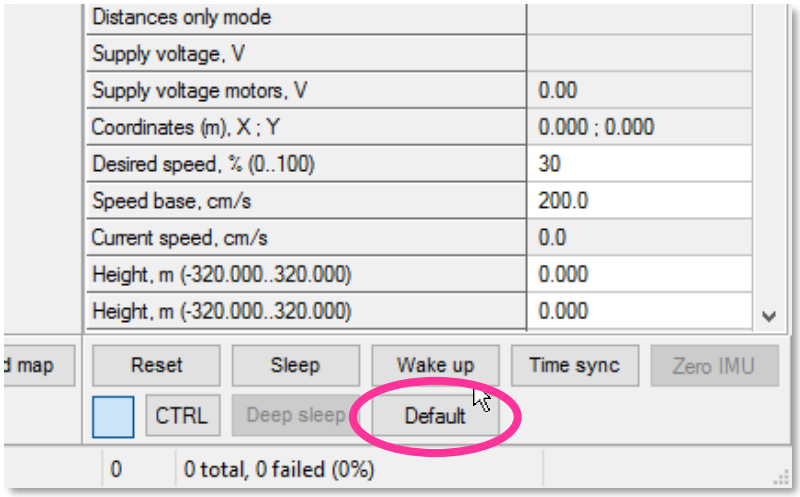
If you experience difficulties in DFU programming, please try the following:

- Use a different computer with a different version of Windows or another operating system

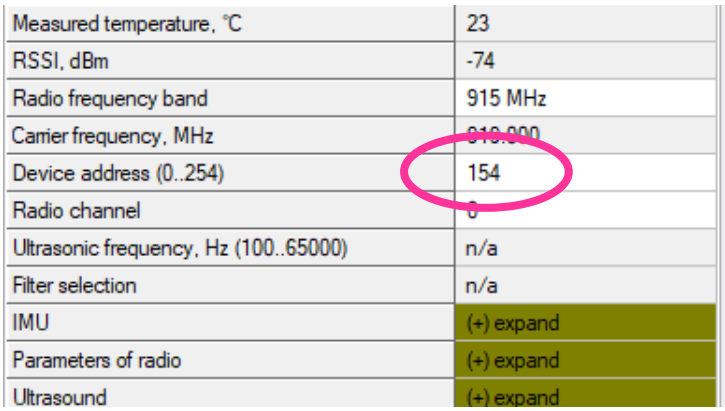
- Install a different DfuSe version (whichever works best with your Windows)

If you have uploaded the latest firmware for all the boards, you can start to activate the system:

6.4.6. While the beacon or modem is connected to the Dashboard, click the DEFAULT button on the Dashboard to upload the default settings



6.4.7. Write down the beacon's address for future use or change the address at your convenience as shown here. Beacons' addresses should not be repeated.

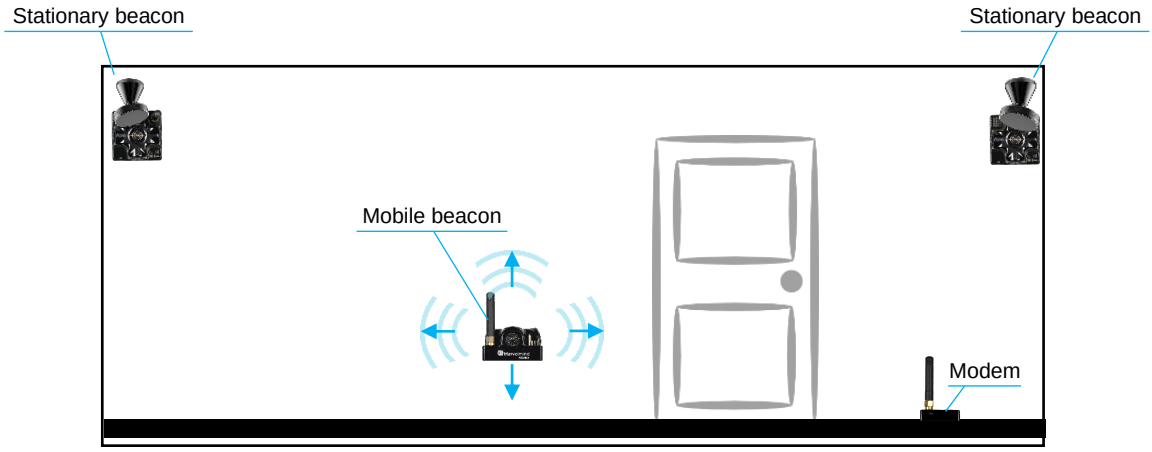


6.4.8. Press the RESET button on your beacons and modem after programming

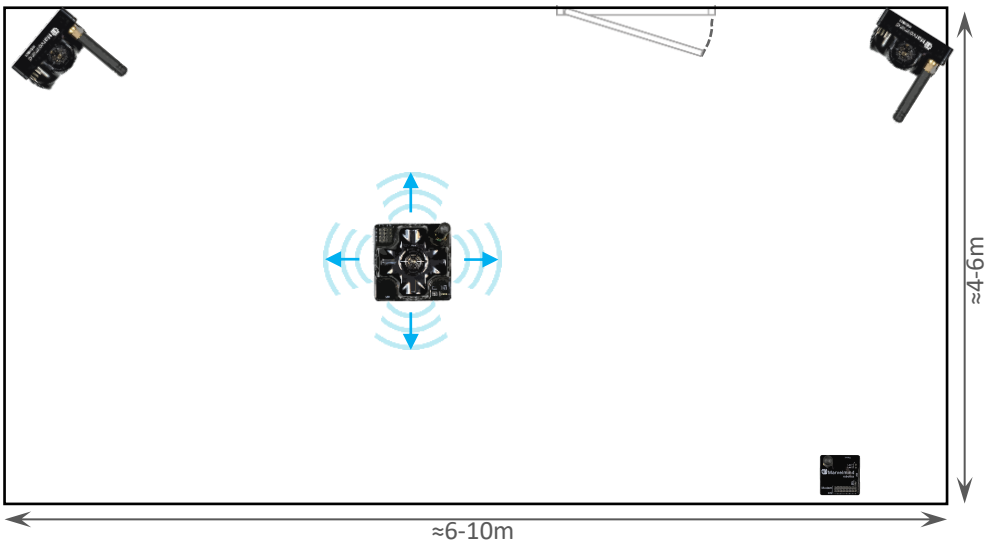
6.4.9. After programming devices with the latest software, the modem and beacons are ready for use

6.4.10. Place the stationary beacons vertically on the walls for optimal ultrasonic coverage. Write down the beacon's height for future changes in the settings. The help video on installation can be found here

Side view of 2D configuration:



Top view of 2D configuration:



6.4.11. Connect the modem via USB to a Windows PC with the Dashboard installed

6.4.12. Run the Dashboard. In the left corner of the Dashboard, the modem should be shown as connected

6.4.13. Wake up all beacons by selecting them on the Dashboard panel

Only 4 stationary beacons may be in 1 submap. If you wake up more beacons, create a new submap for them, or it won't be displayed on the map and in the table of distances.

6.4.14. It may take up to 7-10 seconds for the beacons to wake up

6.4.15. Notice that if the modem is not active and is not powered, the beacons will go into sleep mode automatically after 1 minute

6.4.16. The system may run the frequency search if it is the first time you wake up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are the default ones

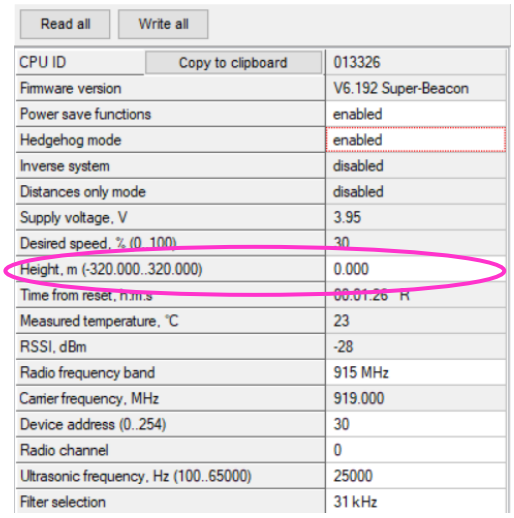
6.4.17. Check that the radio settings on the modem and the radio settings on the beacon are the same

6.4.18. Now you can check RSSI, voltage, ultrasonic filter settings, etc., on the panel in the right corner of the Dashboard

Supply voltage, V	3.95
Desired speed, % (0..100)	30
Height, m (-320.000..320.000)	0.000
Time from reset, h:m:s	00:01:26 R
Measured temperature, °C	23
RSSI, dBm	-28
Radio frequency band	915 MHz
Carrier frequency, MHz	919.000
Device address (0..254)	30
Radio channel	0
Ultrasonic frequency, Hz (100..65000)	25000
Filter selection	31 kHz

6.4.19. Enter the height of stationary beacons. Choose beacon in the list and enter the height value

Enter the height for the mobile beacon if you use 2D mode



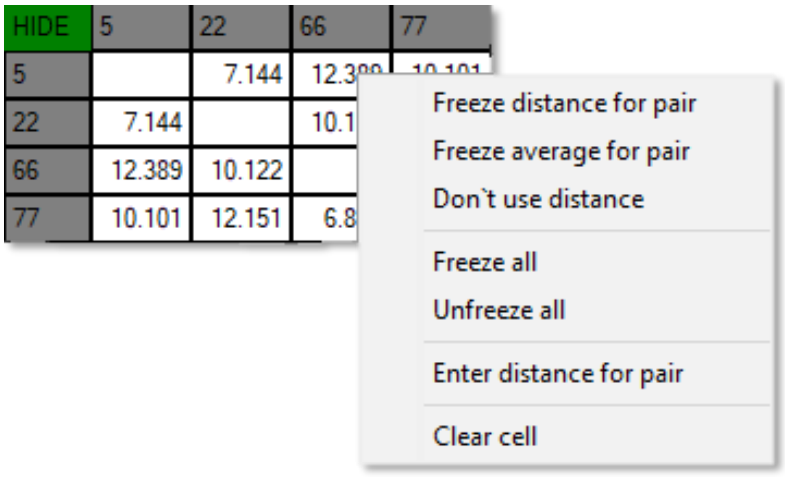
6.4.20. One modem in the current version supports 250 beacons (mobile + stationary combined). If you do not see some of your connected beacons on the map, you may need to scroll to find their addresses

6.4.21. Double-click on the device both to put it into sleep mode and to wake it up

Beacons HW v4.9 cannot build the map automatically, so you must make it manually.

6.4.21.1. Open the Dashboard. Click on the submap; you will see the table of distances

6.4.21.2. Right click on the cell where you want to enter the distance. An additional menu will open; there you can control the distances. Choose **Enter distance for pair** to enter the value

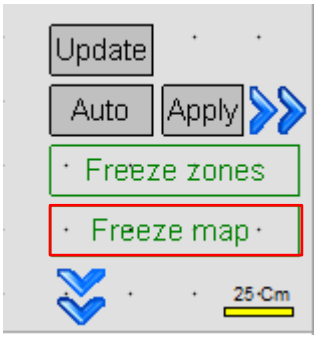


6.4.21.3. Now, enter the measured value (measure it with a laser distance meter or so). Those values will not change until you unfreeze or clear them. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can significantly impact your tracking!

6.4.21.4. Repeat for all cells

HIDE	6	22	66	77
6		8.000	4.200	11.400
22	8.000		13.100	6.500
66	4.200	13.100		10.800
77	11.400	6.500	10.800	

6.4.22. Freeze the map by clicking the button. Stationary beacons will stop measuring relative distances and will be ready to measure the distances from the mobile beacon(s)



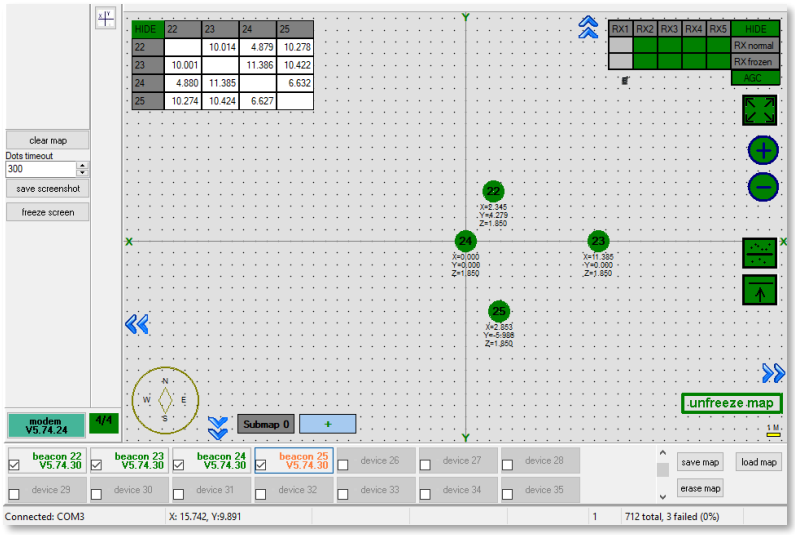
6.4.23. Make a service zone by clicking on the map with Shift + Left Click. See the Submaps chapter for more details

6.4.24. Turn on and wake up the mobile beacon, following the same steps as the stationary beacon. More details in our video: Demo: converting beacon to mobile beacon ("hedgehog")

6.4.25. If you see on the devices' panel in the Dashboard that the beacon is colored orange, it means there are some differences in some of the settings between beacons. For example, some sensors may be off, and some ultrasonic or radio settings may be different. You can manually change the sensors' settings by clicking on the panel in the upper right corner of the Dashboard to change the cells from gray to green to turn on the sensor. It is recommended that the default settings on all beacons and the modem are used if this is your first time using the system.

6.4.26. After you freeze the map of stationary beacons, wake up the mobile beacon. It will be traceable within 5-7 seconds.

6.4.27. The system is now fully operational.



You can upload a picture/map of your room in the Dashboard. You can use a different picture for every floor. Check our Help video for additional information.

6.5. Starter Set NIA-SmallDrone

The steps below describe how to set up the system for the first time. Super-Beacon, Mini-TX beacons, and a modem are required.

Super-Beacon and Mini-TX have different HW and SW. Use the Super-Beacon SW for Super-Beacons and the Mini-TX SW for Mini-TX beacons.

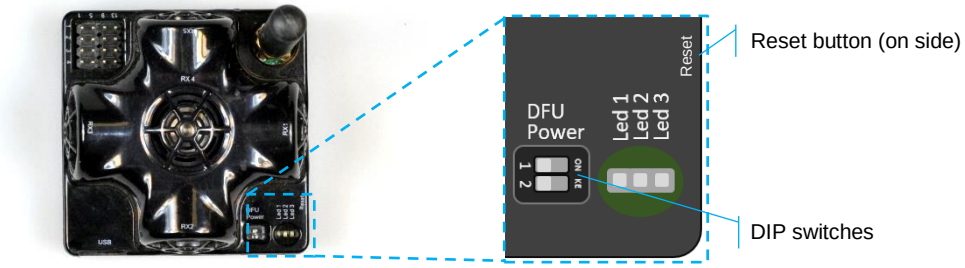
6.5.1. Unpack the system. Look at a similar unpacking video of HW v4.9. The videos have differences, but the basics are the same.

6.5.2. Charge all the beacons using a USB cable. Complete charging takes about 1-2 hours

6.5.3. Turn the beacons on

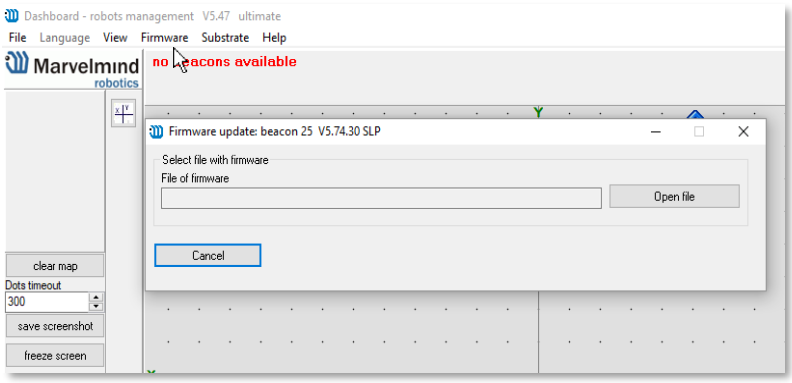
6.5.4. Download SW Pack

6.5.5. Update all the beacons:



Marvelmind robotics

- Run the Dashboard and update the SW for all beacons and modem using **Dashboard => Firmware => Choose the file => Program**



- If you see the message “Not found modem connection to a computer through USB” in the Dashboard or your PC does not recognize beacons/modem, it usually means that the STM32 driver is not installed. To install the driver, download it through the link in the top window in the Dashboard and run the installation file, then click on the link under and install the driver

Make sure that that:

- You are programming the modem’s SW to the modem and the beacon’s SW to the beacon
- You are using SW for Mini-TX if you have Mini-TX and the SW from the same SW pack, i.e., the Dashboard SW, modem SW, and beacon SW must be from the same SW pack. Don’t mix SW releases

If SW flashed SUCCESSFULLY, MOVE DIRECTLY TO 6.5.6. If you have some problems with HEX programming, use DFU programming:

DFU programming or SW uploading is used when HEX SW uploading in the Dashboard cannot be used. For example, when you are updating from a very old SW version or when the SW includes significant changes to the system, the only possible way to update the SW is via DFU programming.

After the DFU SW upgrade, future SW upgrades can be done regularly via the Dashboard.

6.5.5.1. To start programming, move the beacon’s DIP switch to the DFU programming mode, as described in the paragraph on DIP switch modes (DIP switch in Mini-RX and Mini-TX situated inside the body. Carefully disassemble the body to access it, as described in paragraph How to Flash Beacon Mini-RX)

6.5.5.2. Download the latest SW package, unzip, and select the proper version of the SW for your HW and frequency variant. Remember that for DFU programming, you should use DFU SW (DfuSe), not Dashboard’s .hex file

6.5.5.3. Download DfuSe

6.5.5.4. Here you will find different versions of DfuSe. v3.0.5 or v3.0.6, whichever works the best for your Windows: DfuSe v3.0.5 or DfuSe v3.0.6

DFU Programming:

6.5.5.5. Put the DIP switch into ***Power (2)*** **= ON**, ***DFU (1)*** **= ON** (The DIP switch in Mini-RX and Mini-TX situated inside the body. To switch it, carefully disassemble the body)

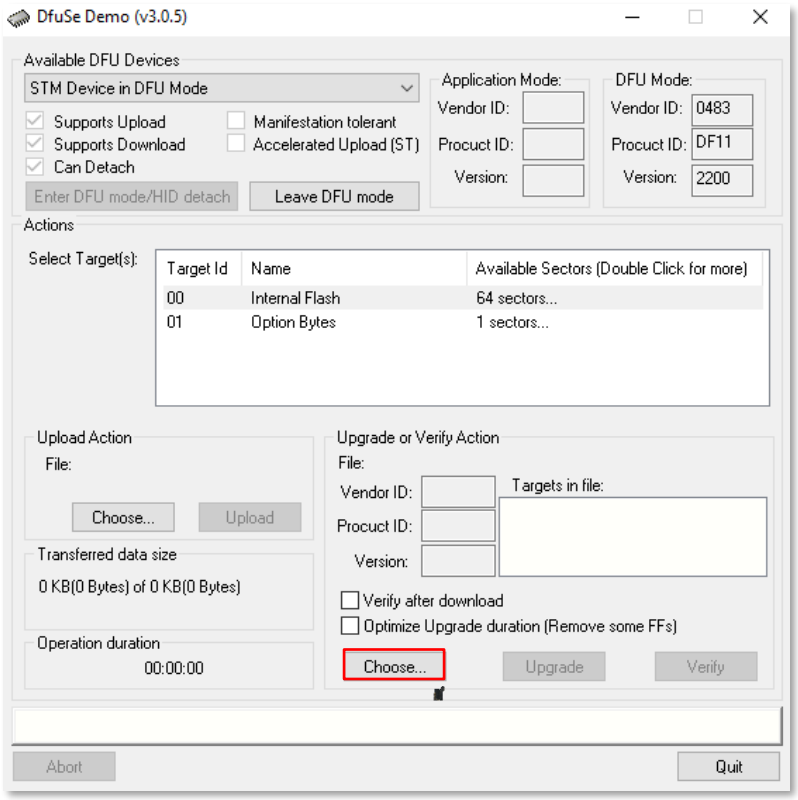
6.5.5.6. Connect the beacon via USB to your PC

6.5.5.7. Run DfuSe

6.5.5.8. Press the **RESET** button on your beacon

6.5.5.9. In the upper left corner of the DfuSe program, you will see the device connected in the DFU mode

6.5.5.10. Choose the DFU driver (file) for the beacon



6.5.5.11. Click the **UPGRADE** button

6.5.5.12. After a few seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW you selected

6.5.5.13. Move the DIP switch into ***Power (2)*** **= ON**, ***DFU (1)*** **= OFF**

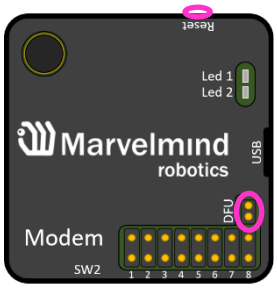
6.5.5.14. Start the Dashboard and press the **RESET** button on the beacon

6.5.5.15. Check SW on the beacon afterwards

6.5.5.16. Everything should be OK with SW now. DFU programming is complete

Follow the same scenario for the modem. The steps are similar to those for beacon DFU programming

6.5.5.17. Short the circuit pins, as shown in the picture, and press the **Reset** button



6.5.5.18. Press the **UPGRADE** button in the DfuSe program

6.5.5.19. After a few seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different one

6.5.5.20. Disconnect the short circuit

6.5.5.21. Start the Dashboard and press the **RESET** button

If you have uploaded the latest firmware for all of the boards, you can start to activate the system:

6.5.6. While the beacon or modem is connected to the Dashboard, click the DEFAULT button on the Dashboard to upload the default settings

6.5.7. Write down the beacon's address for future use or change the address at your convenience as shown here

Hedgehog mode	enabled
Inverse system	enabled
Distances only mode	disabled
Supply voltage, V	3.70
Desired speed, % (0..100)	30
Time from reset, h:m:s	00:00:04 R
Measured temperature, ℃	23
RSSI, dBm	-74
Radio frequency band	915 MHz
Carrier frequency, MHz	919.000
Device address (0..254)	154
Radio channel	0
Ultrasonic frequency, Hz (100..65000)	n/a
Filter selection	n/a
IMU	(+) expand
Parameters of radio	(+) expand
Ultrasound	(+) expand
Interfaces	(+) expand
Georeferencing	(+) expand
Misc. settings	(+) expand
Hedgehogs pairing	(+) expand
Real-time player	disabled
Real-time player backward (0..127)	3
Real-time player forward (0..127)	5

6.5.8. Choose the Mini-RX beacon and enable “Hedgehog mode”. Use this beacon as a mobile beacon in the future. Here is a help video.

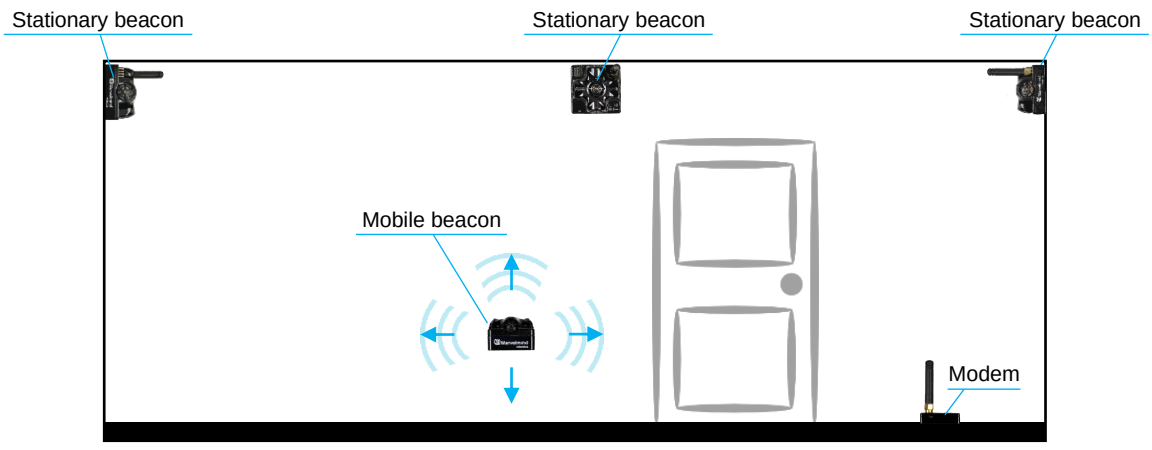
CPU ID	Copy to clipboard	08421E
Firmware version		v7.400i Super-Beacon-2
Power save functions		enabled / active
Hedgehog mode		enabled
Supply voltage, V (3.50..4.35)		4.08
Time from reset, h:m:s		00:02:55 / 19.20.54 / 0
RSSI from modem, dBm		-81
RSSI to modem, dBm		n/a
Profile		General (915 MHz band)
Carrier frequency, MHz		919.0
Radio channel		0
Device address (1..254)		104
Height, m (-320.000..320.000)		0.000
Measured temperature, ℃		23
Ultrasonic frequency, Hz (100..65000)		45000
Advanced settings		(+) expand
IMU		(+) expand
Parameters of radio		(+) expand
Ultrasound		(+) expand
Interfaces		(+) expand
Georeferencing		(+) expand
Misc. settings		(+) expand
Hedgehogs pairing		(+) expand
Real-time player streaming		disabled
Real-time player for gaps		disabled
Real-time player backward (0..127)		3
Real-time player forward (0..127)		5

6.5.9. Press the RESET button on your beacons and modem after programming

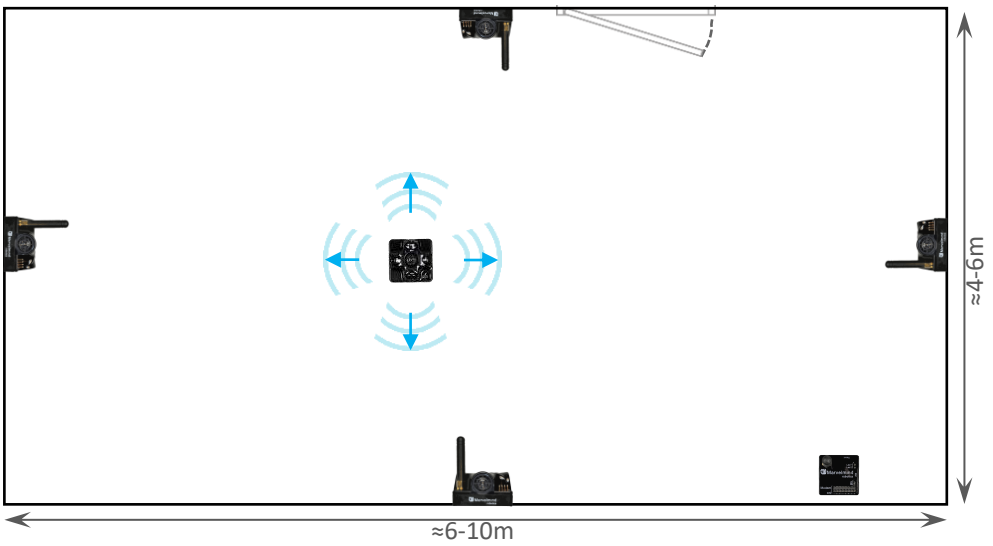
6.5.10. After programming devices with the latest software, the modem and beacons are ready for use

6.5.11. Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon’s height for future changes in the settings. The help video on installation can be found here.

Side view:



Top view:



6.5.12. Connect the modem via USB to a Windows PC with the Dashboard installed

6.5.13. Run the Dashboard. In the left corner of the Dashboard, the modem should be shown as connected

6.5.14. Wake up all beacons by selecting them in the Dashboard on the panel

6.5.15. It may take up to 7-10 seconds for the beacons to wake up

6.5.16. Notice that if the modem is not active and is not powered, the beacons will go into sleep mode automatically after 1 minute

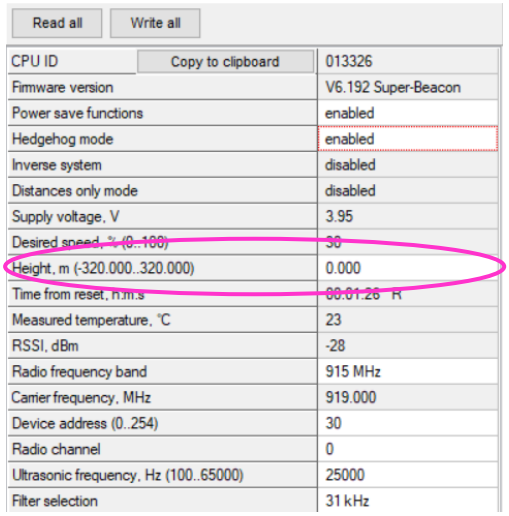
6.5.17. The system may run the frequency search if it is the first time you wake up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are the default ones

6.5.18. Check that the radio settings on the modem and the radio settings on the beacon are the same

6.5.19. Now you can check RSSI, voltage, ultrasonic filter settings, etc., on the panel in the right corner of the Dashboard

Supply voltage, V	3.95
Desired speed, % (0..100)	30
Height, m (-320.000..320.000)	0.000
Time from reset, h:m:s	00:01:26 R
Measured temperature, °C	23
RSSI, dBm	-28
Radio frequency band	915 MHz
Carrier frequency, MHz	919.000
Device address (0..254)	30
Radio channel	0
Ultrasonic frequency, Hz (100..65000)	25000
Filter selection	31 kHz

6.5.20. Enter the height of stationary beacons. Choose beacon in the list and enter the height value



Read all	Write all	
CPU ID	Copy to clipboard	013326
Firmware version		V6.192 Super-Beacon
Power save functions		enabled
Hedgehog mode		enabled
Inverse system		disabled
Distances only mode		disabled
Supply voltage, V		3.95
Desired speed, % (0..100)		30
Height, m (-320.000..320.000)		0.000
Time from reset, h:m:s		00:01:26 R
Measured temperature, °C		23
RSSI, dBm		-28
Radio frequency band		915 MHz
Carrier frequency, MHz		919.000
Device address (0..254)		30
Radio channel		0
Ultrasonic frequency, Hz (100..65000)		25000
Filter selection		31 kHz

6.5.21. One modem in the current version supports 250 beacons (mobile + stationary combined). If you do not see some of your connected beacons on the map, you may need to scroll to find their addresses

6.5.22. Double click on the device to put it into sleep mode or wake it up

Only 4 stationary beacons may be in 1 submap. If you wake up more beacons, create a new submap for them; otherwise, they will not be displayed on the map and in the table of distances.

6.5.23. Build the map:

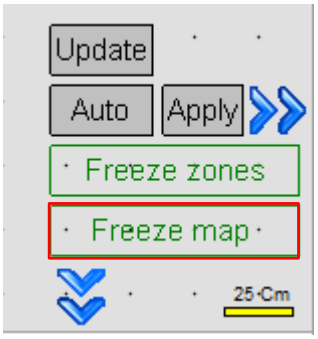
6.5.23.1. Open the Dashboard

6.5.23.2. Click on the Submap. You will see the table of distances

HIDE	5	22	66	77
5		7.144	12.389	10.101
22	7.144		10.122	12.151
66	12.389	10.122		6.879
77	10.101	12.151	6.879	

6.5.23.3. It will automatically calculate the distances between the beacons. If some of them are red, it means that the beacons can't calculate the distances by themselves. Check that there are no obstacles between the beacons and there is a direct line of sight.

6.5.24. If every cell is white, freeze the map by clicking the button. Stationary beacons will stop measuring relative distances and will be ready to calculate distance from the mobile beacon(s)



6.5.25. Turn on and wake up the mobile beacon, following the same steps as the stationary beacon. Here is a helpful video.

6.5.26. If you see on the devices' panel in the Dashboard that the beacon is colored orange, it means there are some differences in some of the settings between beacons. For example, some sensors may be off, and some ultrasonic or radio settings may be different. You can manually change the sensors' settings by clicking on the panel in the upper right corner of the Dashboard to change the cells from gray to green to turn on the sensor. It is recommended that the default settings on all beacons and the modem be used if this is your first time using the system.

6.5.27. After you freeze the map of stationary beacons, wake up the mobile beacon. It will be traceable in 5-7 seconds.

6.5.28. The system is now fully operational.

6.6. Starter Set Industrial-NIA-01

The steps below describe the first setup of the system.

This is a Non-Inverse Architecture. You can find the description and comparison of architectures here.

Pay attention: Industrial beacons have different HW and SW.
Read more on the **Industrial Beacon page**.
Industrial beacons have no battery, so use a power supply cable.
Use specific Industrial beacon's SW for specific Industrial beacons.

Do not disassemble the Industrial beacons. Otherwise, the warranty will be lost.
Version 3 of Industrial RX (from April 2022) **supports ONLY +5V power supply**. Don't use a +12V power supply converter for this version, it will burn the beacon!
Version 3 doesn't have UART RX, but now it is possible to use an Interface connector as a power supply for this version.

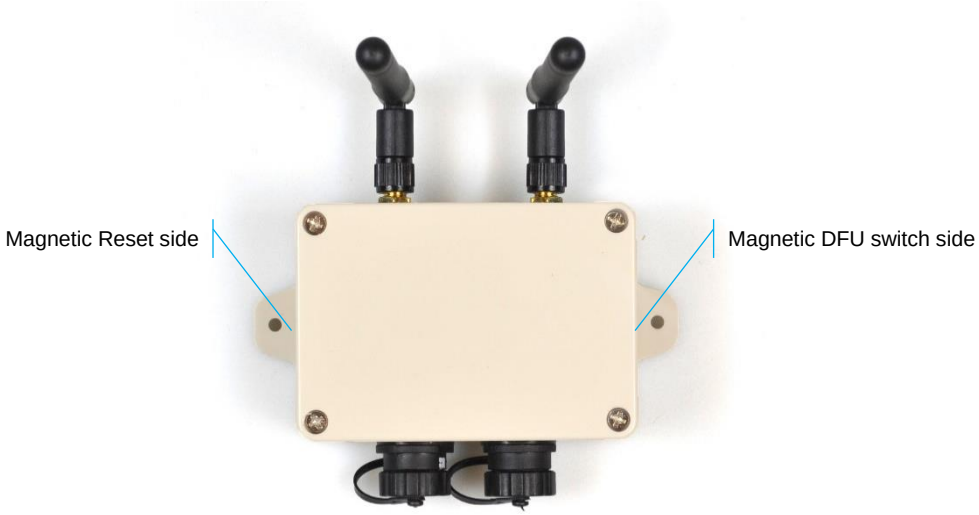
6.6.1. Unpack the system. Take a look at the similar unpacking video for HW v4.9. They are different, but they have some similar basics.

6.6.2. You do not have to charge Industrial beacons; they have no battery

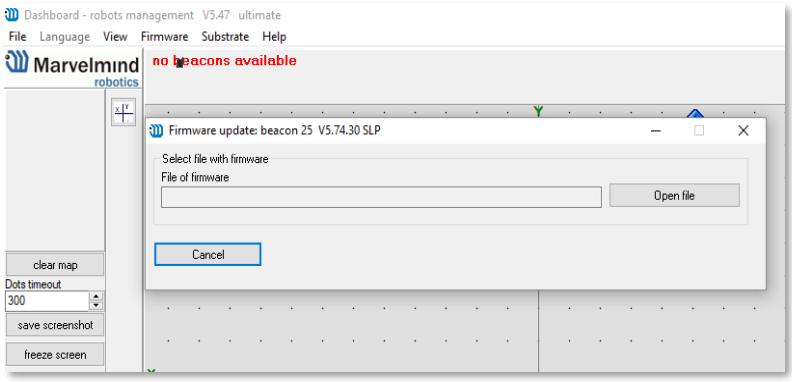
6.6.3. You do not have to turn it on - Industrial beacons are permanently ON

6.6.4. Download SW Pack

6.6.5. Update all the beacons:



- Run the Dashboard and update the SW for all beacons and modem using **Dashboard => Firmware => Choose the file => Program**



- If you see the message “Not found modem connection to a computer through USB” in the Dashboard or your PC does not recognize beacons/modem, it usually means that the STM32 driver is not installed. To install the driver, download it with the link at the top window in the Dashboard and run the installation file, then click on the link under and install the driver

Ensure that:

- You are programming the modem’s SW to the modem and the beacon’s SW to the beacon
- You are using SW for Industrial beacon if you have Industrial beacons, and you have the SW from the same SW pack, i.e., the Dashboard SW, modem SW, and beacon SW must be from the same SW pack. Don’t mix SW releases

If SW flashed SUCCESSFULLY, MOVE DIRECTLY TO 4.6.6. If you have some problems with HEX programming, use DFU programming:

DFU programming or SW uploading is used when HEX SW uploading in the Dashboard cannot be used. For example, when you are updating from a very old SW version or when the SW includes significant changes to the system, the only possible way to update the SW is via DFU programming.

- After the DFU SW upgrade, future SW upgrades can be done regularly via the Dashboard
- Industrial beacons have magnetic DFU mode and reset

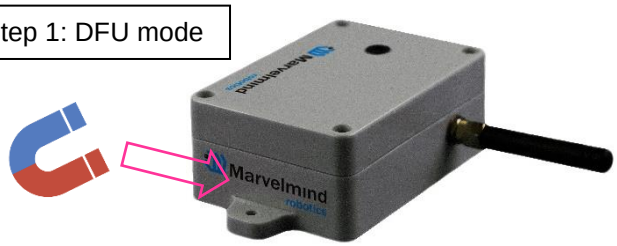
- Download the latest SW package, unzip it, and select the proper version of the SW for your HW and frequency variant. Remember that for DFU programming, you should use DFU SW (DfuSe), not Dashboard's .hex file
- Download DfuSe
- Here you will find different versions of DfuSe. v3.0.5 or v3.0.6, whichever works the best for your Windows: DfuSe v3.0.5 or DfuSe v3.0.6

DFU Programming:

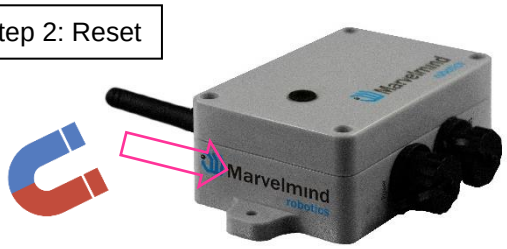
Uploading Beacon Industrial's (Not super) DFU software to Industrial Super-Beacon hardware permanently damages the Industrial Super-Beacon board. Be double attentive to the update.

6.6.5.1. Activate DFU mode and reset the beacon (Industrial beacons have magnetic DFU mode and reset). Place the first magnet (any strong and modern magnet) on the right side of the beacon (Step 1). After that, place a second magnet on the left side of the beacon and remove it in a second just to reset it (Step 2)

Step 1: DFU mode



Step 2: Reset



Magnet examples

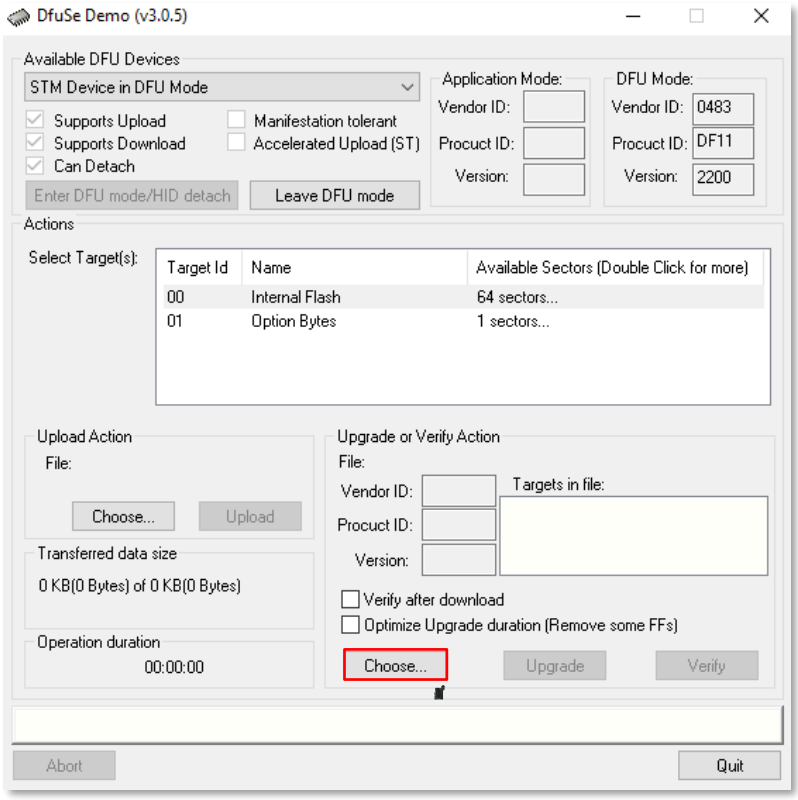
6.6.5.2. Connect the beacon via USB to your PC

6.6.5.3. Connect the power supply cable to your beacon

6.6.5.4. Run DfuSe

6.6.5.5. In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode

6.6.5.6. Choose the DFU driver (file) for the beacon



6.6.5.7. Click the **UPGRADE** button

6.6.5.8. After a few seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW you selected

6.6.5.9. Start the Dashboard

6.6.5.10. Reset the beacon again

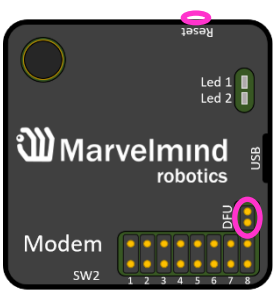
6.6.5.11. Check SW on the beacon afterwards

6.6.5.12. Everything should be OK with SW now. DFU programming is complete.

DFU Programming for the modem:

The steps are similar to those for beacon DFU programming.

6.6.5.13. Short the circuit pins, as shown in the picture, and press the **Reset** button



6.6.5.14. The modem will go to DFU mode. Press the **UPGRADE** button in the DfuSe program

6.6.5.15. The DFU will be uploaded to the modem after a couple of seconds. Make sure it takes 1-3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different one.

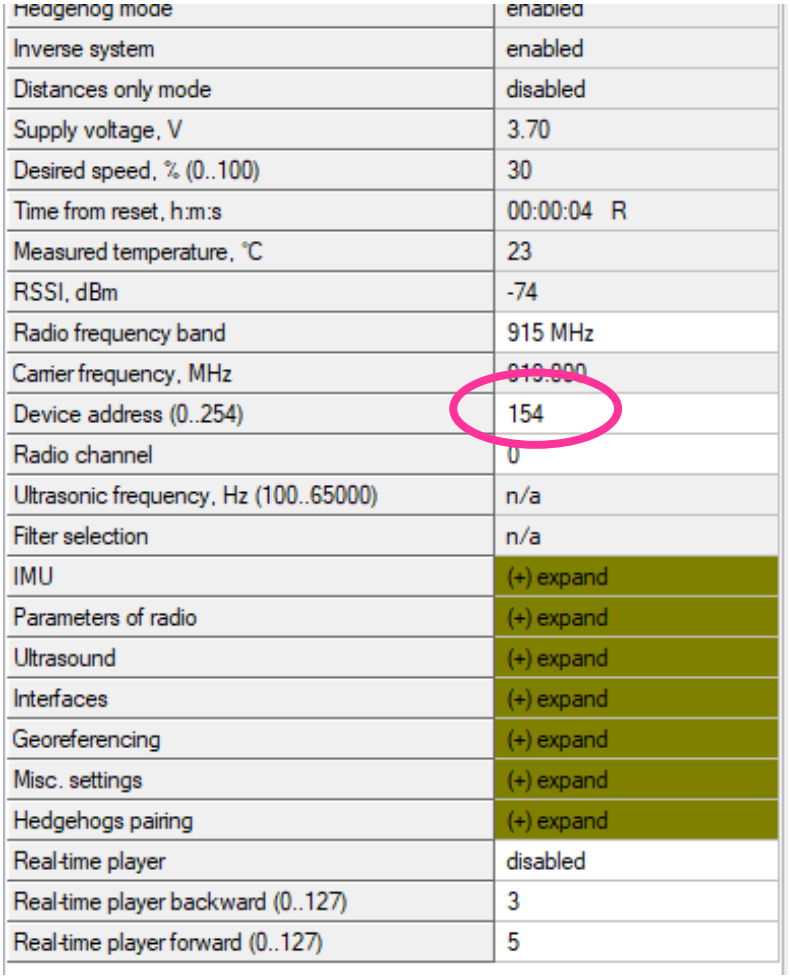
6.6.5.16. Disconnect the short circuit.

6.6.5.17. Start the Dashboard and press the **RESET** button.

If you have uploaded the latest firmware for all the boards, you can start to activate the system:

6.6.6. While the beacon or modem is connected to the Dashboard, click the DEFAULT button on the Dashboard to upload the default settings

6.6.7. Write down the beacon's address for future use or change the address at your convenience as shown here:



Hedgehog mode	enabled
Inverse system	enabled
Distances only mode	disabled
Supply voltage, V	3.70
Desired speed, % (0..100)	30
Time from reset, h:m:s	00:00:04 R
Measured temperature, °C	23
RSSI, dBm	-74
Radio frequency band	915 MHz
Carrier frequency, MHz	913.000
Device address (0..254)	154
Radio channel	0
Ultrasonic frequency, Hz (100..65000)	n/a
Filter selection	n/a
IMU	(+) expand
Parameters of radio	(+) expand
Ultrasound	(+) expand
Interfaces	(+) expand
Georeferencing	(+) expand
Misc. settings	(+) expand
Hedgehogs pairing	(+) expand
Real-time player	disabled
Real-time player backward (0..127)	3
Real-time player forward (0..127)	5

Power save functions	enabled / active
Hedgehog mode	enabled
Supply voltage, V (3.50..4.35)	4.08
Time from reset, h:m:s	00:02:55 / 19.20.54 / 0
RSSI from modem, dBm	-81
RSSI to modem, dBm	n/a
Profile	General (915 MHz band)
Carrier frequency, MHz	919.0
Radio channel	0
Device address (1..254)	104
Height, m (-320.000..320.000)	0.000
Measured temperature, °C	23
Ultrasonic frequency, Hz (100..65000)	45000
Advanced settings	(+) expand
IMU	(+) expand

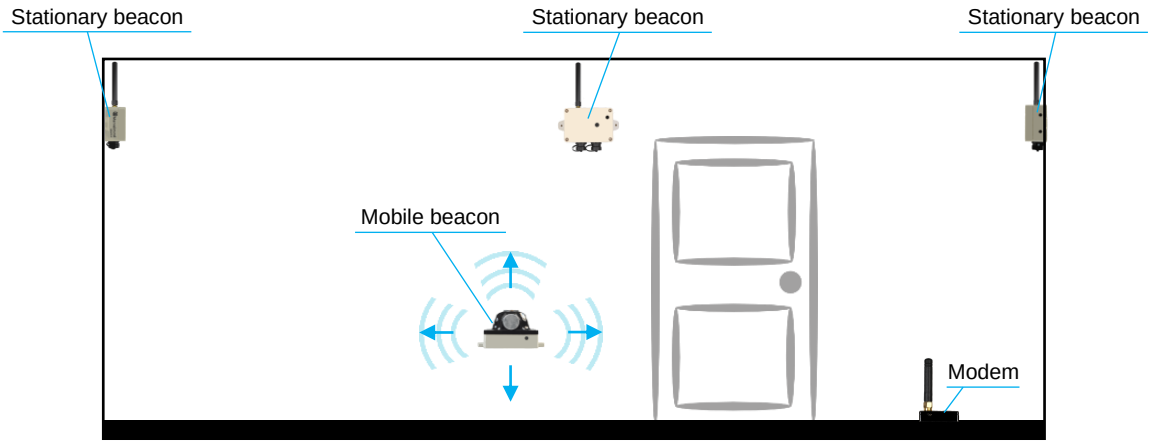
6.6.8. Choose the Industrial-TX-25 beacon and enable “Hedgehog mode”. Use this beacon as a mobile beacon in the future. Here is a help video.

6.6.9. Press the RESET (Industrial beacons have magnetic re button on your beacons and modem after programming

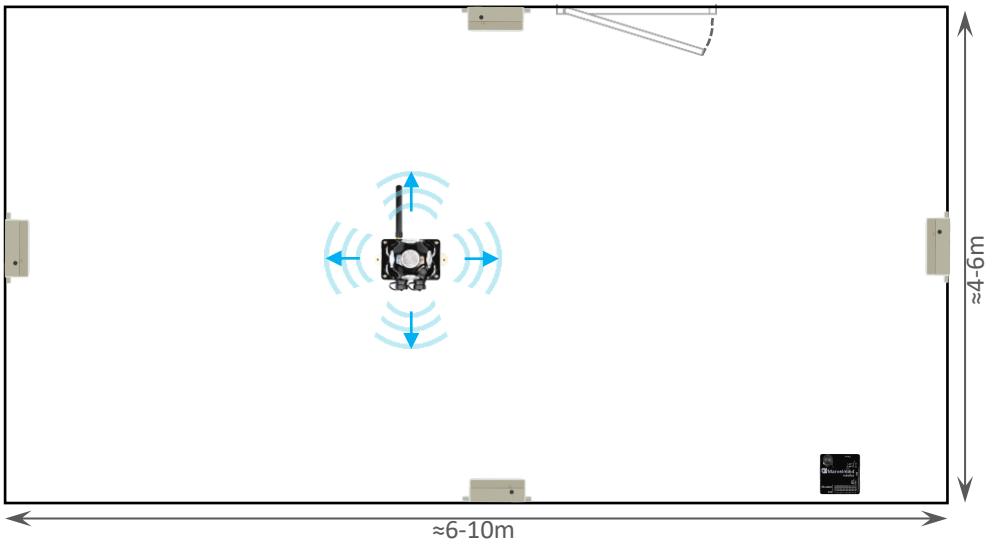
6.6.10. After programming devices with the latest software, the modem and beacons are ready for use

6.6.11. Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon’s height for future changes in the settings. The help video on installation can be found here.

Side view:



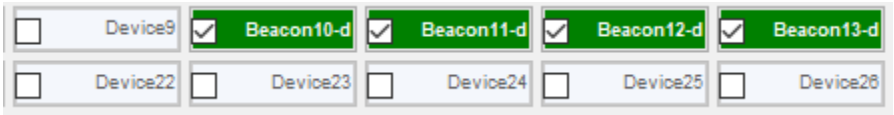
Top view:



6.6.12. Connect the modem via USB to a Windows PC with the Dashboard installed

6.6.13. Run the Dashboard. In the left corner of the Dashboard, the modem should be shown as connected

6.6.14. Wake up all beacons by clicking on the buttons in the Dashboard on the panel



6.6.15. It may take up to 7-10 seconds for the beacons to wake up

6.6.16. If the modem is not active and is not powered, the beacons will go into sleep mode automatically after 1 minute

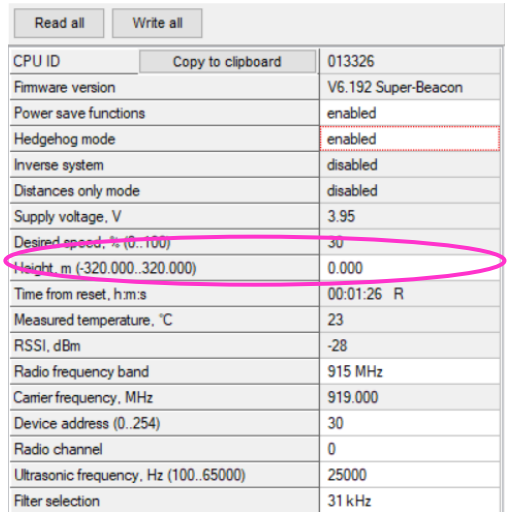
6.6.17. The system may run the frequency search if it is the first time you wake up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are the default ones

6.6.18. Check that the radio settings on the modem and the radio settings on the beacon are the same

6.6.19. Now you can check RSSI, voltage, ultrasonic filter settings, etc., on the panel in the right corner of the Dashboard

Supply voltage, V	3.95
Desired speed, % (0..100)	30
Height, m (-320.000..320.000)	0.000
Time from reset, h:m:s	00:01:26 R
Measured temperature, °C	23
RSSI, dBm	-28
Radio frequency band	915 MHz
Carrier frequency, MHz	919.000
Device address (0..254)	30
Radio channel	0
Ultrasonic frequency, Hz (100..65000)	25000
Filter selection	31 kHz

6.6.20. Enter the height of stationary beacons. Choose beacon in the list and enter the height value



Enter the height for the mobile beacon if you use 2D mode

6.6.21. One modem in the current version supports 250 beacons (mobile + stationary combined). If you do not see some of your connected beacons on the map, you may need to scroll to find their addresses

6.6.22. Double click on the device to put it into sleep mode or wake it up

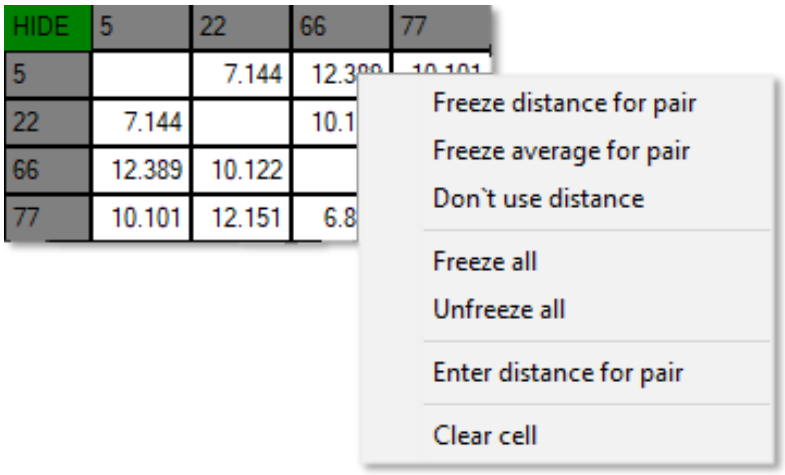
Only 4 stationary beacons may be in 1 submap. If you wake up more beacons, create a new submap for them. Or it won't be displayed on the map or in the distances table.

Now you can proceed to building the map:

Industrial-RX beacons cannot build the map automatically, so you have to make it manually.

6.6.22.1. Open the Dashboard. You will see the table of distances

6.6.22.2. Right click on the cell where you want to enter the distance. An additional menu will open; there you can control the distances. Choose **Enter distance for pair** to enter the value

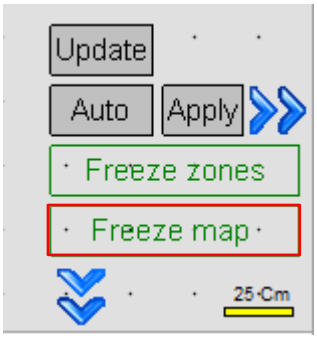


6.6.22.3. Now, enter the measured value (measure it with a laser distance meter or so). Those values will not change until you unfreeze or clear them. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can significantly impact your tracking!

6.6.22.4. Repeat for all cells

HIDE	6	22	66	77
6		8.000	4.200	11.400
22	8.000		13.100	6.500
66	4.200	13.100		10.800
77	11.400	6.500	10.800	

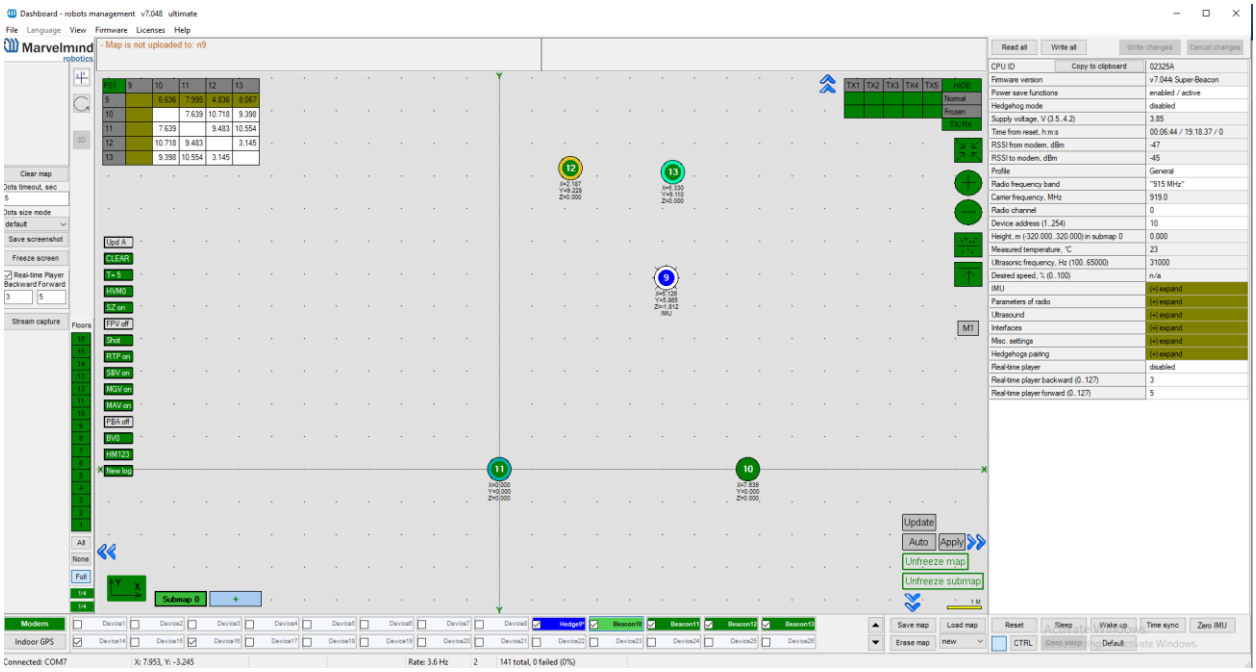
6.6.23. Freeze the map by clicking the button. Stationary beacons will stop measuring relative distances and will be ready to measure the distances from the mobile beacon(s)



6.6.24. Turn on and wake up the mobile beacon, following the same steps as the stationary beacon. Here is a help video.

6.6.25. If you see on the devices' panel in the Dashboard that the beacon is colored orange, it means there are some differences in some of the settings between beacons. For example, some sensors may be off, and some ultrasonic or radio settings may be different. You can manually change the sensors' settings by clicking on the panel in the upper right corner of the Dashboard to change the cells from gray to green to turn on the sensor. It is recommended that the default settings on all beacons and the modem be used if this is your first time using the system.

6.6.26. After you freeze the map of stationary beacons, wake up the mobile beacon. It will be traceable within 5-7 seconds.

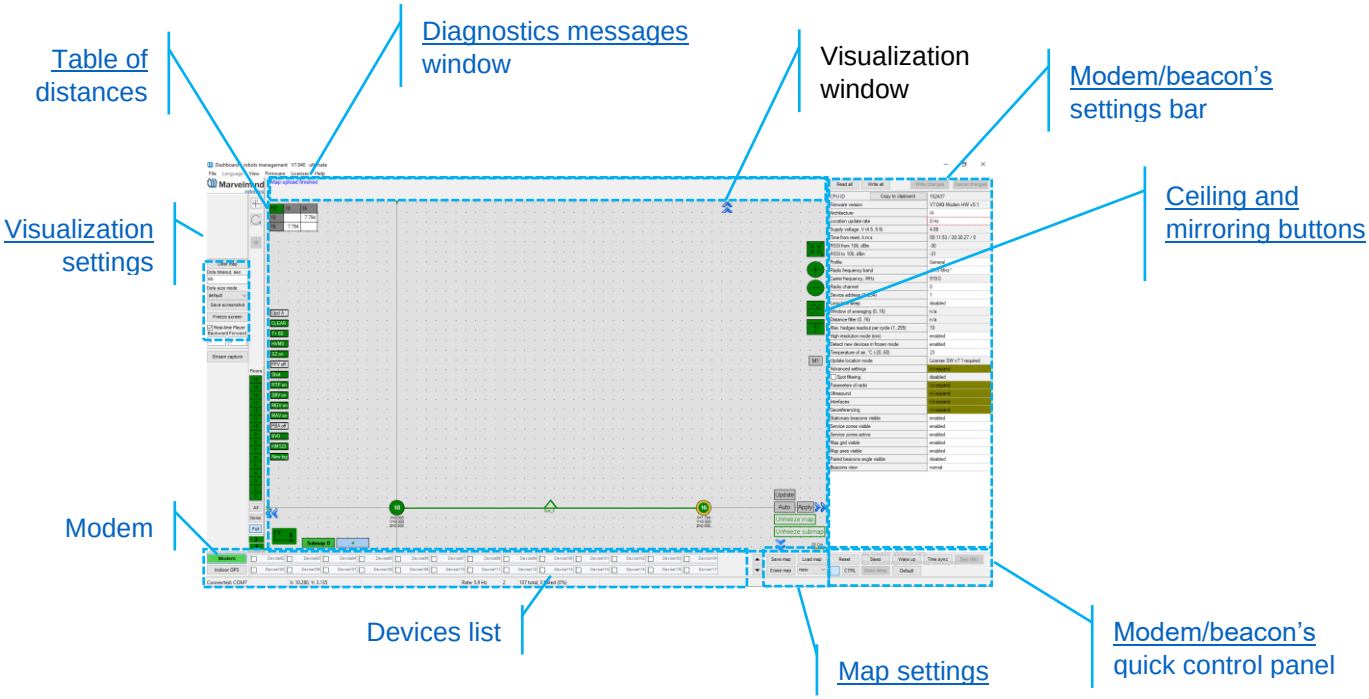


6.6.27. The system is now fully operational

7. Dashboard Menu and Parameters

7.1. Dashboard General View

This picture shows the Dashboard's general interface and items' positions.

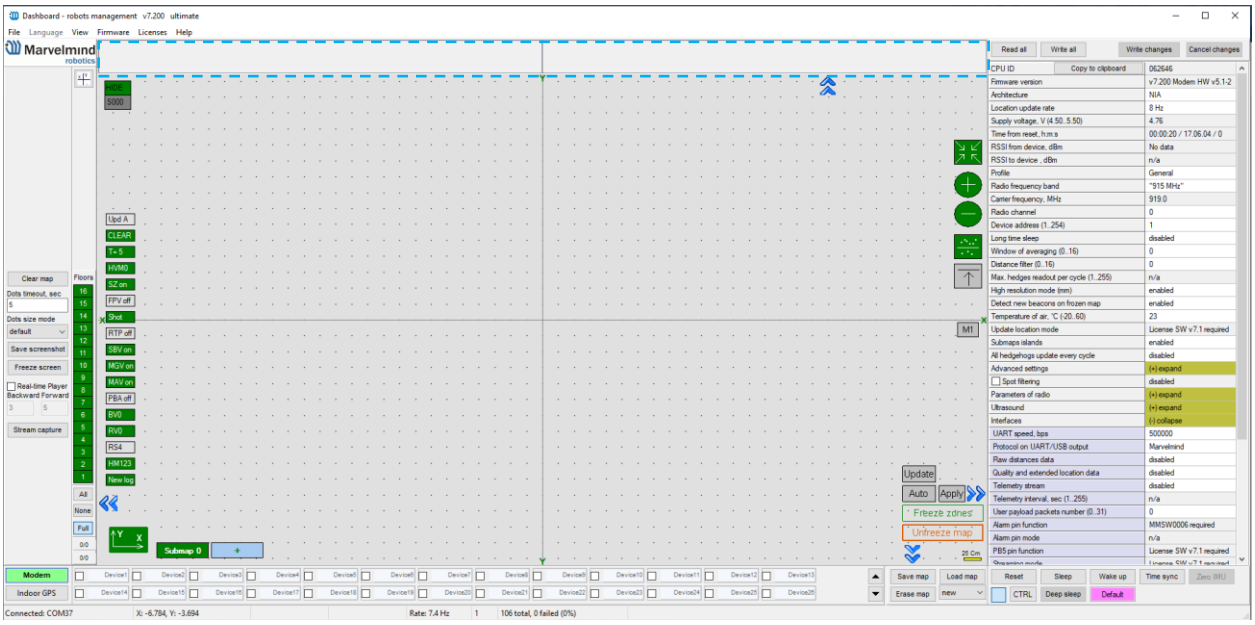


Marvelmind robotics

7.2. Diagnostics Messages Window

The diagnostic messages window is an area where essential system messages appear. It may contain a lot of helpful information.

The Diagnostics window is placed at the top of the Dashboard.



If the field is empty, the system found no issues with the launch. If you have any orange or red messages, please check them carefully and fix the problem.

There are 4 categories of reports:

- Orange – minor issue
- Red – major issue
- Green – Successfully completed settings
- Blue – Successfully completed process

Here is the list of the messages (relevant for Dashboard v7.200):

Left diagnostic window:

- Same ultrasonic frequency in submap0 beacons: n2, n3 - use beacons with different frequencies in IA submaps
- Paired beacons 25/26 ultrasonic and IMU fusion not completed. Angular difference: 45 degrees appears if the angle difference between beacons is more than 5 degrees
- IA architecture can't be selected. Upload IA firmware to modem
- NIA architecture can't be selected. Upload NIA firmware to modem
- MF NIA architecture can't be selected. Upload NIA firmware to modem
- No MF NIA license (MMSW0004) for beacons n5, n6, n7. Buy the license. MF NIA doesn’t work even if the license is not activated for one beacon in the system.
- Device N10 (V7.000) not supported
- N10 (V7.000) - too old. Update firmware
- N10 (V7.000) - newer than the dashboard. Update dashboard
- N10 (V7.000) - older than modem. Update firmware
- N10 (V7.000) - newer than modem. Update modem firmware
- Mixed IA and NIA devices
- UBX protocol for PX4 requires license MMSW0003. Buy the license.
- Beacons not assigned to submaps: n10, n11. All submaps frozen. Unfreeze or add a submap
- Beacons not assigned to submaps: n10, n11. Maximum 4 beacons per submap. Add submap
- Beacons too close: n10, n11. Place beacons at least 2 meters from the modem
- Devices with duplicated addresses: n10, n11
- FEC mismatch to modem: n10, n11 - change FEC in radio parameters
- Discharged devices: n10, n11
- 'Distances were changed in frozen submap0
- Sleeping beacons in frozen submap0
- Network setting read failed - Error reading Super-Modem network settings
- Network setting write failed - Error writing super modem network settings

- Not found UWB device - connect UWB beacon or UWB modem to modem HW v5.1 (only for Marvelmind UWB devices. In progress)
- Single hedge readout per cycle - increase the value and refreeze the map - In IA, the number of transmitted coordinates of hedgehogs per cycle 1 is entered in the modem settings. This greatly slows down the update of the coordinates of hedgehogs in the dashboard (if there are many of them). By default, this parameter is 10
- Modem HW v4.9 doesn"t support MF NIA
- You need at least 3 beacons for MF NIA. Add beacons.
- Uploading map to beacons n10, n11, n12
- Check the table of distances for submap 0 – The table of distances is not white (there are discrepancies in distances)

- More than one beacon nailed to floorplan: n10, n11. Unnail for scaling
- Floorplan scaling: click the first point on the floorplan. ESC to cancel.
- Floorplan scaling: click the second point on the floorplan. ESC to cancel.
- Floorplan is glued. Can't scale
- Floorplan is glued. Can't move
- Can't move submap - beacons n10, n11 are nailed to floorplan
- Can't move submap - beacons n10, n11 are fixed
- Can't rotate submap - beacons n10, n11 are nailed to floorplan
- Can't rotate submap - beacons n10, n11 are fixed
- Can't move: beacon n10 is nailed to floorplan
- More than one fixed beacon in submap0. Submap doesn't automatically rebuild
- Not found USB connection. Possibly, the driver was not installed. Download and install driver
- Can't set manual location. Beacon 10 is in frozen submap0. Unfreeze for manual location
- Enable Interfaces/IMU via modem/Raw IMU data to see gyro
- Enable Interfaces/IMU via modem/Raw IMU data to see the accelerometer
- Beacon n10 has no license MMSW0007. Buy the license
- Beacon n10 has no license MMSW0008. Buy the license

- Map upload finished
- Switch to recorded state 719 - Revert to the previous state by CTRL+Z (license 7.1 required)
- Licenses updated

- Paired beacons 25/26 ultrasonic and IMU fusion completed. Angular difference: 2 degrees. 4
- Network setting read completed
- Network setting write completed

Right diagnostic window:

- Adding beacons on frozen map disabled
- Stream capture mode was disabled
- Map is not frozen
- Submaps not frozen: 0, 1, 2
- No optional SW pack license (MMSW0005) for beacons: n10, n11
- Stream capture mode enabled

7.3. Table of Distances

The table of distances shows the measured distance between all beacons. The map and its graphical visualization depend on distances, an essential system part.

There are two ways of measuring:

- Measuring by ultrasound (automatic)
- Measuring by user (manual)

Measuring by ultrasound is impossible for Mini-RX and Industrial-RX beacons.
It is better to use manual input in noisy cases and cases with long distances.

Measuring by ultrasound:

1. In most cases, the system automatically builds the table of distances. If everything is good, there would be figures in cells, and they would change a little; the color of each cell would be white

HIDE	5	22	66	77
5		7.144	12.389	10.101
22	7.144		10.122	12.151
66	12.389	10.122		6.879
77	10.101	12.151	6.879	

2. If color differs, check the colors' definitions (next page) and solve the problem
3. Freeze the map only if the cells are white

Measuring by the user (necessary for Mini-RX beacons and Industrial-RX beacons and noisy cases):

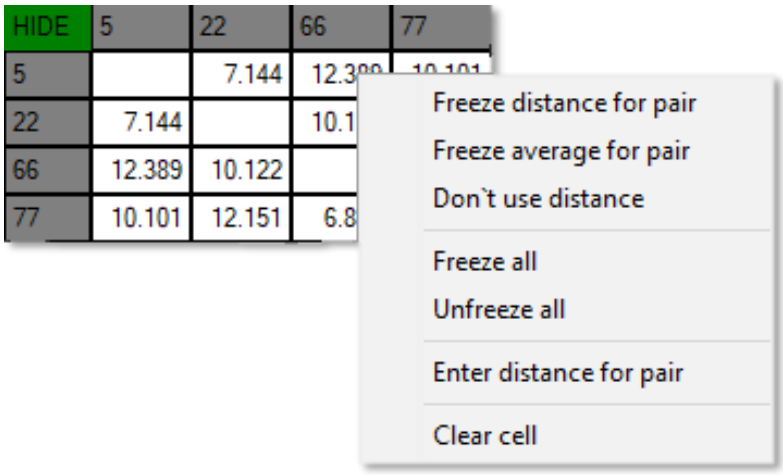
- Use manual input if the table of distances wasn't built. It may happen if the environment is boisterous, or the distances exceed the maximum possible range of the beacons. In that case, the cells' color would be green.
- Be careful with figures because a small mistake in the values will cause errors in location!

For accurate distance measurements, see the Automatic submap self-calibration license.

How to freeze/enter distance manually:

7.3.1.1. Open the Dashboard. You will see the table of distances

7.3.1.2. Right click on the cell you want to freeze/enter. An additional menu will open. There you can control the distances table. Choose **Freeze distance for the pair** to freeze it



7.3.1.3. Now, cells are frozen. Those values would not change until you unfreeze them. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can significantly impact your tracking!

HIDE	6	22	66	77
6		8.000	27.378	5.054
22	8.000		28.688	18.739
66	33.772	29.794		18.741
77	17.315	7.585	3.522	

7.3.1.4. Repeat for all cells

HIDE	6	22	66	77
6		8.000	4.200	11.400
22	8.000		13.100	6.500
66	4.200	13.100		10.800
77	11.400	6.500	10.800	

- White means that everything is good, you can freeze the map

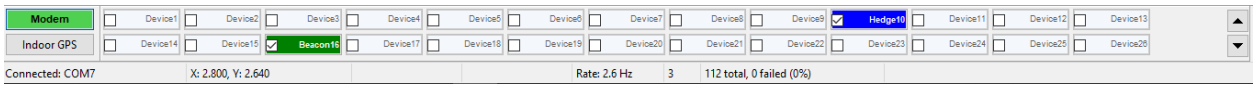
- Yellow means that something seems to be wrong, check distances and sensors before freezing

- Red means some critical misses, **DO NOT freeze the map**. Manually measure and enter distances

- Green means frozen distance, you can freeze the map, but be careful with values

7.4. Devices List

The Devices list contains information about all the beacons in the system and allows users to search for, add, and delete beacons.



Devices in this section are divided into two types:

- Stationary beacon (beacon)
- Mobile beacon (hedge)

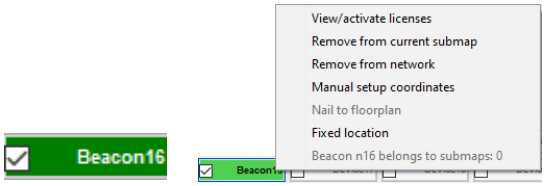
The devices list allows users to manage devices
Use double click to put the beacon into sleep mode

7.4.1. Stationary beacon (beacon)

- Right click to open an additional menu

  There you can:

- Remove the beacon from the current submap
- Remove the beacon from the whole network
- Manually setup coordinates (x, y, z)

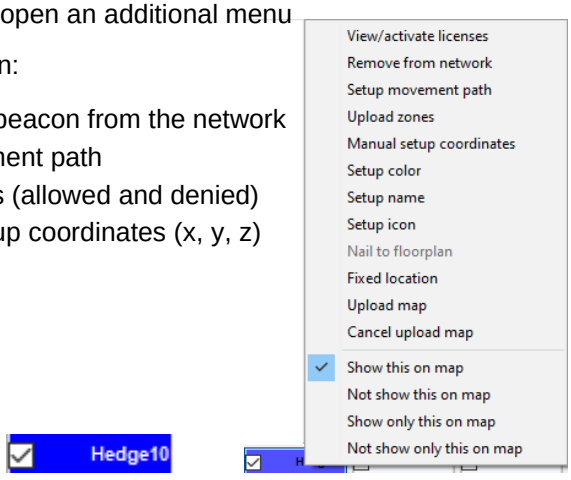


7.4.2. Mobile beacon (hedge)

- Right click to open an additional menu

  There you can:

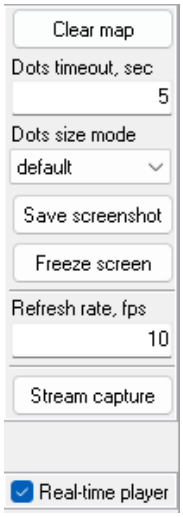
- Remove the beacon from the network
- Setup movement path
- Upload zones (allowed and denied)
- Manually setup coordinates (x, y, z)



7.5. Visualization Settings

The visualization settings window has some functions to control the visualization process:

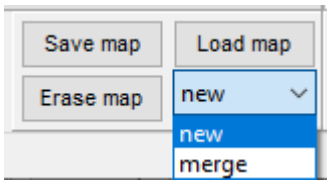
- Clear map – clear all movement path
- Dots timeout – time of path's existence (Video: Help: Dots timeout)
- Dots size mode – the size of dots
- Save screenshot – screenshot file save to **Dashboard's folder/screenshots**
- Freeze screen – The map freezes, no updates of the path



7.6. Map Settings

Map Settings offer some helpful tools:

- Save map – saves map as *.ini* file into **Dashboard folder/maps**
- Load map – loads map from *.ini* format file
- Erase map – erases map and clears it
- New/merge – build a new map or upgrade the current map



7.7. Dashboard Monitoring Mode

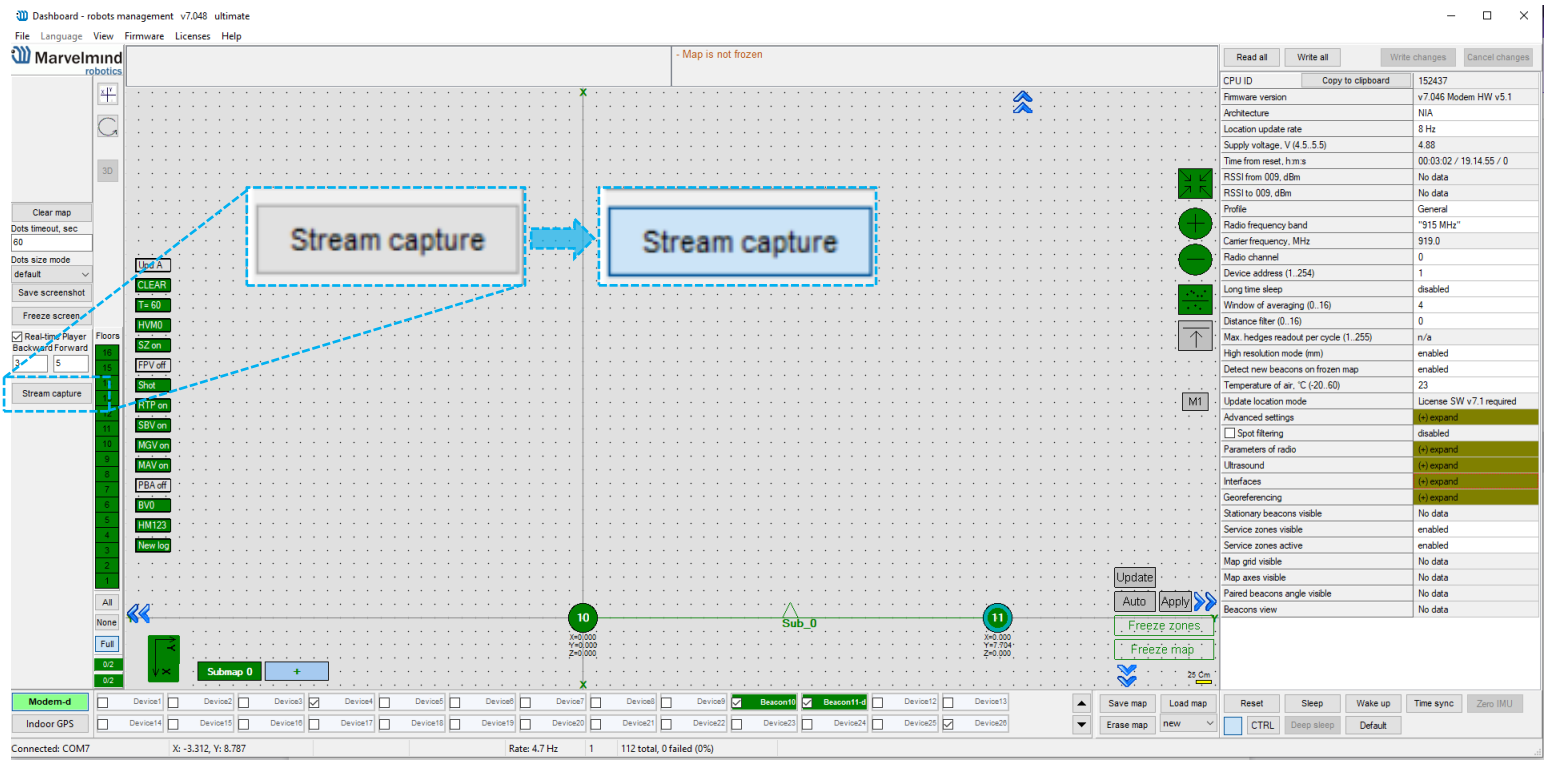
Dashboard Monitoring Mode is a mode that allows you to observe tracking without any ability to control and modify the system.

Now, you can divide permissions between users to avoid accidental changes to any settings and the system being corrupted. That is something like a safety button.

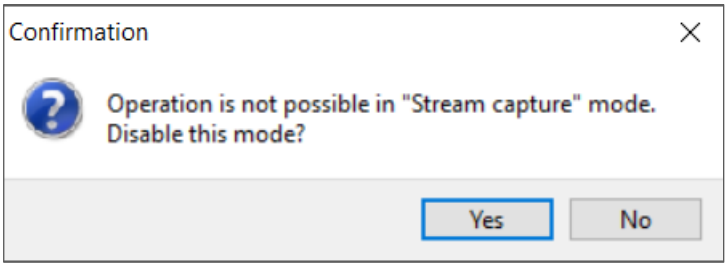
This is the first version of Dashboard Monitoring Mode. New functionality and appearance may come with future SW updates

How to enable Dashboard Monitoring Mode:

- Click on the “Stream capture” button (It will be renamed in future updates into “Dashboard Monitoring Mode”)



- If you try to change settings while Dashboard Monitoring Mode is on, the notification window will appear:

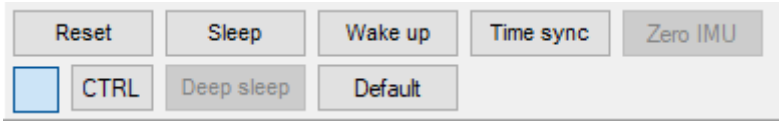


7.8. Modem/Beacon’s Quick Control Panel

The control panel allows the user to interact with devices. It can work with one device or with all devices in the system.

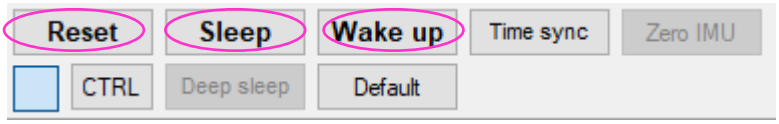
List of functions:

- Reset – Resets device
- Sleep – Send device asleep (battery economy mode)
- Wake up – Wakes up the device (from sleeping mode)
- Default – Drops all device’s settings to factory default
- Time sync – Sends time from your PC to Hedgehog (for stream it out via UART)

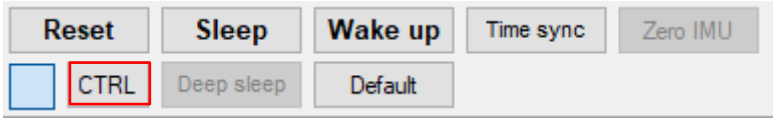


Additional Ctrl feature:

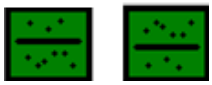
- To apply the action to all beacons in the system, use Ctrl + Left Click on the button. This applies only to buttons that turn **bold** while Ctrl is pressed.



- The CTRL button can replace the physical keyboard button for devices without a keyboard.



7.9. Celling and Mirroring Buttons on the Dashboard

- The **Mirroring** button allows the map to be displayed as a mirror reflection 

- The **Ceiling** button shows where the mobile beacon is located with respect to the stationary beacons 

- When the arrow points up, it means that the mobile beacon is below the stationary beacon 

- When the arrow points down, it means that the mobile beacon is **above the stationary beacons** 

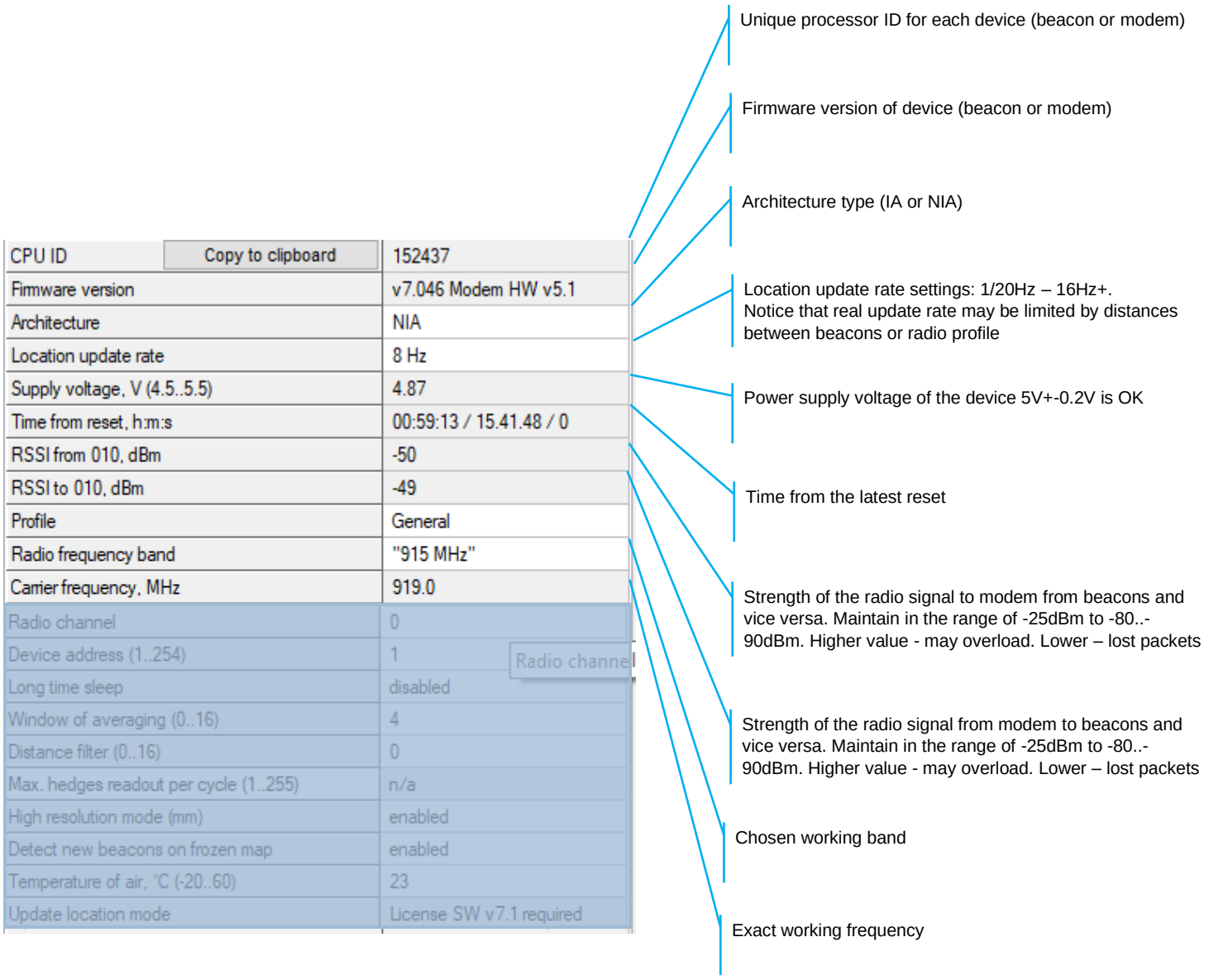
- **The Center Map** button 

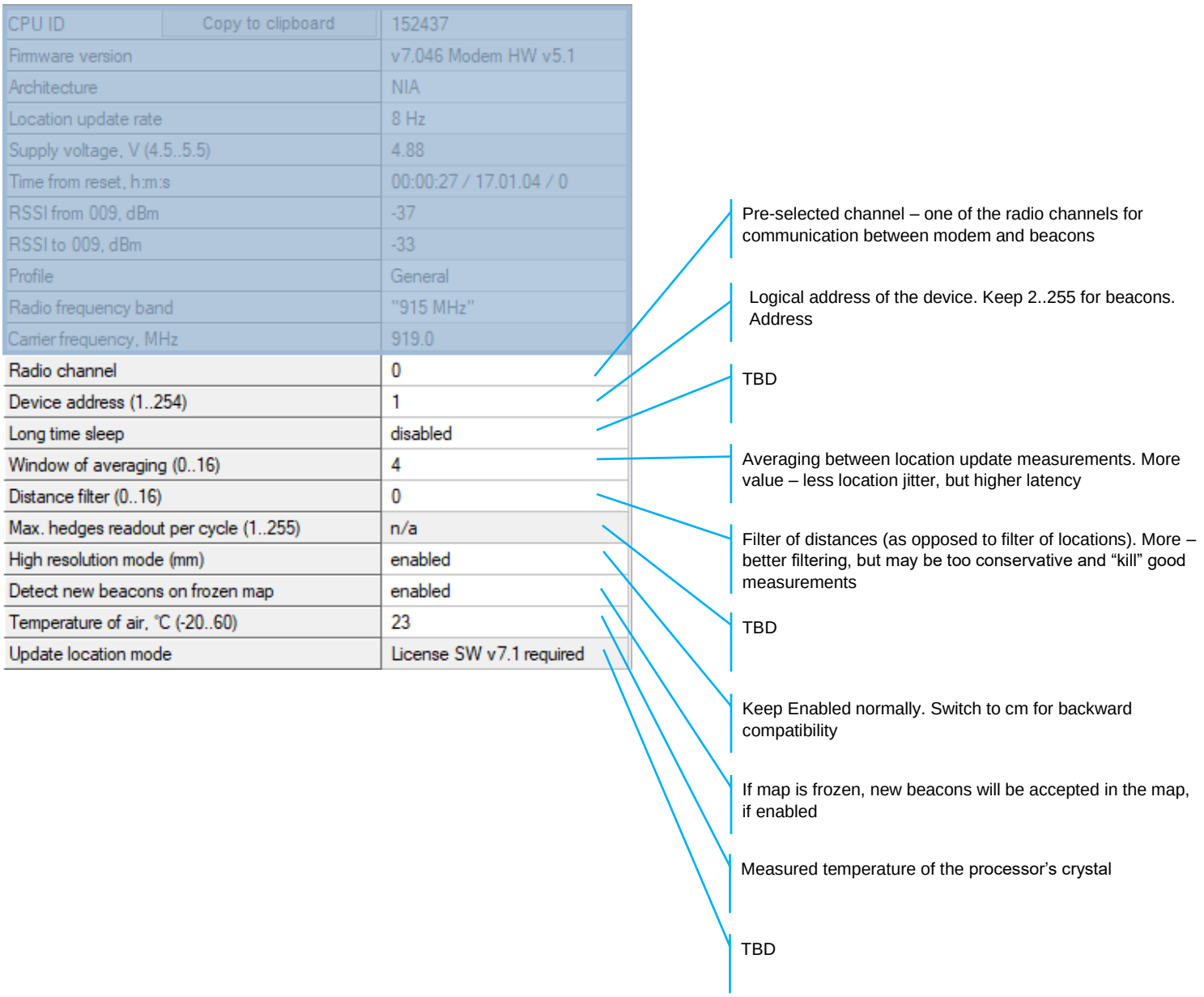
7.10. Detailed Settings

This bar allows users to adjust devices very precisely. It contains a lot of parameters for advanced usage

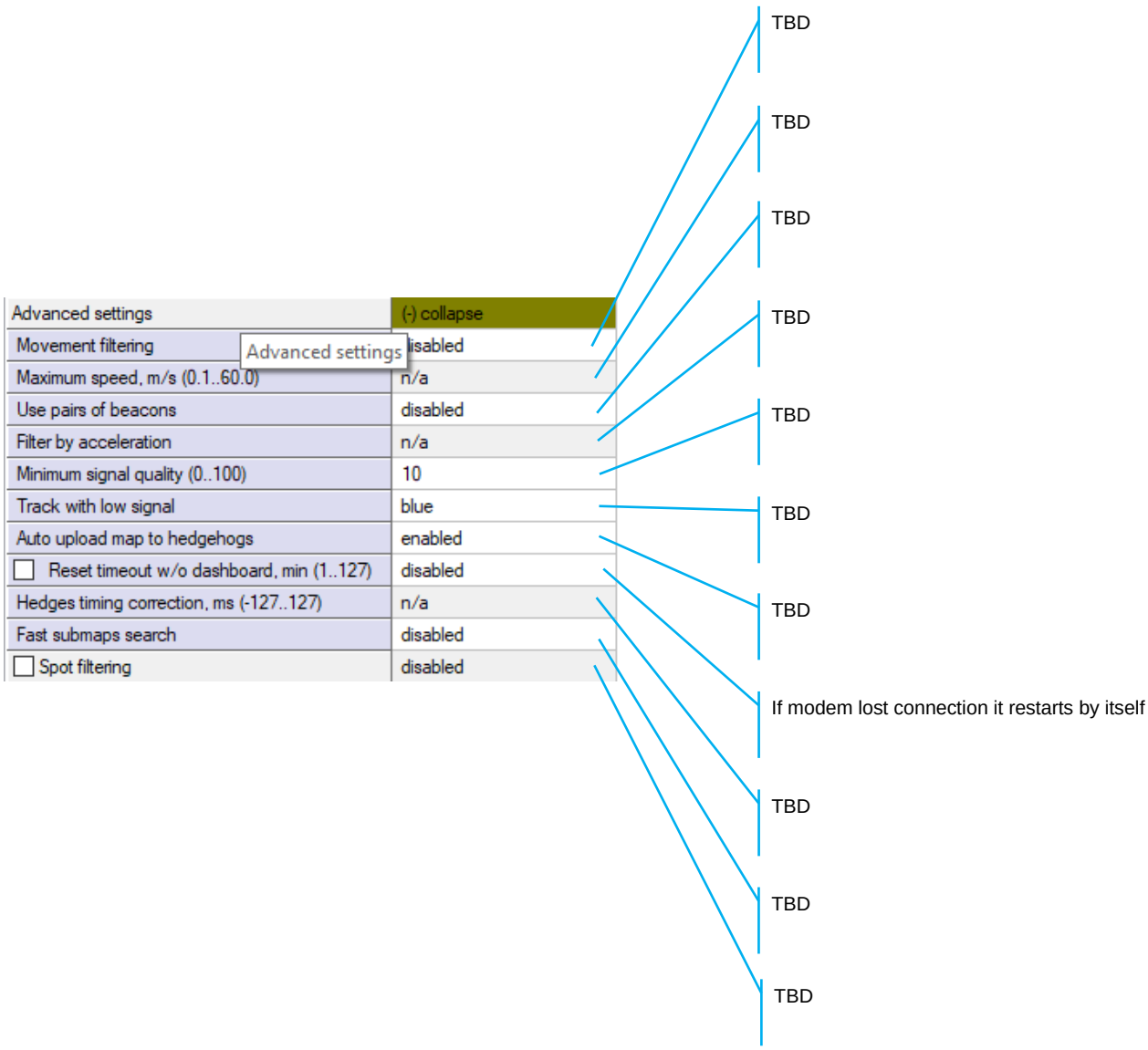
7.10.1. Modem Settings

7.10.1.1. Basic Settings

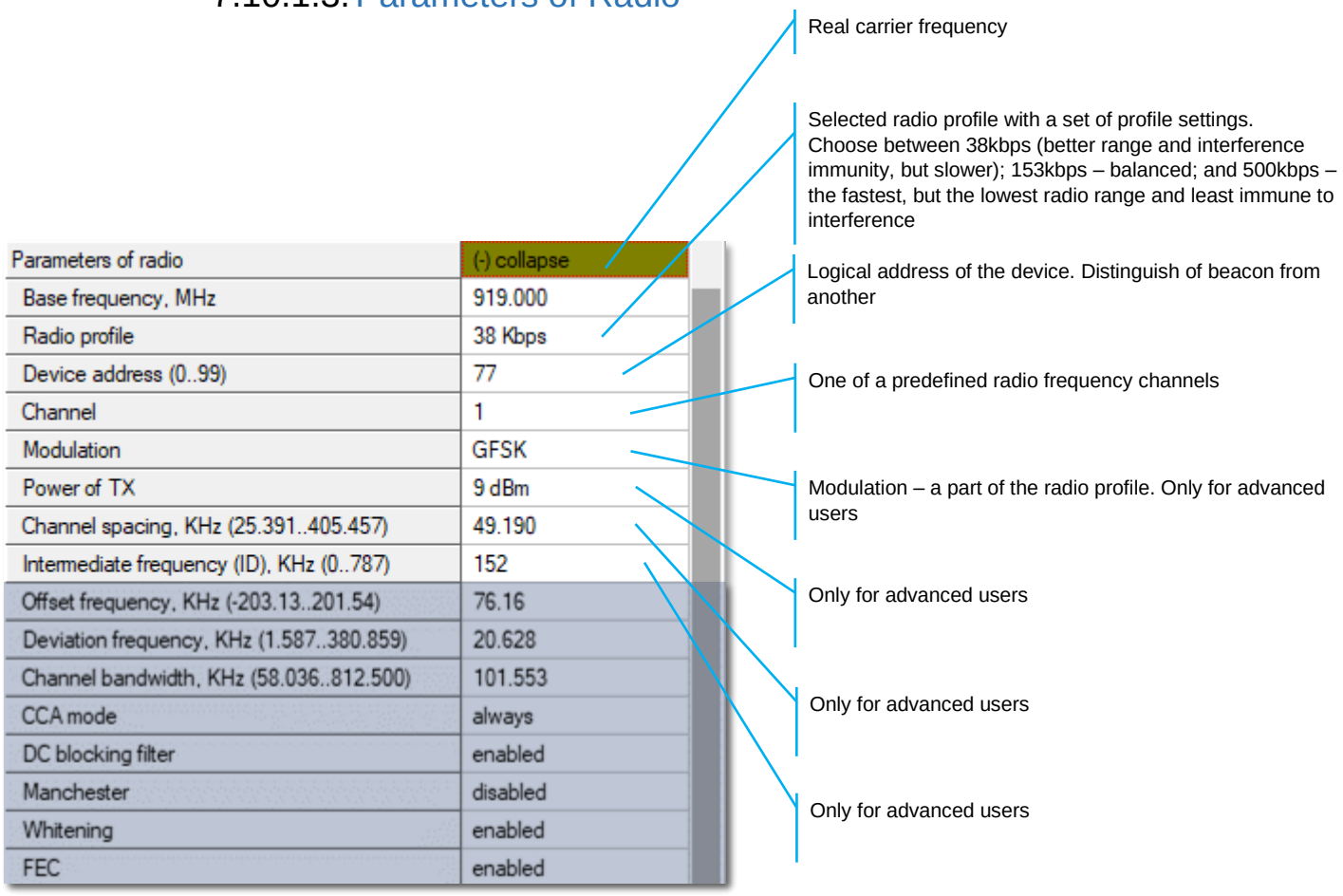



CPU ID
Copy to clipboard
152437
Firmware version
v7.046 Modem HW v5.1
Architecture
NIA
Location update rate
8 Hz
Supply voltage, V (4.5..5.5)
4.88
Time from reset, h:m:s
00:00:27 / 17.01.04 / 0
RSSI from 009, dBm
-37
RSSI to 009, dBm
-33
Profile
General
Radio frequency band
"915 MHz"
Carrier frequency, MHz
919.0
Radio channel
0
Device address (1..254)
1
Long time sleep
disabled
Window of averaging (0..16)
4
Distance filter (0..16)
0
Max. hedges readout per cycle (1..255)
n/a
High resolution mode (mm)
enabled
Detect new beacons on frozen map
enabled
Temperature of air, °C (-20..60)
23
Update location mode
License SW v7.1 required
Pre-selected channel – one of the radio channels for communication between modem and beacons
Logical address of the device. Keep 2..255 for beacons. Address
TBD
Averaging between location update measurements. More value – less location jitter, but higher latency
Filter of distances (as opposed to filter of locations). More – better filtering, but may be too conservative and “kill” good measurements
TBD
Keep Enabled normally. Switch to cm for backward compatibility
If map is frozen, new beacons will be accepted in the map, if enabled
Measured temperature of the processor’s crystal
TBD

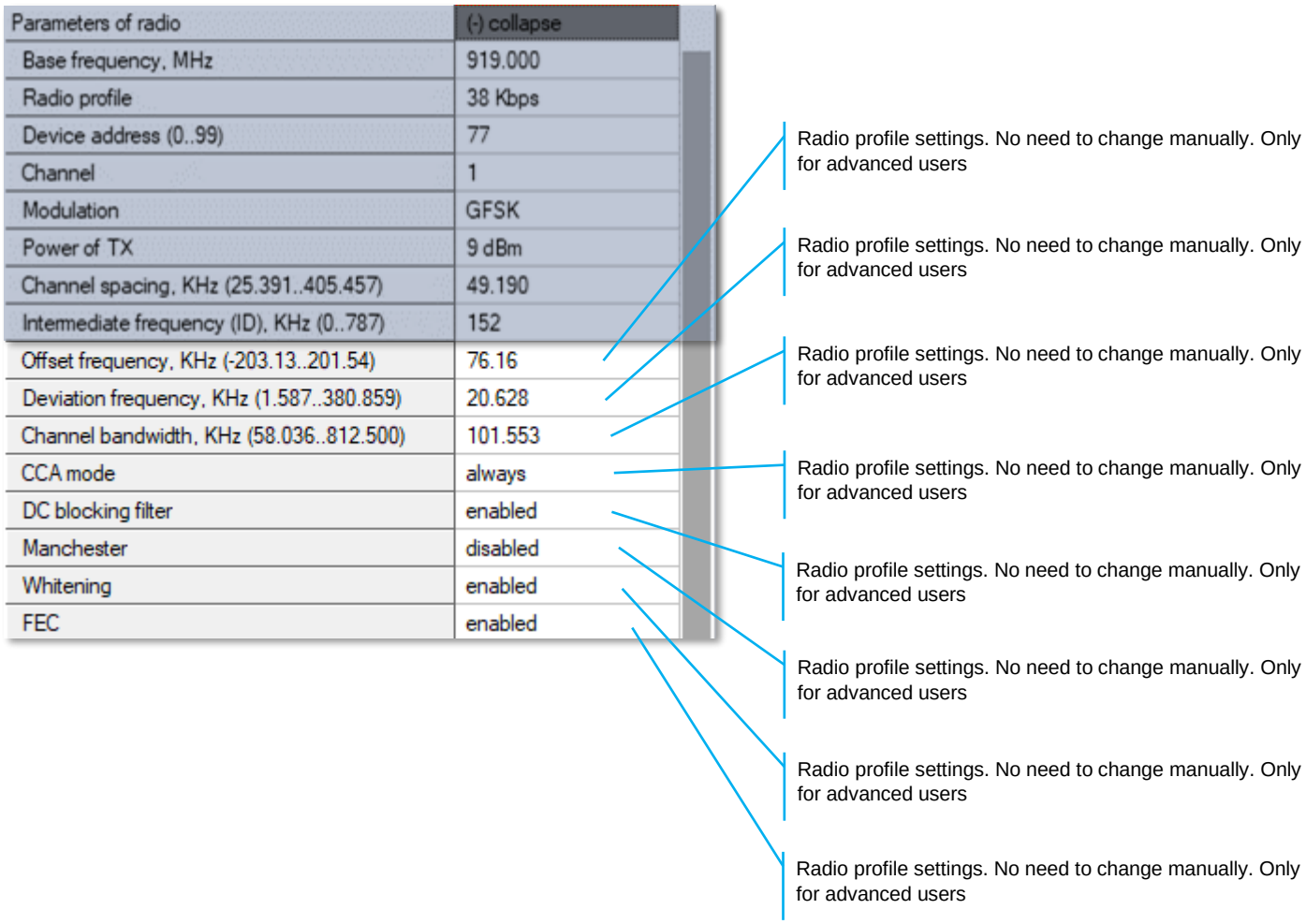
7.10.1.2. Advanced Settings



7.10.1.3. Parameters of Radio

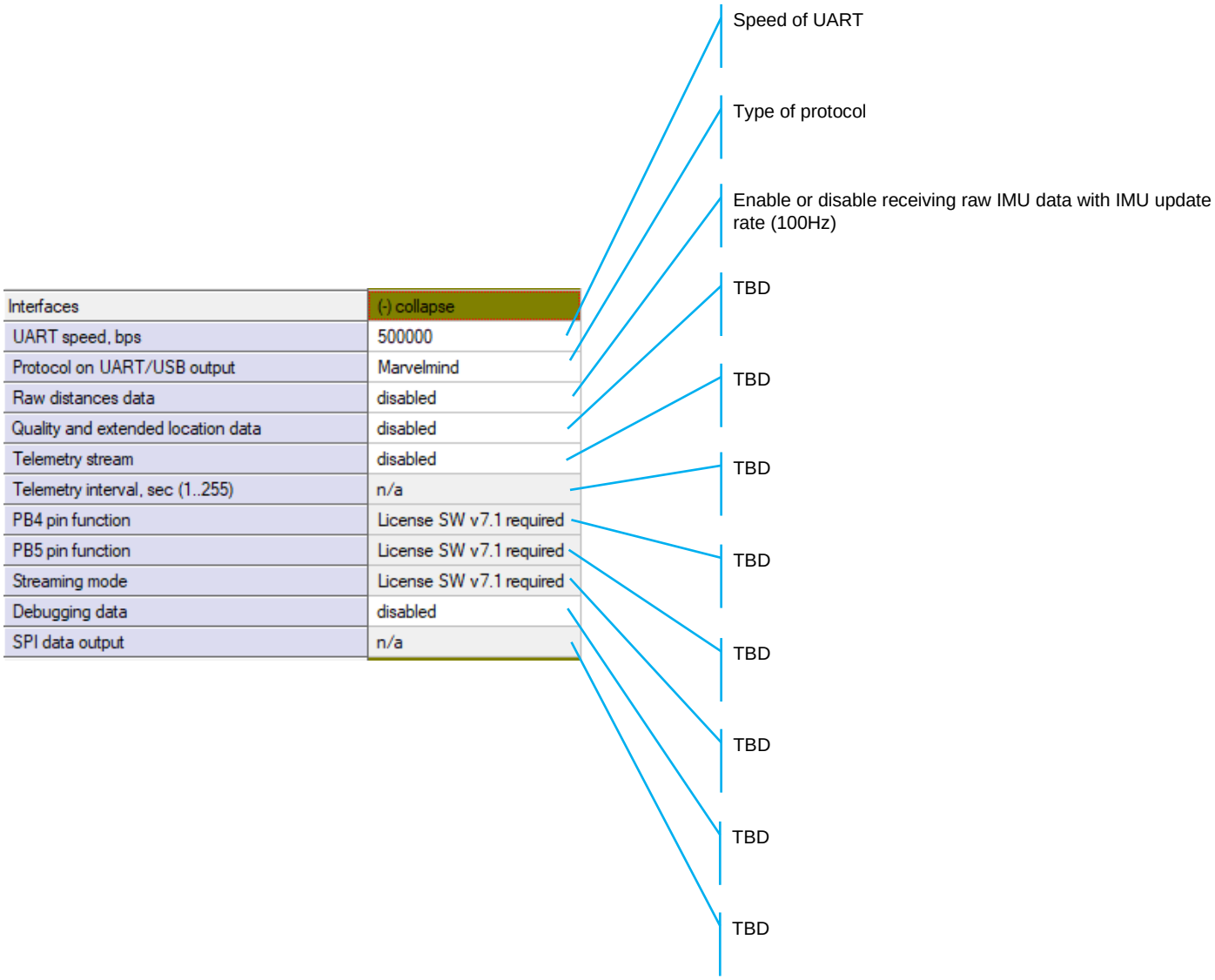


Parameters of radio	(-) collapse
Base frequency, MHz	919.000
Radio profile	38 Kbps
Device address (0..99)	77
Channel	1
Modulation	GFSK
Power of TX	9 dBm
Channel spacing, KHz (25.391..405.457)	49.190
Intermediate frequency (ID), KHz (0..787)	152
Offset frequency, KHz (-203.13..201.54)	76.16
Deviation frequency, KHz (1.587..380.859)	20.628
Channel bandwidth, KHz (58.036..812.500)	101.553
CCA mode	always
DC blocking filter	enabled
Manchester	disabled
Whitening	enabled
FEC	enabled


Parameters of radio
(-) collapse
Base frequency, MHz
919.000
Radio profile
38 Kbps
Device address (0..99)
77
Channel
1
Modulation
GFSK
Power of TX
9 dBm
Channel spacing, KHz (25.391..405.457)
49.190
Intermediate frequency (ID), KHz (0..787)
152
Offset frequency, KHz (-203.13..201.54)
76.16
Deviation frequency, KHz (1.587..380.859)
20.628
Channel bandwidth, KHz (58.036..812.500)
101.553
CCA mode
always
DC blocking filter
enabled
Manchester
disabled
Whitening
enabled
FEC
enabled
Radio profile settings. No need to change manually. Only for advanced users
Radio profile settings. No need to change manually. Only for advanced users
Radio profile settings. No need to change manually. Only for advanced users
Radio profile settings. No need to change manually. Only for advanced users
Radio profile settings. No need to change manually. Only for advanced users
Radio profile settings. No need to change manually. Only for advanced users
Radio profile settings. No need to change manually. Only for advanced users
Radio profile settings. No need to change manually. Only for advanced users

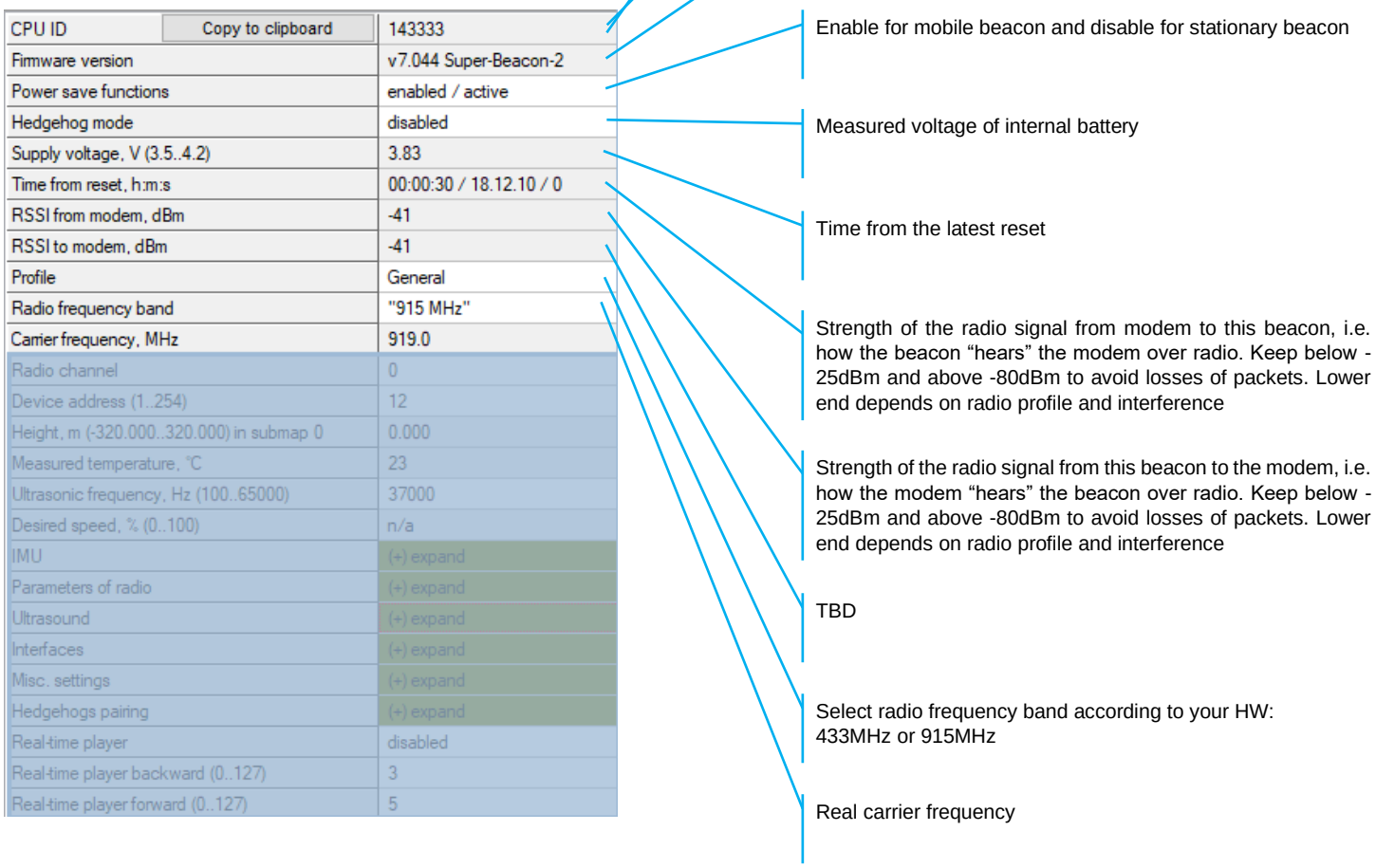
7.10.1.4. Interfaces

Interfaces	(-) collapse
UART speed, bps	500000
Protocol on UART/USB output	Marvelmind
Raw distances data	disabled
Quality and extended location data	disabled
Telemetry stream	disabled
Telemetry interval, sec (1..255)	n/a
PB4 pin function	License SW v7.1 required
PB5 pin function	License SW v7.1 required
Streaming mode	License SW v7.1 required
Debugging data	disabled
SPI data output	n/a

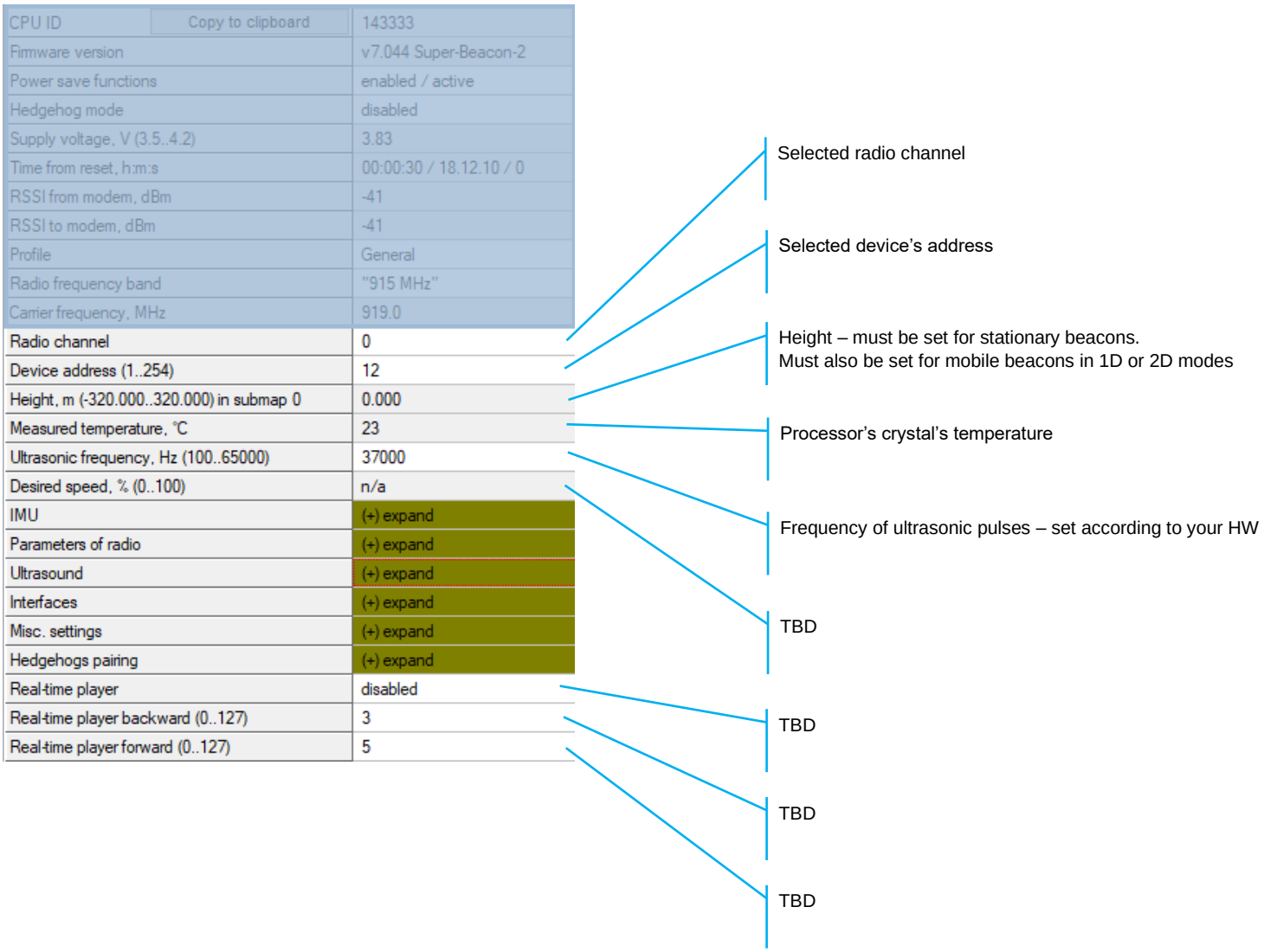


7.10.2. Beacon's Settings

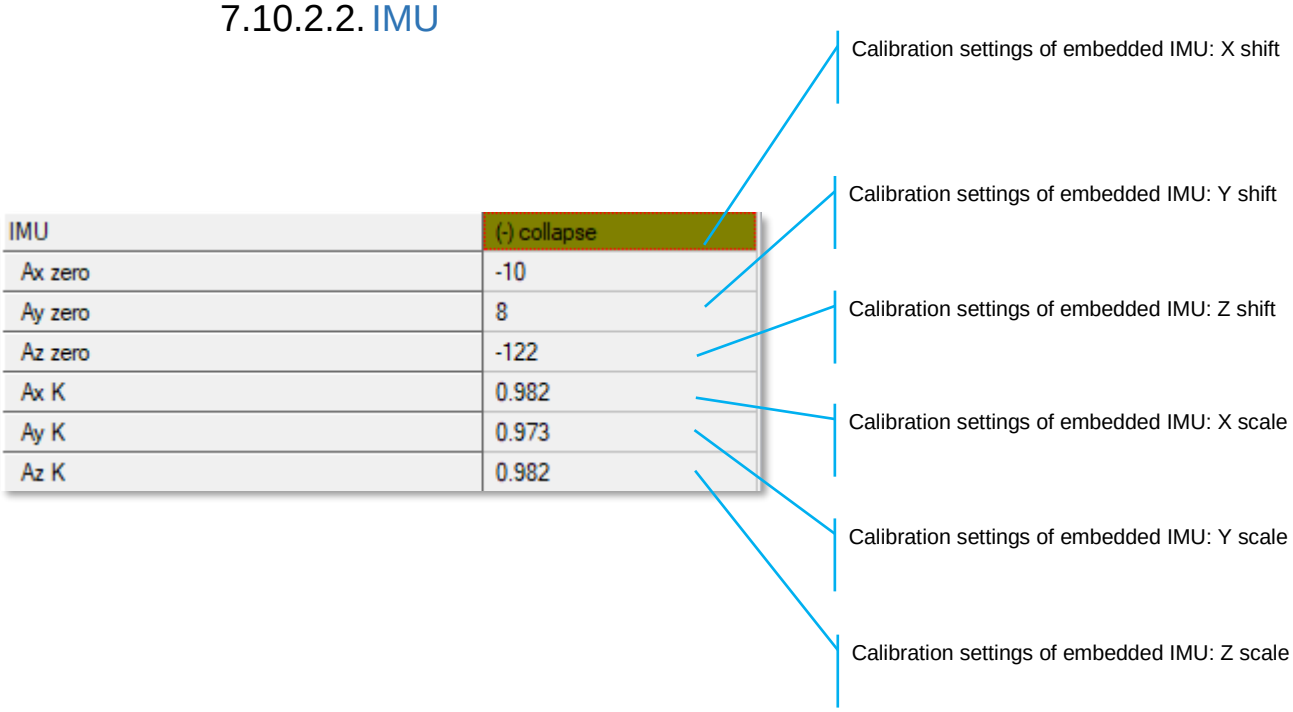
7.10.2.1. Basic Settings



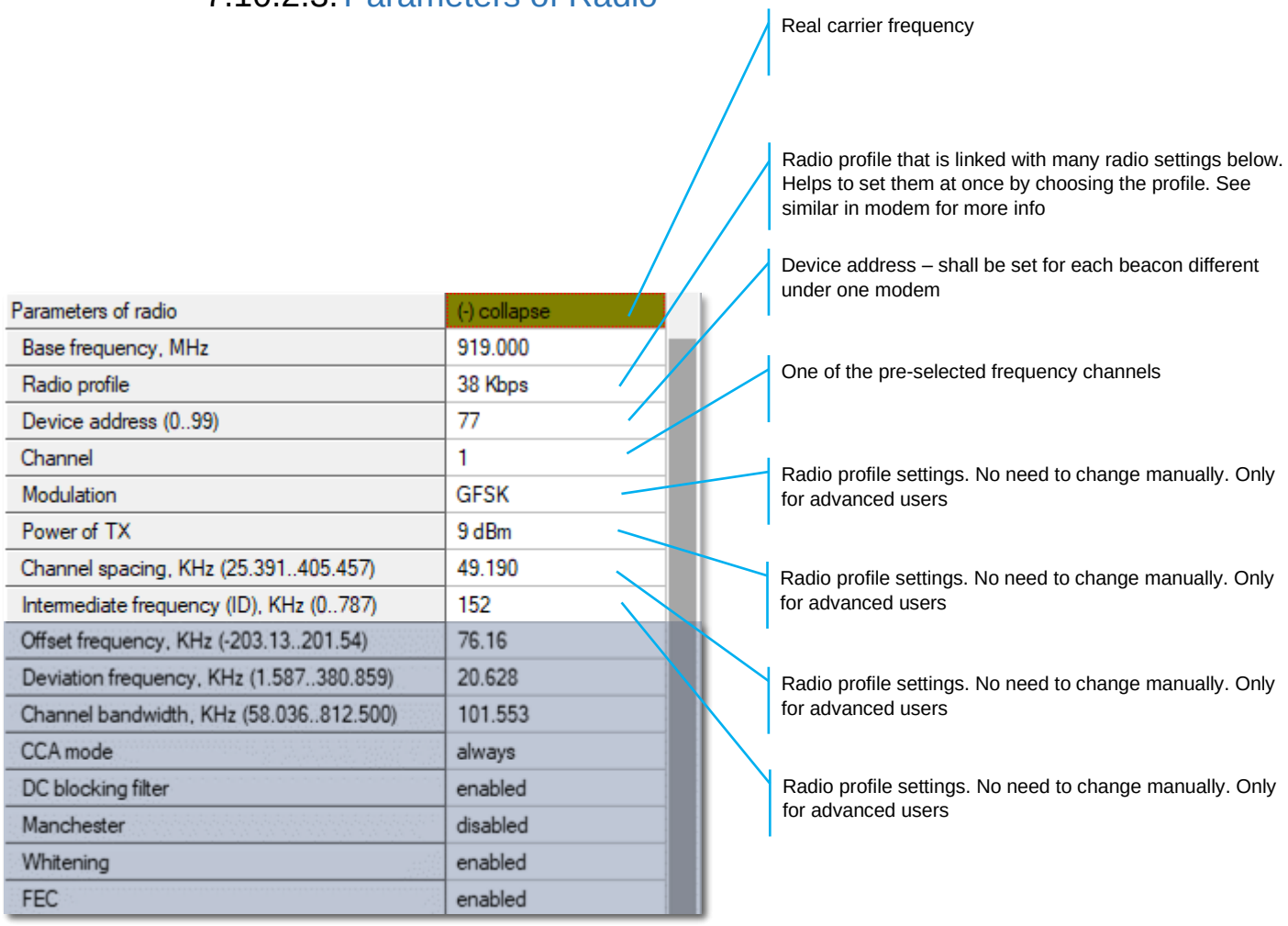
CPU ID	Copy to clipboard	143333
Firmware version		v7.044 Super-Beacon-2
Power save functions		enabled / active
Hedgehog mode		disabled
Supply voltage, V (3.5..4.2)		3.83
Time from reset, h:m:s		00:00:30 / 18.12.10 / 0
RSSI from modem, dBm		-41
RSSI to modem, dBm		-41
Profile		General
Radio frequency band		"915 MHz"
Carrier frequency, MHz		919.0
Radio channel		0
Device address (1..254)		12
Height, m (-320.000..320.000) in submap 0		0.000
Measured temperature, °C		23
Ultrasonic frequency, Hz (100..65000)		37000
Desired speed, % (0..100)		n/a
IMU		(+) expand
Parameters of radio		(+) expand
Ultrasound		(+) expand
Interfaces		(+) expand
Misc. settings		(+) expand
Hedgehogs pairing		(+) expand
Real-time player		disabled
Real-time player backward (0..127)		3
Real-time player forward (0..127)		5

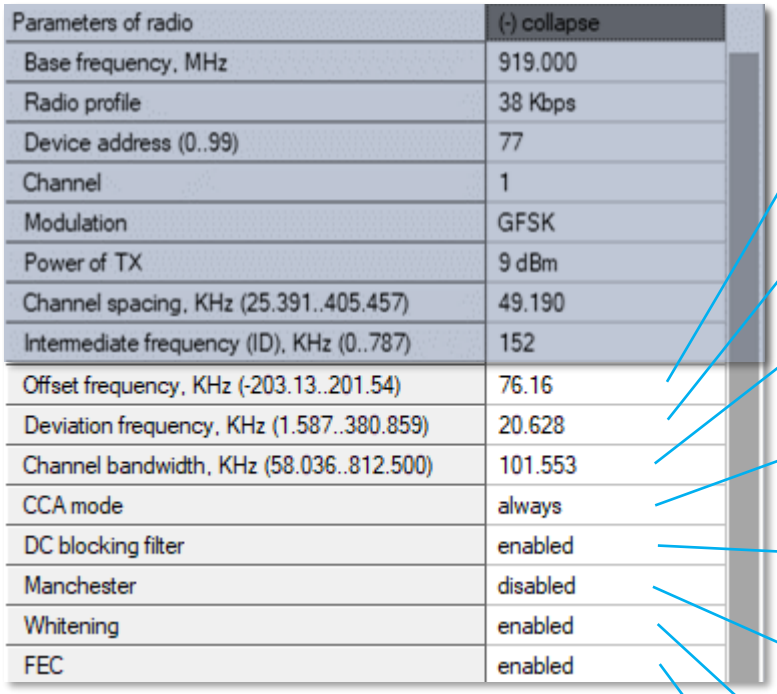

CPU ID
Copy to clipboard
143333
Firmware version
v7.044 Super-Beacon-2
Power save functions
enabled / active
Hedgehog mode
disabled
Supply voltage, V (3.5..4.2)
3.83
Time from reset, h:m:s
00:00:30 / 18.12.10 / 0
RSSI from modem, dBm
-41
RSSI to modem, dBm
-41
Profile
General
Radio frequency band
"915 MHz"
Carrier frequency, MHz
919.0
Radio channel
0
Device address (1..254)
12
Height, m (-320.000..320.000) in submap 0
0.000
Measured temperature, °C
23
Ultrasonic frequency, Hz (100..65000)
37000
Desired speed, % (0..100)
n/a
IMU
(+) expand
Parameters of radio
(+) expand
Ultrasound
(+) expand
Interfaces
(+) expand
Misc. settings
(+) expand
Hedgehogs pairing
(+) expand
Real-time player
disabled
Real-time player backward (0..127)
3
Real-time player forward (0..127)
5
Selected radio channel
Selected device's address
Height – must be set for stationary beacons.
Must also be set for mobile beacons in 1D or 2D modes
Processor's crystal's temperature
Frequency of ultrasonic pulses – set according to your HW
TBD
TBD
TBD
TBD

7.10.2.2. IMU



7.10.2.3. Parameters of Radio





Parameters of radio	(-) collapse
Base frequency, MHz	919.000
Radio profile	38 Kbps
Device address (0..99)	77
Channel	1
Modulation	GFSK
Power of TX	9 dBm
Channel spacing, KHz (25.391..405.457)	49.190
Intermediate frequency (ID), KHz (0..787)	152
Offset frequency, KHz (-203.13..201.54)	76.16
Deviation frequency, KHz (1.587..380.859)	20.628
Channel bandwidth, KHz (58.036..812.500)	101.553
CCA mode	always
DC blocking filter	enabled
Manchester	disabled
Whitening	enabled
FEC	enabled

Radio profile settings. No need to change manually. Only for advanced users

Radio profile settings. No need to change manually. Only for advanced users

Radio profile settings. No need to change manually. Only for advanced users

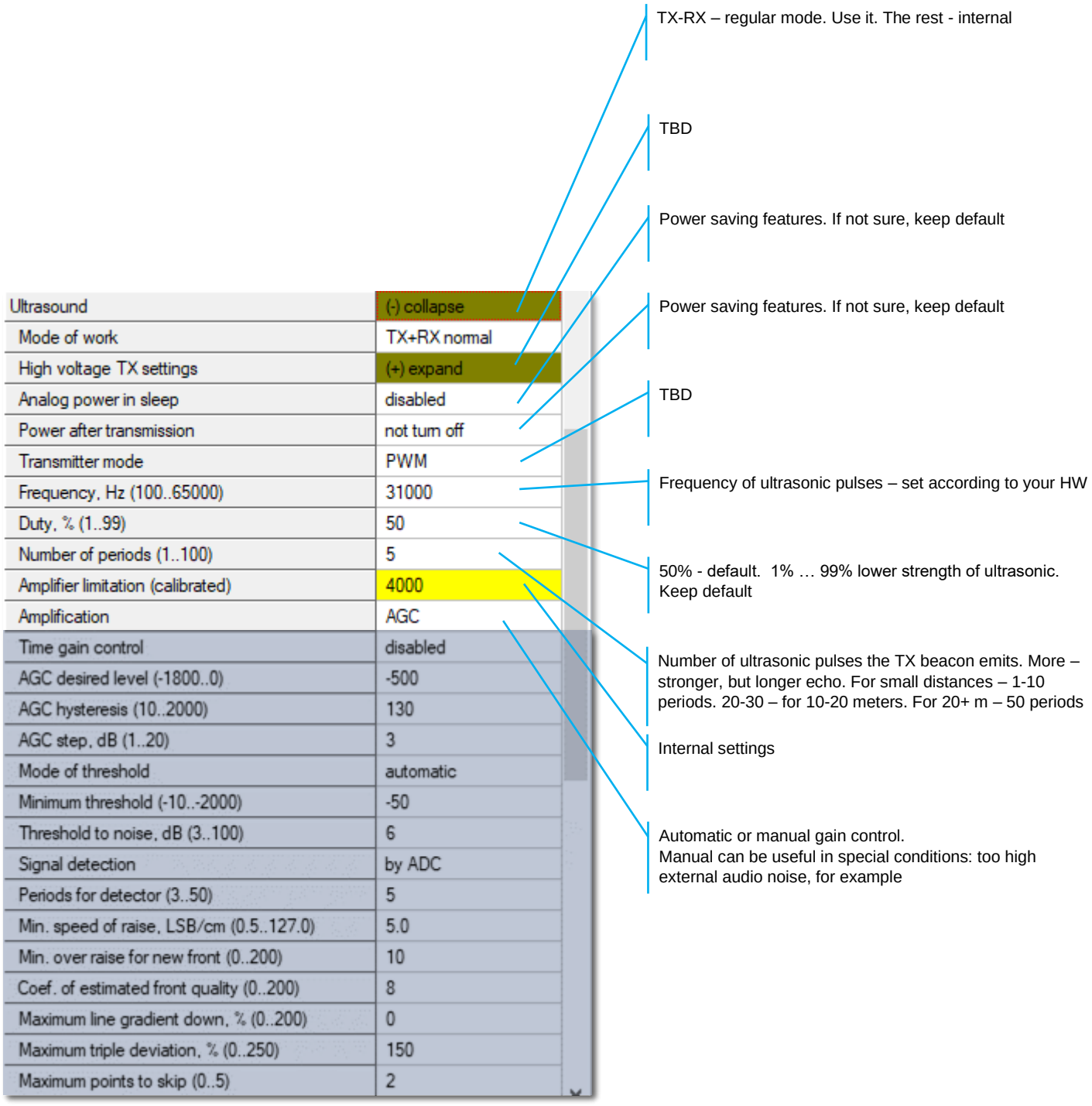
Radio profile settings. No need to change manually. Only for advanced users

Radio profile settings. No need to change manually. Only for advanced users

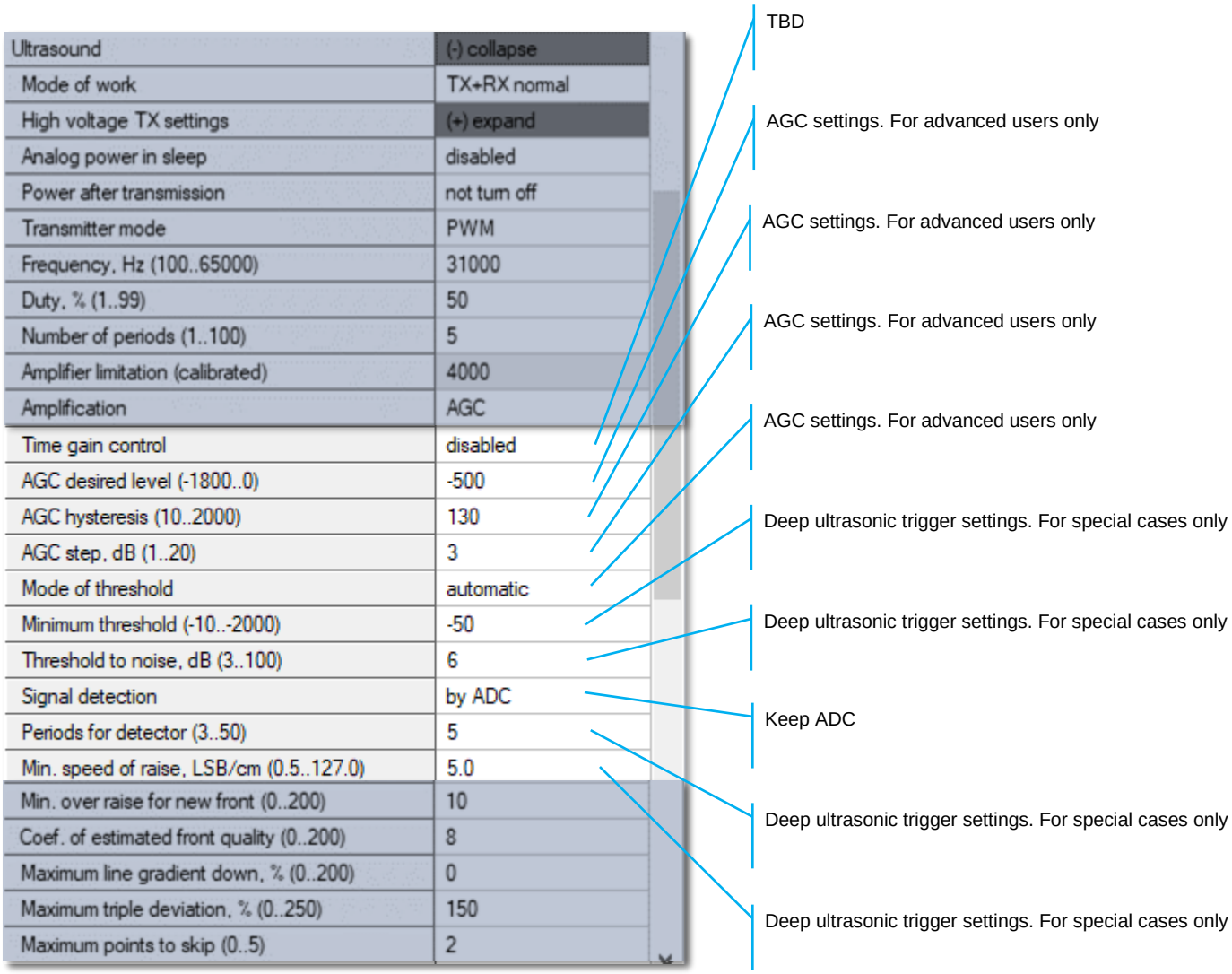
Radio profile settings. No need to change manually. Only for advanced users

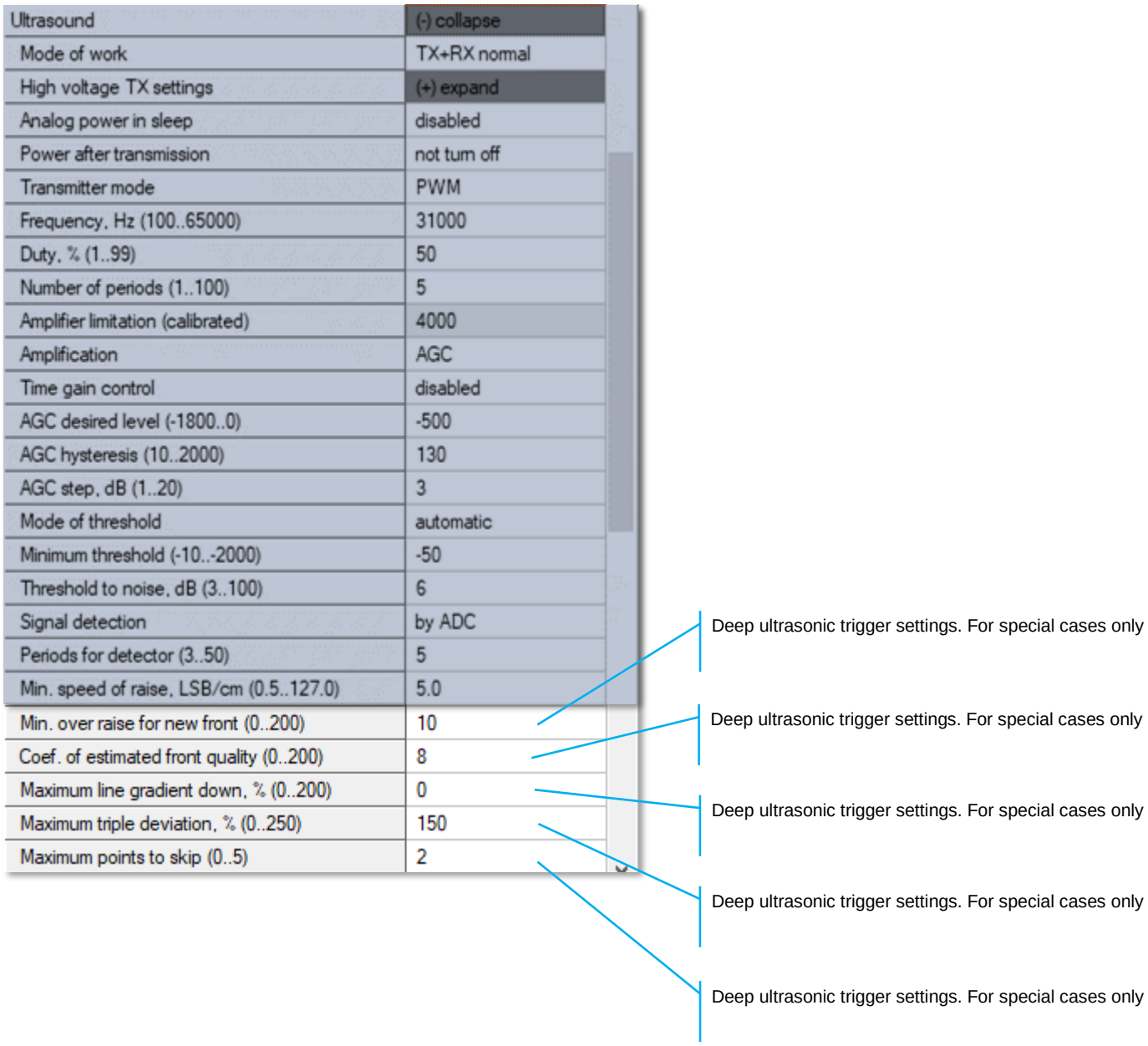
Radio profile settings. No need to change manually. Only for advanced users

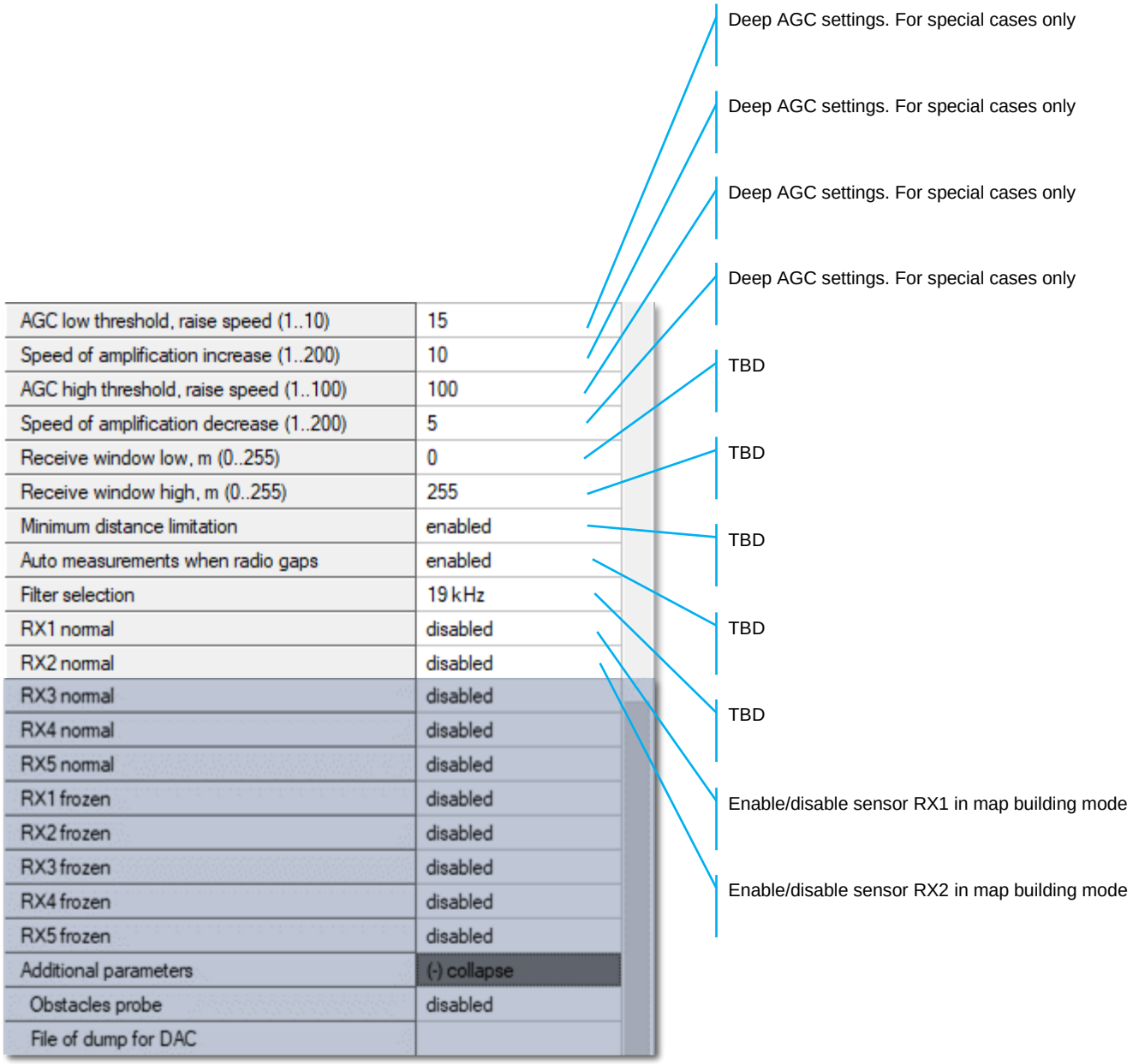
7.10.2.4. Ultrasound

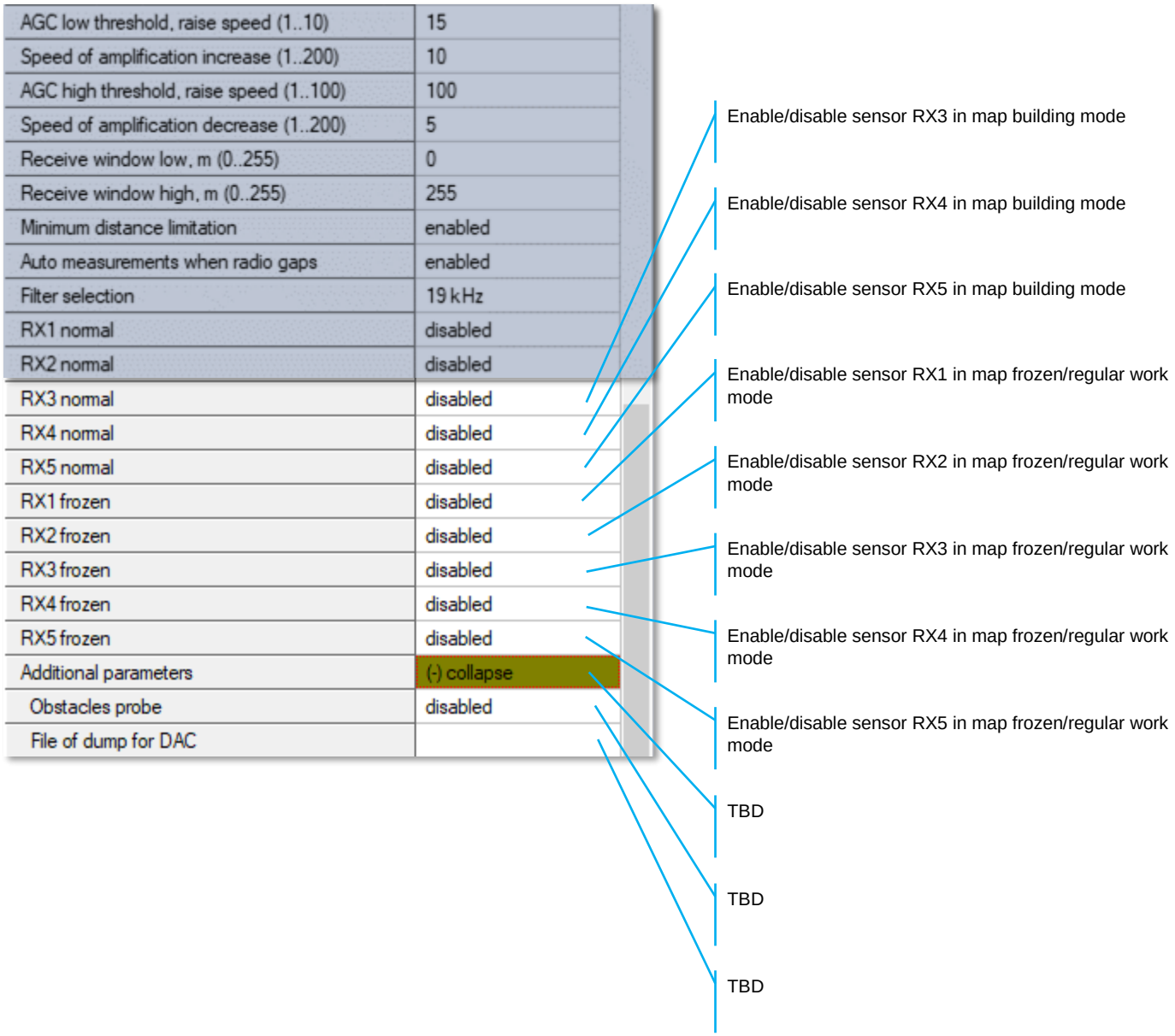


Ultrasound	(-) collapse
Mode of work	TX+RX normal
High voltage TX settings	(+) expand
Analog power in sleep	disabled
Power after transmission	not turn off
Transmitter mode	PWM
Frequency, Hz (100..65000)	31000
Duty, % (1..99)	50
Number of periods (1..100)	5
Amplifier limitation (calibrated)	4000
Amplification	AGC
Time gain control	disabled
AGC desired level (-1800..0)	-500
AGC hysteresis (10..2000)	130
AGC step, dB (1..20)	3
Mode of threshold	automatic
Minimum threshold (-10..-2000)	-50
Threshold to noise, dB (3..100)	6
Signal detection	by ADC
Periods for detector (3..50)	5
Min. speed of raise, LSB/cm (0.5..127.0)	5.0
Min. over raise for new front (0..200)	10
Coef. of estimated front quality (0..200)	8
Maximum line gradient down, % (0..200)	0
Maximum triple deviation, % (0..250)	150
Maximum points to skip (0..5)	2

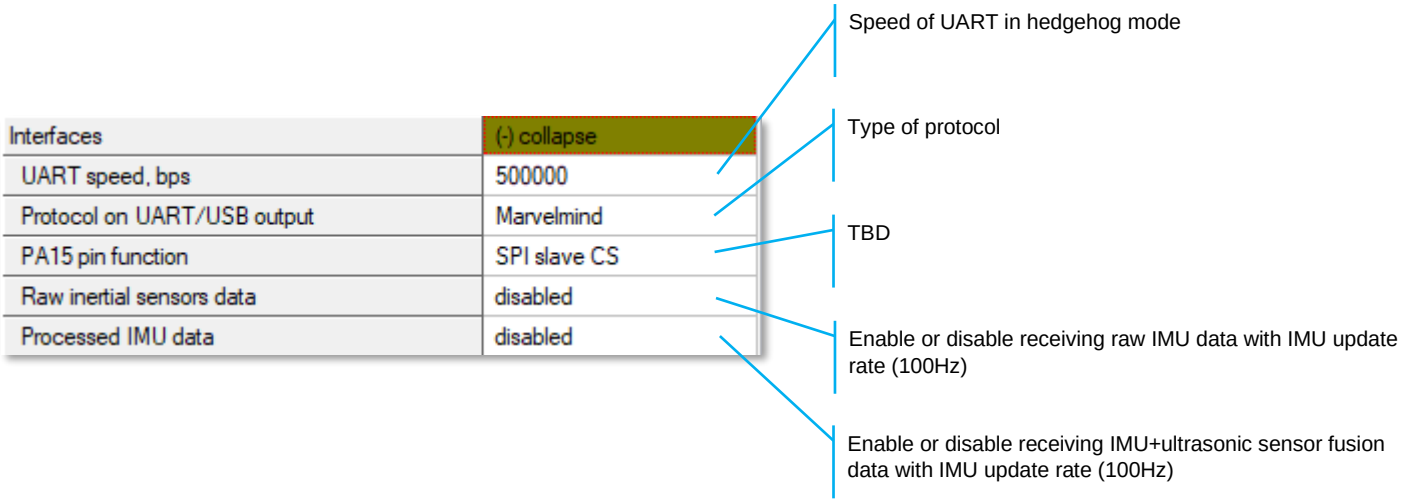

Ultrasound
(-) collapse
Mode of work
TX+RX normal
High voltage TX settings
(+) expand
Analog power in sleep
disabled
Power after transmission
not turn off
Transmitter mode
PWM
Frequency, Hz (100..65000)
31000
Duty, % (1..99)
50
Number of periods (1..100)
5
Amplifier limitation (calibrated)
4000
Amplification
AGC
Time gain control
disabled
AGC desired level (-1800..0)
-500
AGC hysteresis (10..2000)
130
AGC step, dB (1..20)
3
Mode of threshold
automatic
Minimum threshold (-10..-2000)
-50
Threshold to noise, dB (3..100)
6
Signal detection
by ADC
Periods for detector (3..50)
5
Min. speed of raise, LSB/cm (0.5..127.0)
5.0
Min. over raise for new front (0..200)
10
Coef. of estimated front quality (0..200)
8
Maximum line gradient down, % (0..200)
0
Maximum triple deviation, % (0..250)
150
Maximum points to skip (0..5)
2
TBD
AGC settings. For advanced users only
AGC settings. For advanced users only
AGC settings. For advanced users only
AGC settings. For advanced users only
Deep ultrasonic trigger settings. For special cases only
Deep ultrasonic trigger settings. For special cases only
Keep ADC
Deep ultrasonic trigger settings. For special cases only
Deep ultrasonic trigger settings. For special cases only


Ultrasound
(-) collapse
Mode of work
TX+RX normal
High voltage TX settings
(+) expand
Analog power in sleep
disabled
Power after transmission
not turn off
Transmitter mode
PWM
Frequency, Hz (100..65000)
31000
Duty, % (1..99)
50
Number of periods (1..100)
5
Amplifier limitation (calibrated)
4000
Amplification
AGC
Time gain control
disabled
AGC desired level (-1800..0)
-500
AGC hysteresis (10..2000)
130
AGC step, dB (1..20)
3
Mode of threshold
automatic
Minimum threshold (-10..-2000)
-50
Threshold to noise, dB (3..100)
6
Signal detection
by ADC
Periods for detector (3..50)
5
Min. speed of raise, LSB/cm (0.5..127.0)
5.0
Min. over raise for new front (0..200)
10
Coef. of estimated front quality (0..200)
8
Maximum line gradient down, % (0..200)
0
Maximum triple deviation, % (0..250)
150
Maximum points to skip (0..5)
2
Deep ultrasonic trigger settings. For special cases only
Deep ultrasonic trigger settings. For special cases only
Deep ultrasonic trigger settings. For special cases only
Deep ultrasonic trigger settings. For special cases only
Deep ultrasonic trigger settings. For special cases only

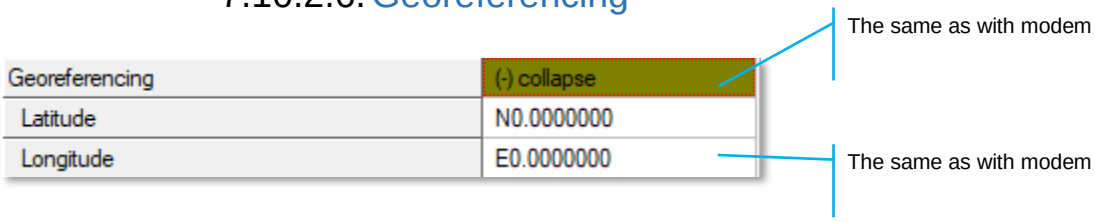

AGC low threshold, raise speed (1..10)
15
Speed of amplification increase (1..200)
10
AGC high threshold, raise speed (1..100)
100
Speed of amplification decrease (1..200)
5
Receive window low, m (0..255)
0
Receive window high, m (0..255)
255
Minimum distance limitation
enabled
Auto measurements when radio gaps
enabled
Filter selection
19 kHz
RX1 normal
disabled
RX2 normal
disabled
RX3 normal
disabled
RX4 normal
disabled
RX5 normal
disabled
RX1 frozen
disabled
RX2 frozen
disabled
RX3 frozen
disabled
RX4 frozen
disabled
RX5 frozen
disabled
Additional parameters
(-) collapse
Obstacles probe
disabled
File of dump for DAC
Deep AGC settings. For special cases only
Deep AGC settings. For special cases only
Deep AGC settings. For special cases only
Deep AGC settings. For special cases only
TBD
TBD
TBD
TBD
TBD
Enable/disable sensor RX1 in map building mode
Enable/disable sensor RX2 in map building mode



7.10.2.5. Interfaces

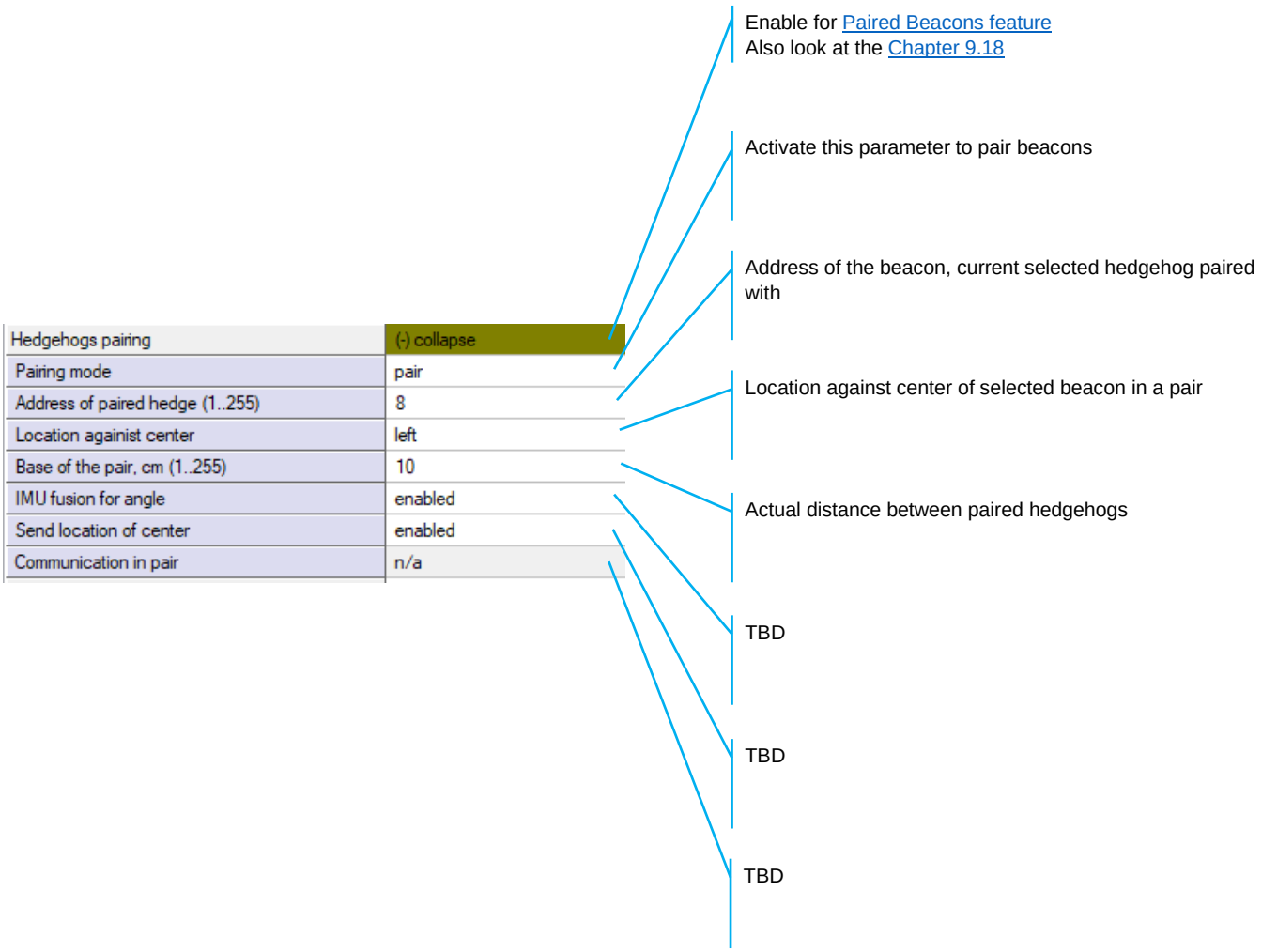


7.10.2.6. Georeferencing



7.10.2.7. Misc. Settings

7.10.2.8. Hedgehogs Pairing



7.11. Radio Frequency Band and Carrier Frequency

- For devices with HW 433 MHz allowable Radio band 433

- For devices with HW 915 MHz allowable Radio bands 868 and 915, but when using antennas at 433 MHz, it is possible to use 433 MHz

*Mini-RX beacons and Super-Beacons are 868/915MHz only

It is possible to change the radio frequency, but radio performance can be severely degraded. It may be enough for smaller distances, up to 10-20 meters, but not more.

Radio frequency band	433 MHz
Carrier frequency, MHz	433.400

Radio frequency band	915 MHz
Carrier frequency, MHz	919.000

Radio frequency band	868 MHz
Carrier frequency, MHz	869.504

7.12. Different Hedgehog Colors in the Dashboard

You can choose any color for your hedge, but it still has some permanent colors, which inform you about some tracking issues:

- **Blue** - standard mode and confident tracking
- **Orange** - system provides the best location data possible, but confidence is lower than blue
- **Transparent Blue** - lost radio packets
- **Transparent Orange** – weak ultrasonic coverage

7.13. Different Beacons' Colors in the Dashboard

Beacons can have different ultrasonic frequencies. Because of that, they have different colors to make them easier to distinguish:

- Stationary beacons – Green center – 
- Mobile beacons – Dark blue center – 

Examples:

- Stationary beacons:

 19KHz

 22kHz

 25KHz

 28kHz

 31KHz

 34kHz

 37KHz

 45KHz

- Mobile beacons:

 19KHz

 22kHz

 25KHz

 28kHz

 31KHz

 34 kHz

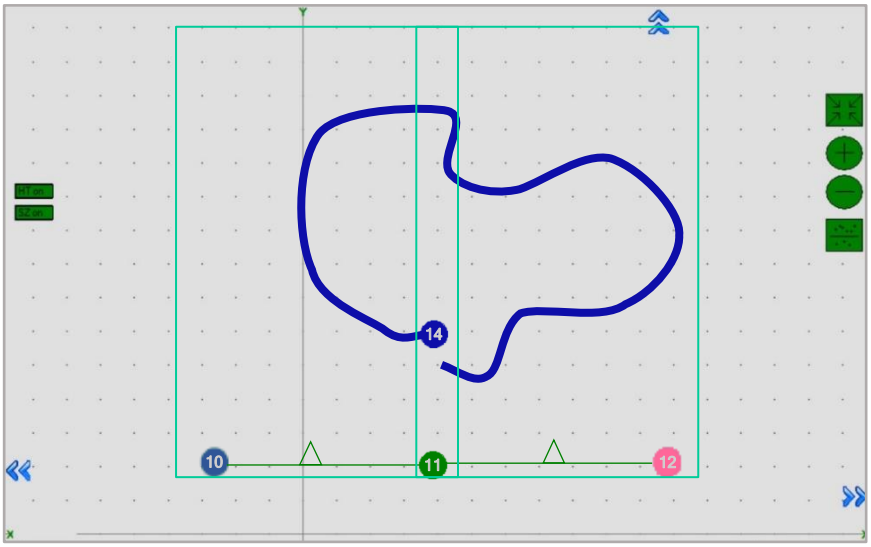
 37KHz

 45KHz

8. The Map

8.1. Introduction

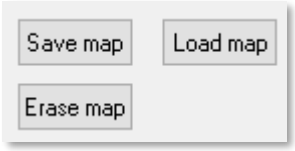
Map – the most significant unit in Marvelmind Indoor GPS. It consists of submaps and forms a complete map of all stationary devices you have. After you build and tune all the submaps and wake up the mobile beacon, you must click the Modem icon and Freeze the map. It is the final stage of building the system. After you freeze the map, tracking will appear.



You can **Save**, **Load**, **Erase** map:

Map Settings offers some helpful tools; it is situated in the bottom right corner of the Dashboard:

- Save map – saves map as *.ini* file into **Dashboard folder/maps**
- Load map – loads map from *.ini* format file
- Erase map – erases map and clears it



Here is the main tutorial video about maps:

- Help: submaps, service zones, handover zones

Check:

- 8 basic steps from unpacking to autonomous drive/flight
- Step-by-step guide on how to build complex maps

Detailed explanation of complex map building:

- Building submaps: Part 1
- Building submaps: Part 2

8.2. Map Layers

The map consists of several layers. Each layer can be attached to the other.

4) Service zones

3) Beacons and Submaps

2) Floorplan – plan/scheme/picture of a floor where you placed beacons

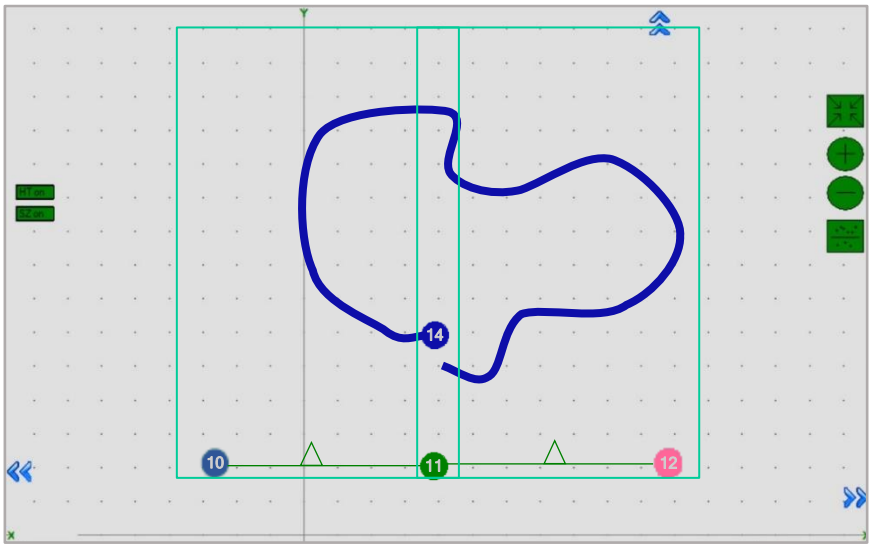
1) Ether – map grid

8.3. The Submap

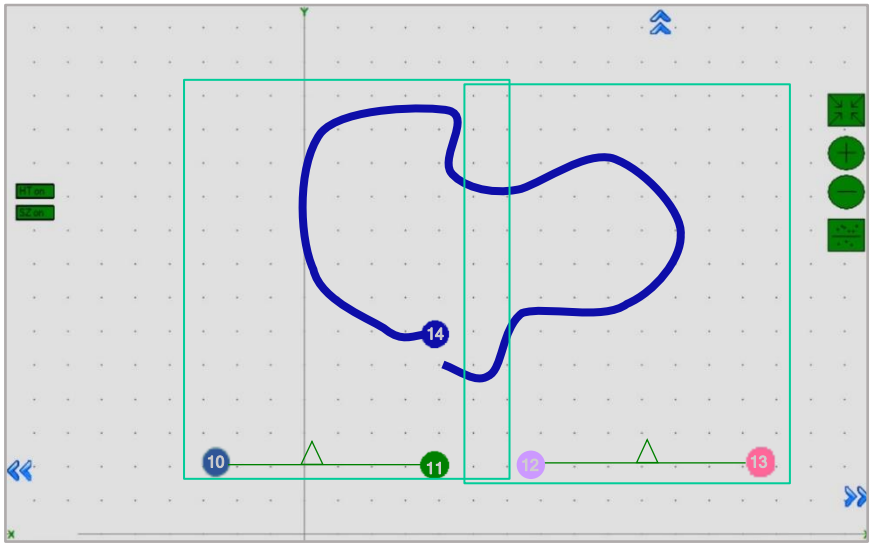
Submap is a logical unit. A part of the map. It unites beacons to work together in the system. The submap can contain 1 to 4 beacons. It can be 1D, 2D, and 3D.

Different types of submaps can be used together. Mix 1D, 2D, and 3D as you wish. For example, a map of the office floor may contain a 1D submap for the corridor and 2D/3D submaps for office rooms. All that submaps will form a big map with the coverage you need.

Submaps can contain the same beacons, making it possible to use 3 beacons instead of 4. This is very helpful in the IA because we are limited to 8 ultrasonic frequencies.



Example 1. Used 3 beacons for 2 2D submaps. Beacon 11 – neighboring. It belongs to Submap 0 and Submap 1 at the same time. 2 vacant frequencies left:



Example 2. Used 4 beacons for 2 2D submaps. Submap 0 and Submap 1 are independent. 1 vacant frequency left:

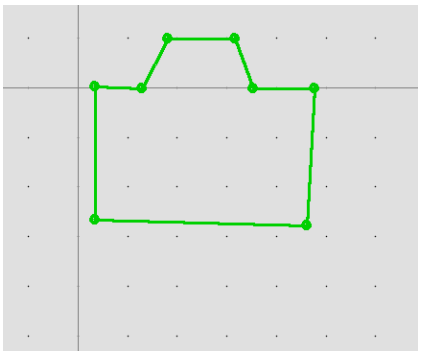
Different configurations suit different cases. You can also have submaps with neighboring beacons and submaps without them on one map.

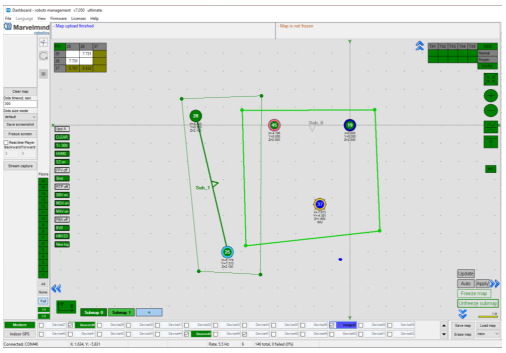
Here is a tutorial video about submaps:

- Help: using submaps to build large maps

8.4. Submaps' Service Zones

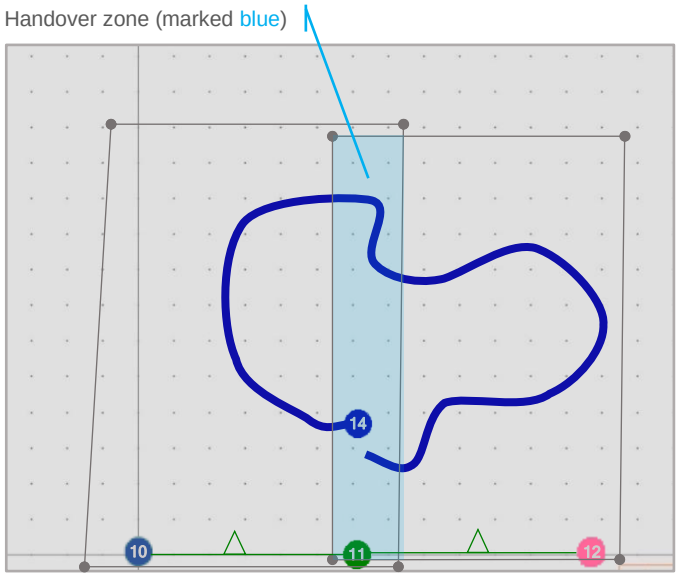
A service zone (or service area) is an area that serves a submap. Service zone must be drawn for any submap you build. It helps to divide tracking between different submaps and outline the area of responsibility of every submap.





8.5. Handover Zones

The handover zone is an area created when service zones cross. It facilitates the smooth transfer of mobile beacons from the service zone of one submap to another.

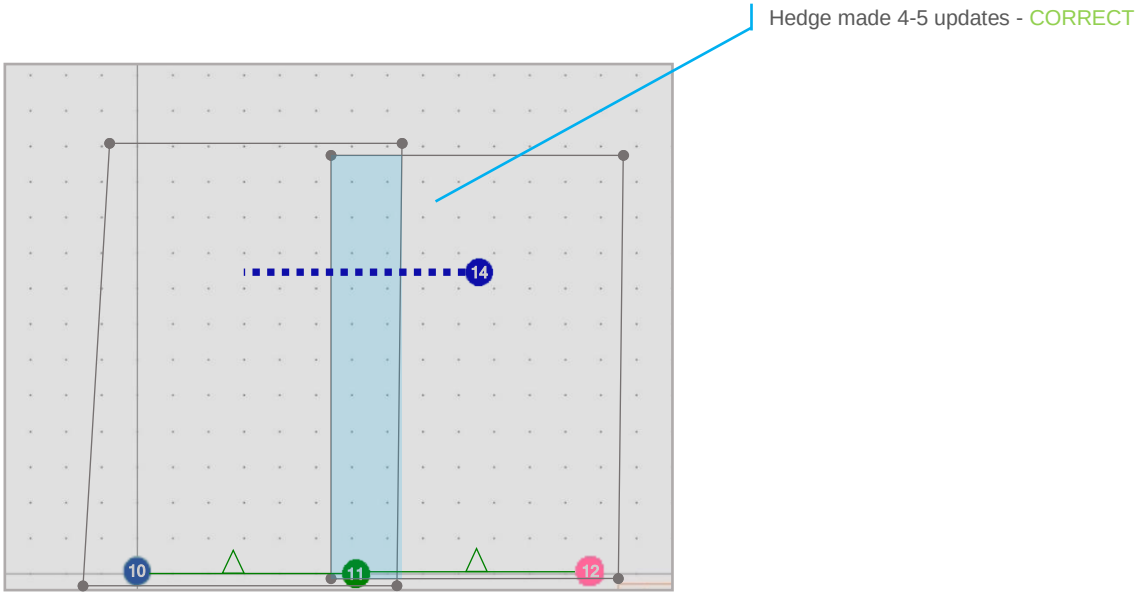


How to create a Handover zone correctly:

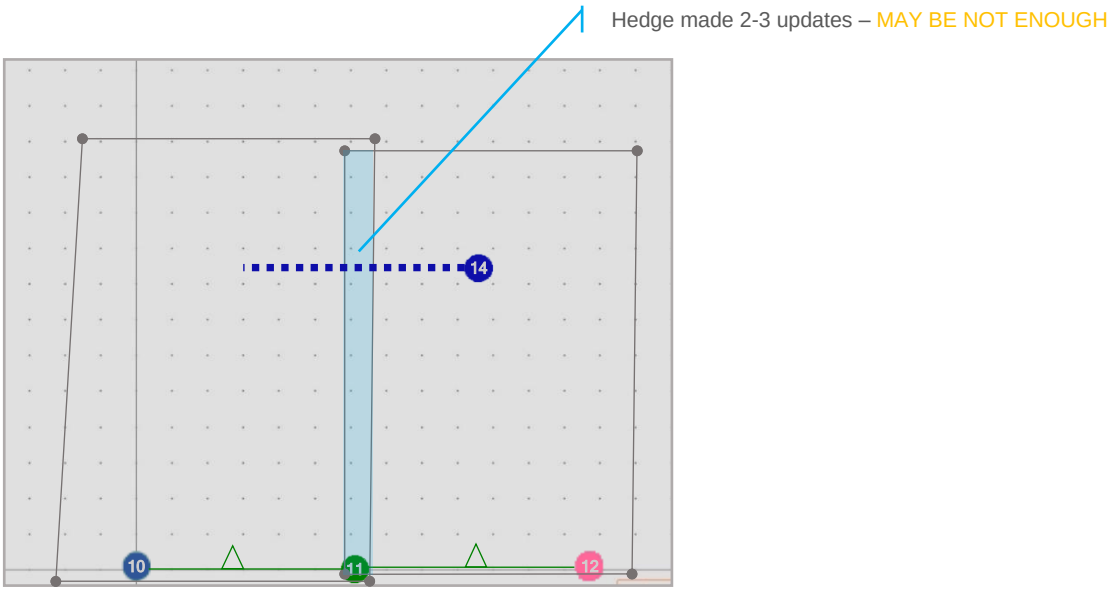
The size of a Handover zone may differ and depends on the mobile beacon's speed and the system's update rate. We recommend testing it with the speed of your mobile beacon mounted on a person/robot/copter. The general recommendation to make the handover smooth and correct is to ensure that your mobile beacon makes at least 4 refreshes in a handover zone.

Look at the following examples:

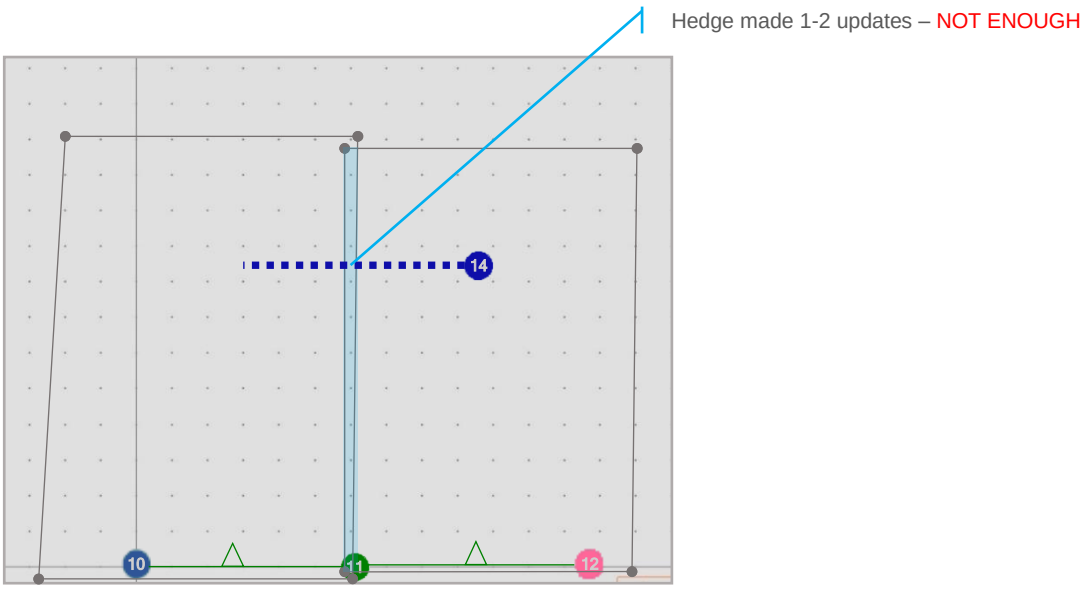
- **Example 1**: Normal handover zone:



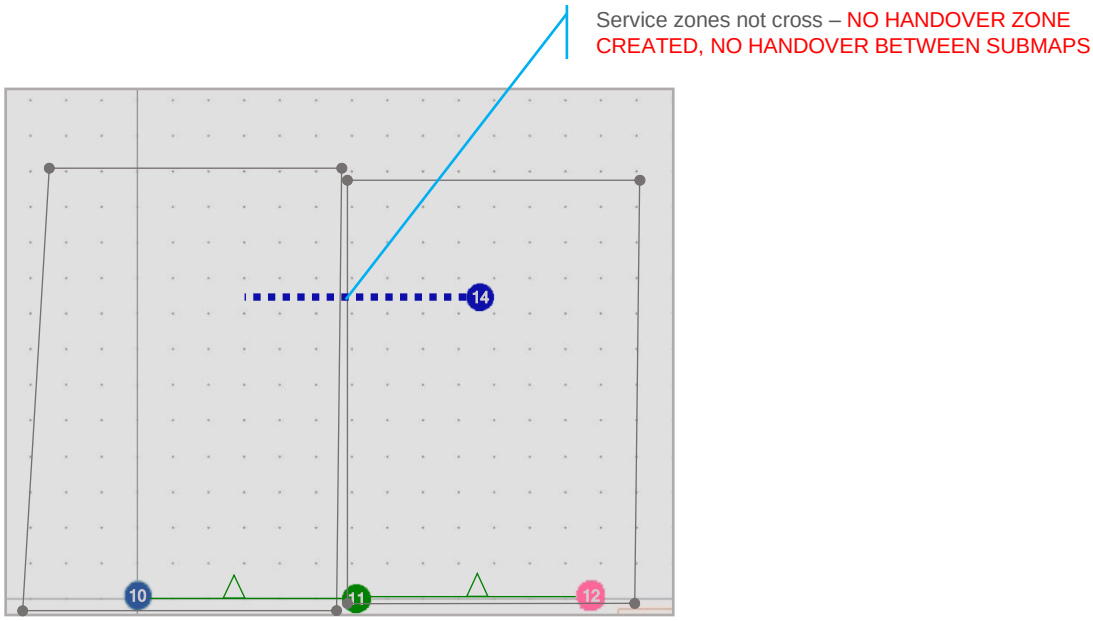
- **Example 2**: Small handover zone:



- **Example 3**: Too small handover zone:



- **Example 4**: No handover zone:



8.6. Beacons' Ultrasonic Frequencies

The system may have different ultrasonic frequencies for beacons. This can be used for different aims and cases. In IA, it's necessary to have stationary beacons of different frequencies.

Please notice that it is hardware-defined and cannot be just changed via settings in the Dashboard

Different frequencies can be used:

- In IA, as a basic rule of Inverse Architecture's functionality
- In Multi-frequency NIA to increase update rate for multiple mobile beacons

To make it easy to distinguish, stationary beacons with different frequencies in the Dashboard are colored in different colors:

- 19KHz beacon
- 22KHz beacon
- 25KHz beacon
- 28KHz beacon
- 31KHz beacon
- 34KHz beacon
- 37KHz beacon
- 45KHz beacon

Learn more about submaps, service zones, and handover zones here: How to create indoor navigation maps

Learn more about maps larger than 30x30m here: How to build maps larger than 30x30m

Learn more about building large indoor positioning systems here: How to build large indoor positioning systems

Here is the main tutorial video about maps:

- Help: submaps, service zones, handover zones

Check:

- 8 basic steps from unpacking to autonomous drive/flight
- Step-by-step guide on how to build complex maps

Detailed explanation of complex map building:

- Building submaps: Part 1
- Building submaps: Part 2

9. Features

9.1. Microphone Settings

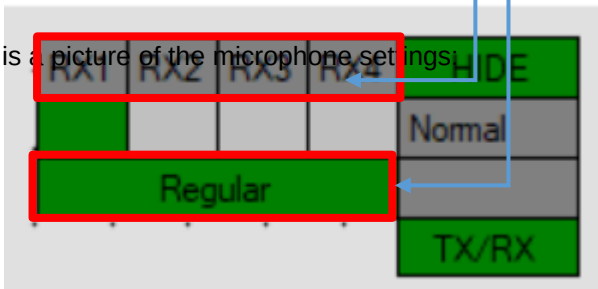
9.1.1. Specific Marvelmind Devices

For different devices, different microphone modes should be turned on.

Turn on the mic by clicking on RX1…RX4

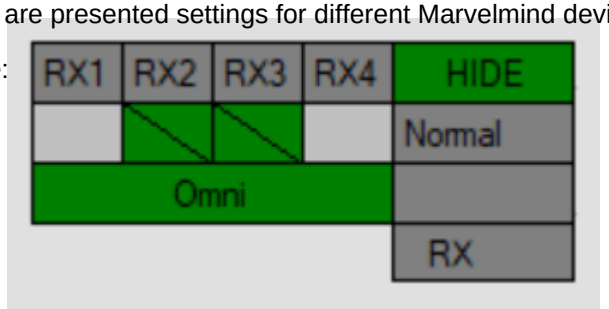
Change the mics' mode by clicking on the bottom panel.

Below is a picture of the microphone settings:

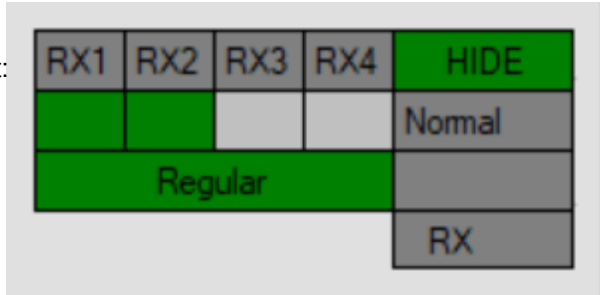


Below are presented settings for different Marvelmind devices:

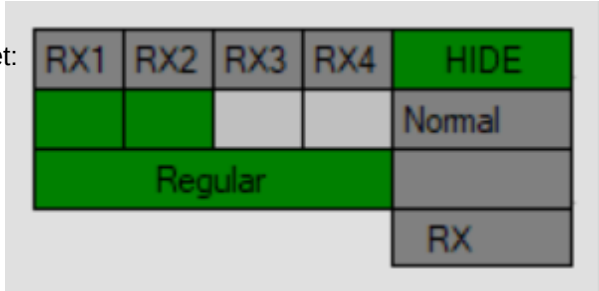
Badge:



Jacket:



Helmet:



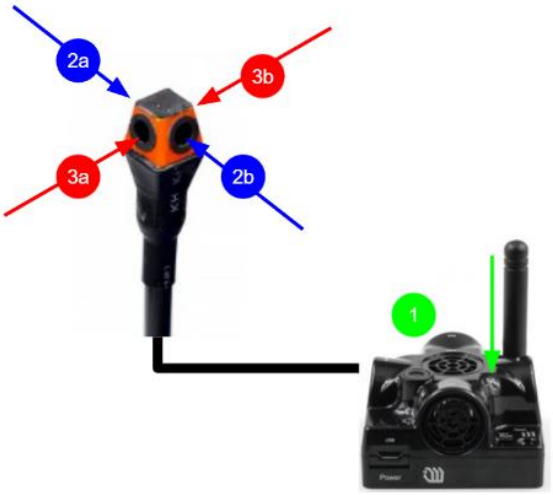
9.1.2. Separate Omni-Microphone

You can additionally purchase an Omni-microphone for improved performance.

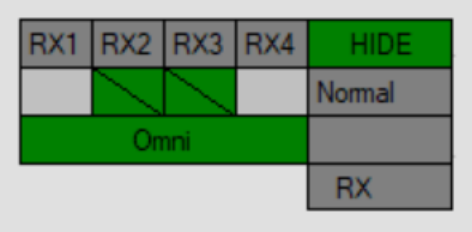
Before buying, inform us which device you want to use for the Omni-microphone.

On Super-Beacon, Omni-mic works in Omni mode on RX3 and RX4. On Super-Beacon-2, Omni-mic works in Omni mode on RX2 and RX3.

Below is the location of different mics on the Omni-mic:



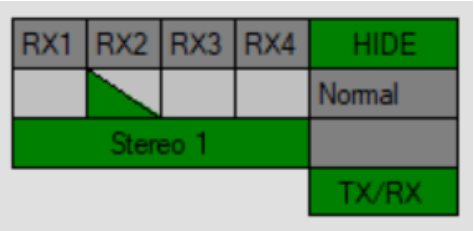
Example of correct settings for Omni-mic on Super-Beacon-2 in Omni mode:



Also, if you want to use a specific microphone on Omni-mic, you can switch mode to Stereo and turn on one of the pairs or even one of the mics in one pair.

To turn one of the pairs on Omni-mic, click on the box RX2…RX4, depending on which Super-Beacon you have and which pair you want to have turned on:

To turn on one of the mics in a specific pair, press on a particular box below RX2…RX4, using CTRL button:



9.2. Restart if Modem is Disconnected

This feature resets the beacon when it loses connection with the modem.

Follow these steps to switch on this feature.

9.2.1. Connect beacon via USB or radio and expand Misc. settings in settings bar:

Misc. settings	(-) collapse
Sleep by timeout	60 sec no connection
Sleep with external power	60 sec no connection
Status LED	enabled
Restart if modem is disconnected	disabled
Timeout of restart without modem, sec (5..250)	n/a

9.2.2. Enable the “Restart if modem is disconnected” option:

Misc. settings	(-) collapse
Sleep by timeout	60 sec no connection
Sleep with external power	60 sec no connection
Status LED	enabled
Restart if modem is disconnected	enabled
Timeout of restart without modem, sec (5..250)	10

9.2.3. Enter a value for “Timeout of restart without modem” in sec:

Misc. settings	(-) collapse
Sleep by timeout	60 sec no connection
Sleep with external power	60 sec no connection
Status LED	enabled
Restart if modem is disconnected	enabled
Timeout of restart without modem, sec (5..250)	10

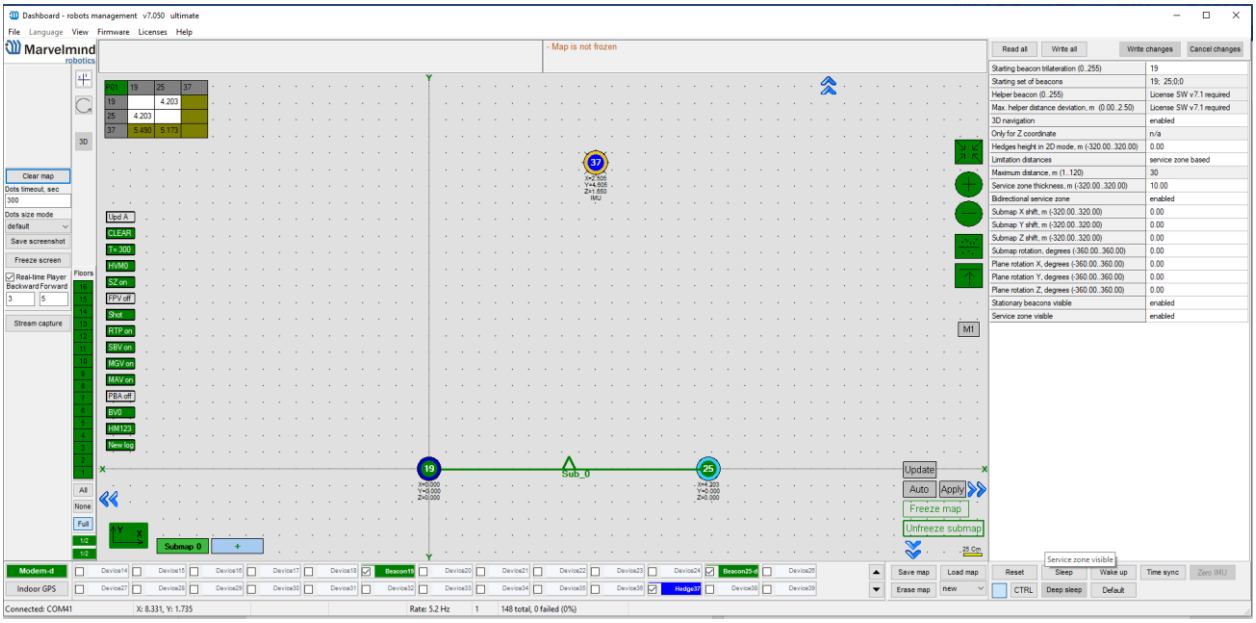
9.2.4. The “Restart if modem is disconnected” feature setup is completed.

9.3. Geofencing Zones

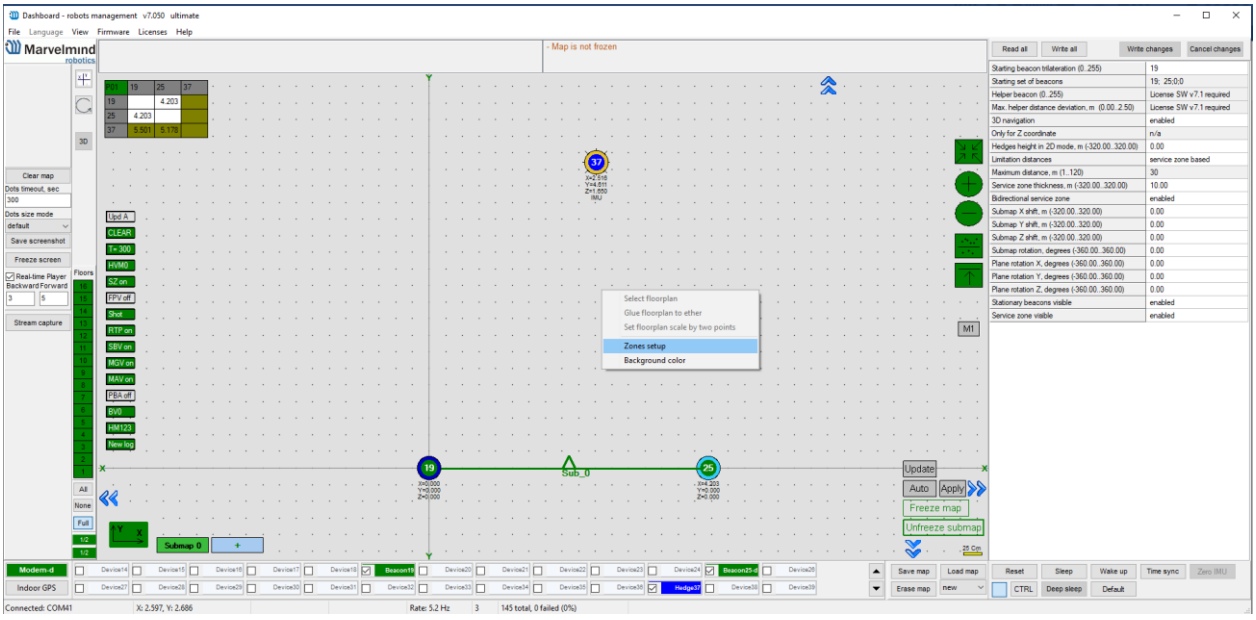
Geofencing zones are a subset of zones that can be created to prevent people from crossing dangerous zones. Zone violations lead to alarms and will be written into a CSV file.

How to create a geofencing zone:

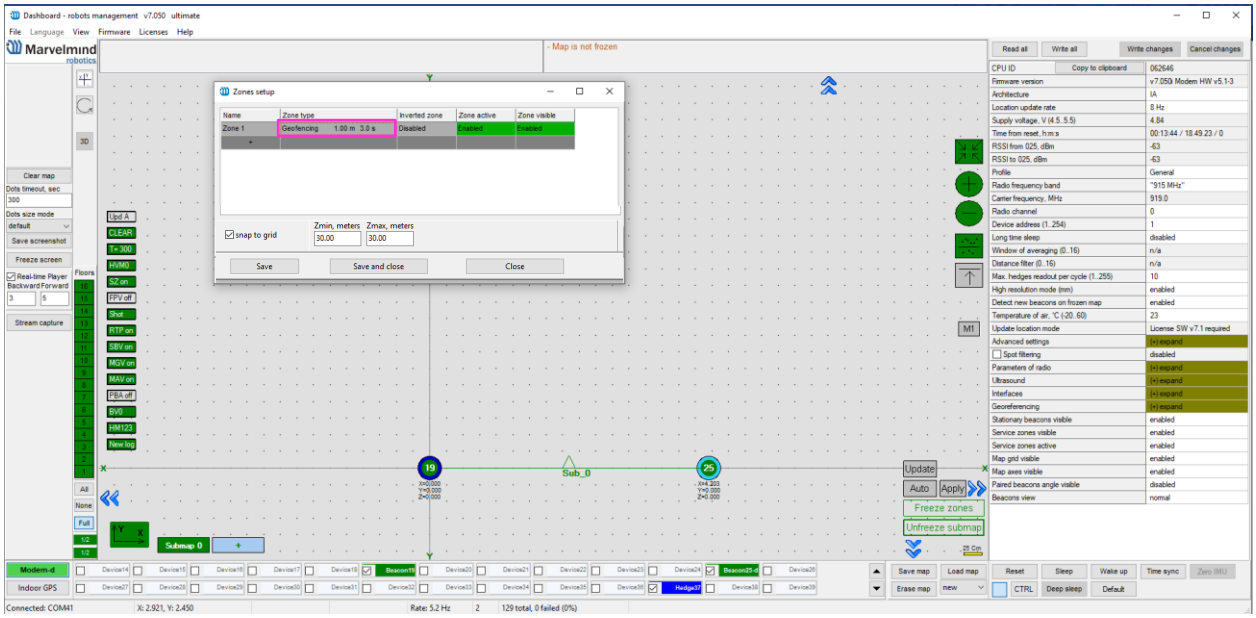
- Unfreeze map; submap may be frozen



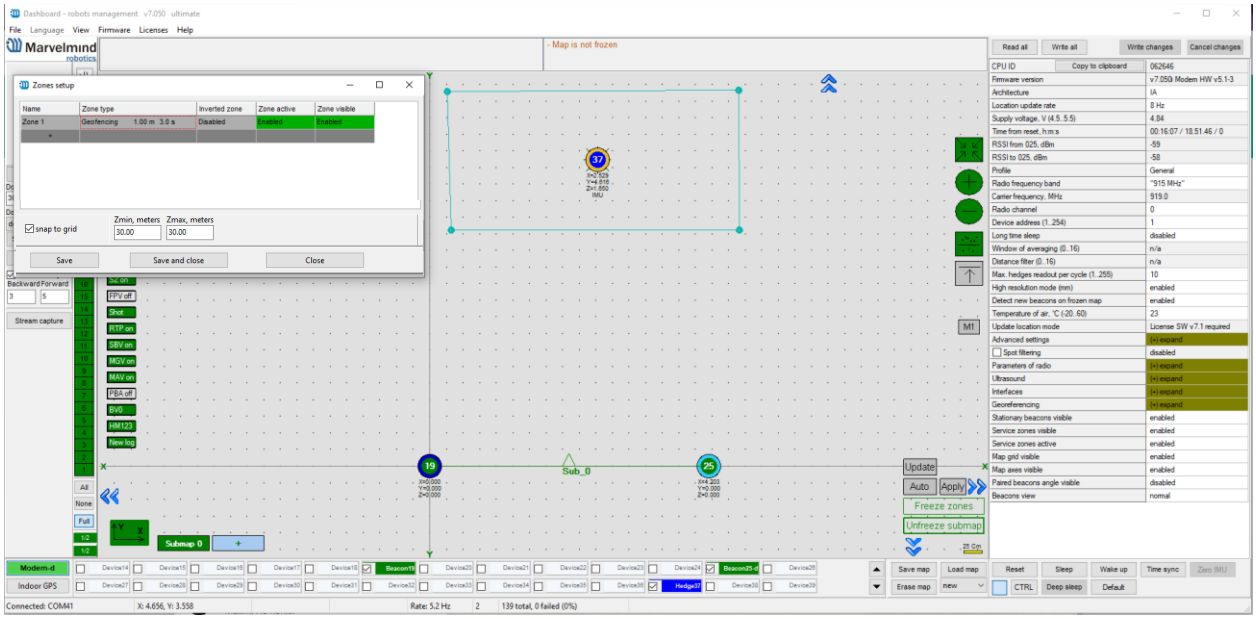
- **Right click on the map -> Zones setup**



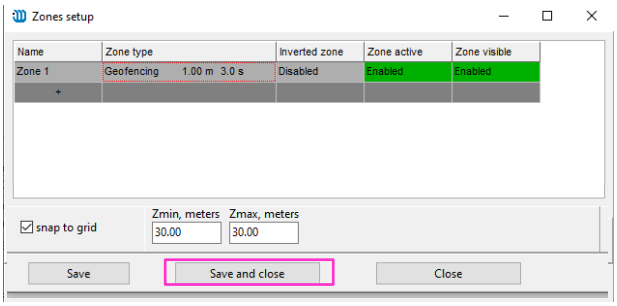
- Left Click on Zone type and choose Geofencing



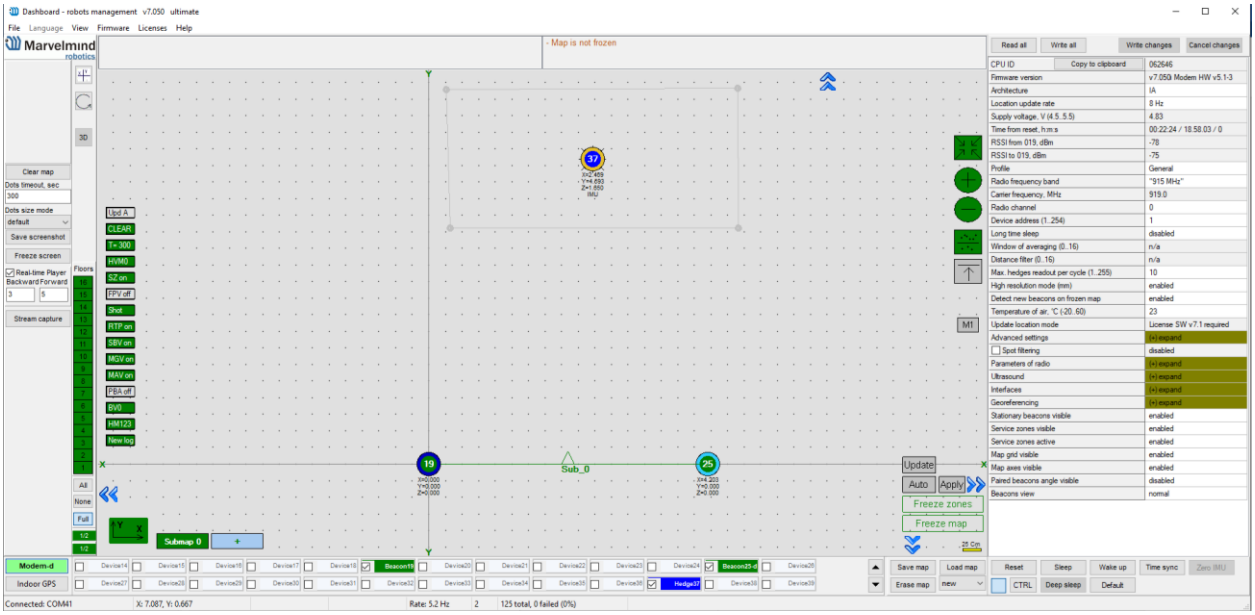
- Create a zone using **Shift + Left Click** and clicking on the map; click on the point to remove it



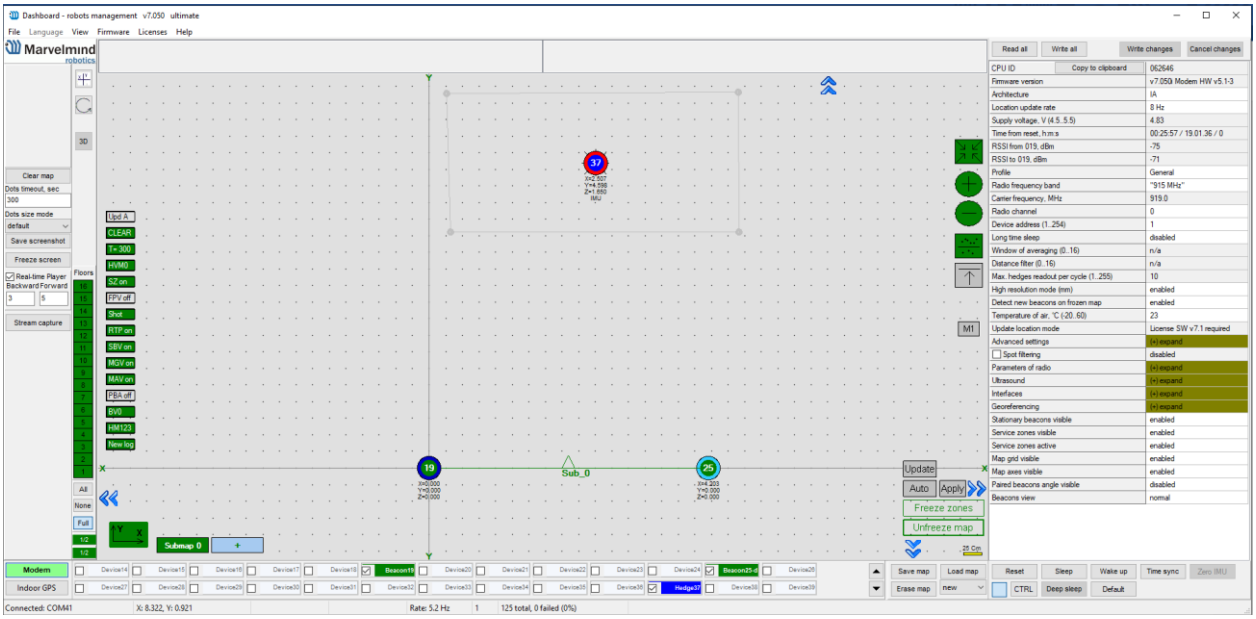
- You can **tune the zone by entering the distance and entering time**. If the zone is created, press **Save and close** to save the zone



- After you Save and Close the Zones setup window, the zone turns grey. Freeze the map



- Zone created and ready to work. If the mobile beacon crosses the zone for a tuned distance and tuned time, that violation will be recorded in a CSV file, and the hedgehog will be colored red in the Dashboard

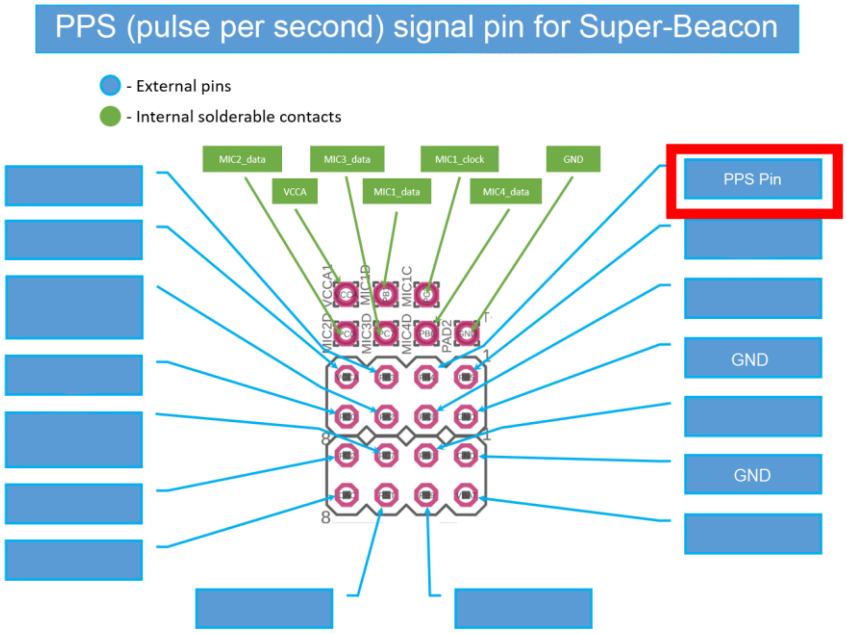


9.4. PPS (Pulse per Second) Signal

This feature is used to get a pulse signal from Super-Beacon every second. Works with Super-Beacon in NIA only.

To switch on PPS, follow the instructions below:

9.4.1. Connect a speaker to Super-Beacon 4x4 pinout according to scheme:



9.4.2. Connect beacon via dashboard or radio and expand Interfaces in a settings bar:

Interfaces	(-) collapse
UART speed, bps	500000
Streaming output	USB+UART
Protocol on UART/USB output	Marvelmind
PB4 pin function	SPI MISO
Quality and extended location data	disabled
Alarm pin function	None
Alarm pin mode	n/a
Streaming mode	License SW v7.1 required
Debugging data	disabled
SPI data output	disabled

9.4.3. Choose PPS output in the PB$ pin function option:

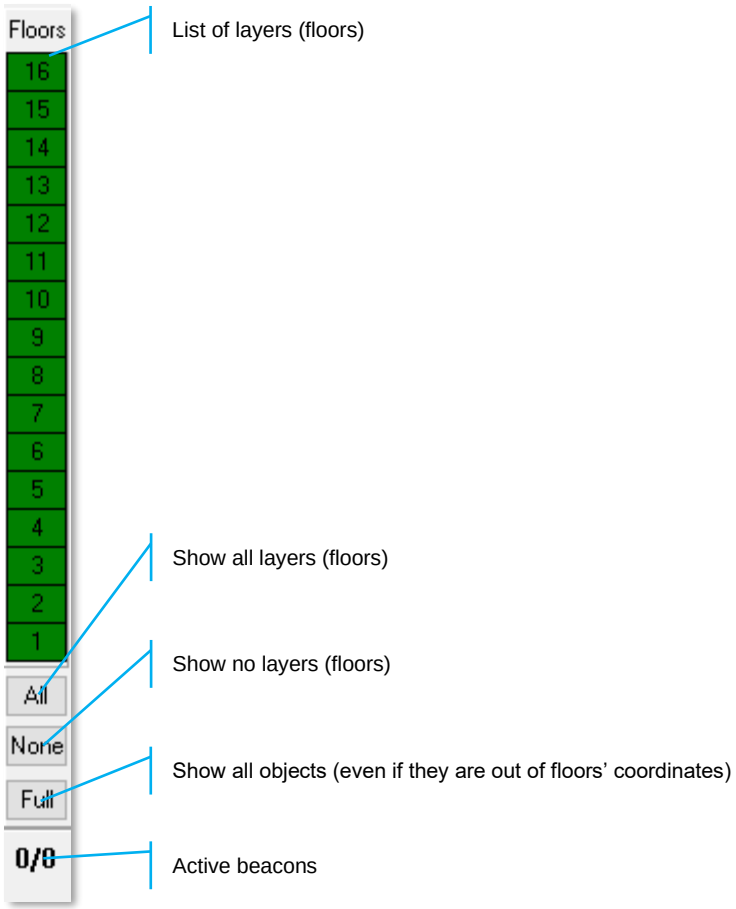
Interfaces	(-) collapse
UART speed, bps	500000
Streaming output	USB+UART
Protocol on UART/USB output	Marvelmind
PB4 pin function	PPS output
Quality and extended location data	disabled
Alarm pin function	None
Alarm pin mode	n/a
Streaming mode	License SW v7.1 required
Debugging data	disabled
SPI data output	disabled

9.4.4. PPS pin settings completed.

9.5. Floors Feature (FN0011)

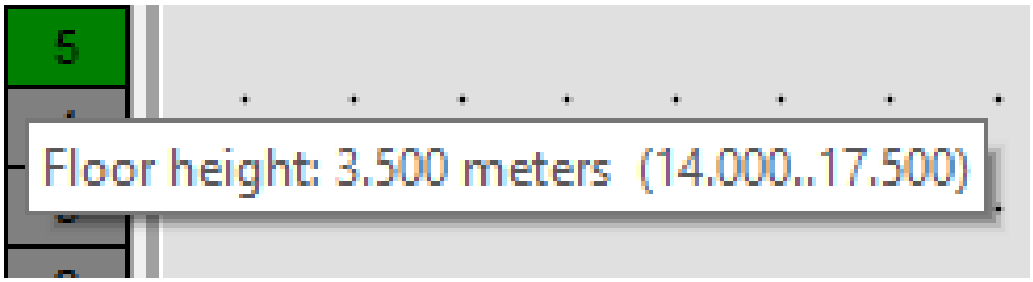
9.5.1. The General View

The floor feature allows the building to create complicated multi-level maps. Every submap corresponds to some height, and height corresponds to floors.

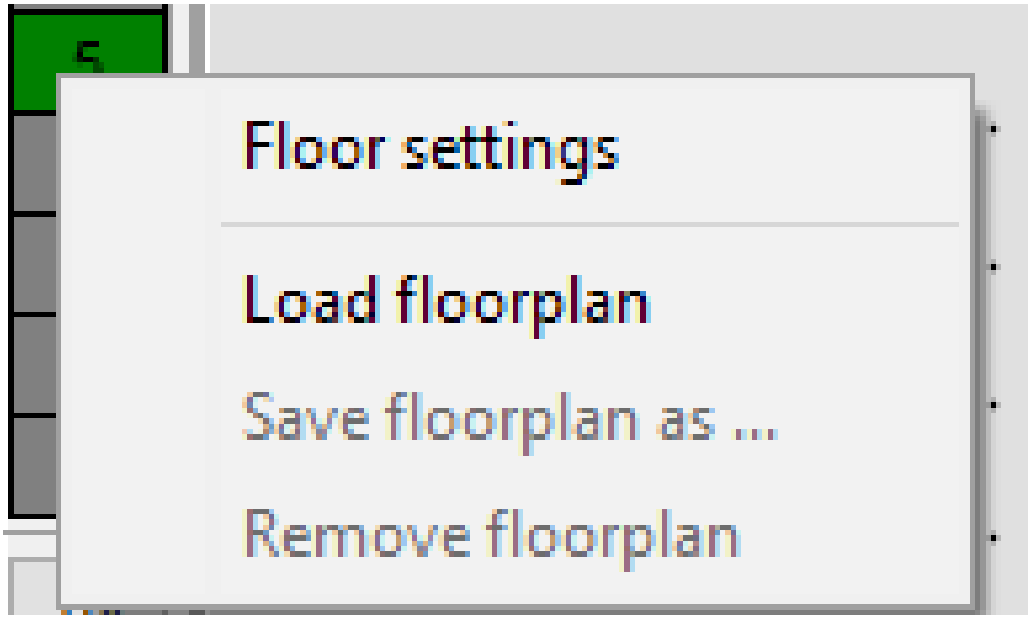


9.5.2. Floor Settings

- Every floor has its adjustable height and its floor plan

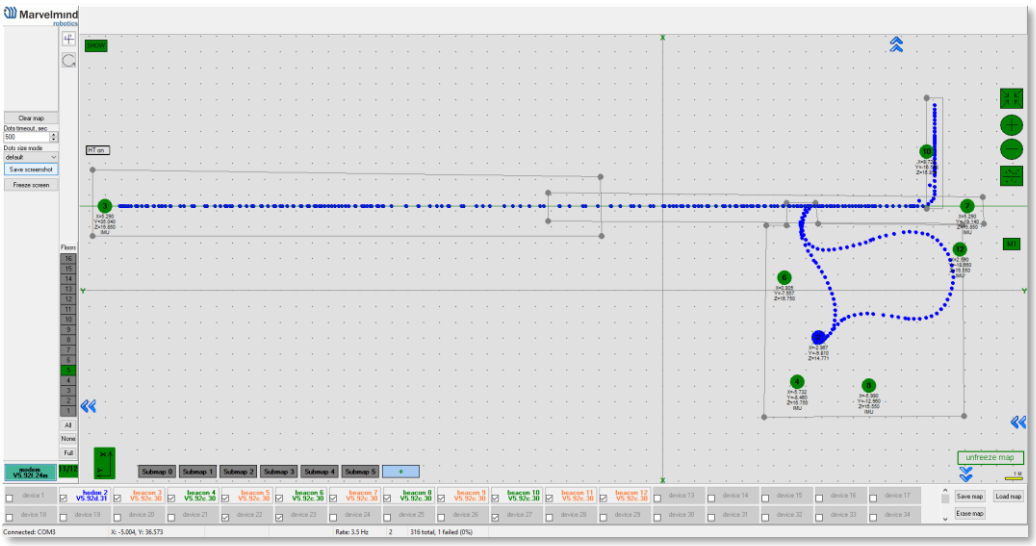


- Right click on the floor area to see an additional menu. There you can change the height of the floor. You can also insert your floorplan for that floor (.png, .jpeg, .bmp, .tiff)

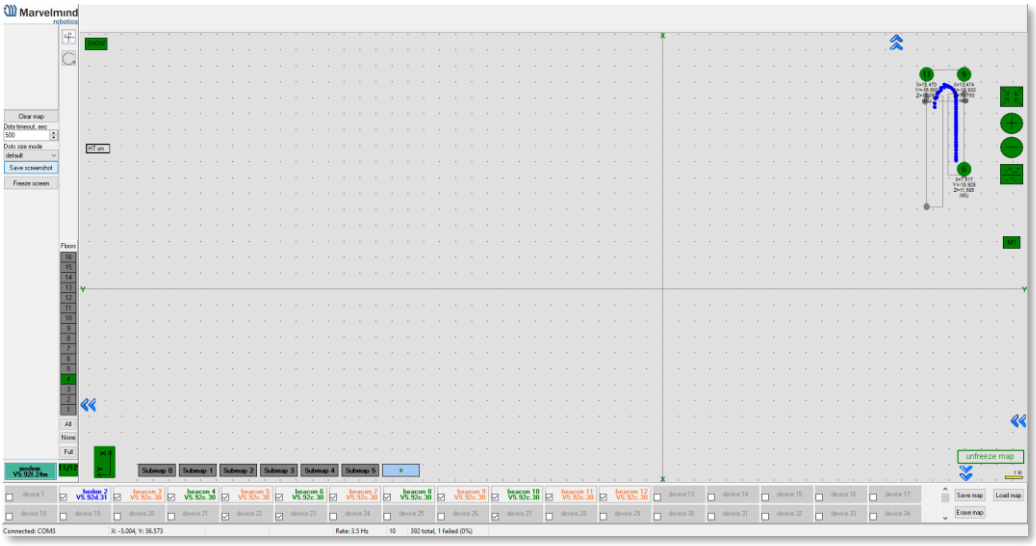


- Floors 4 and 5 are enabled:

- Floor 5 is enabled:



- Floor 4 is enabled:



9.5.3. Map Layers

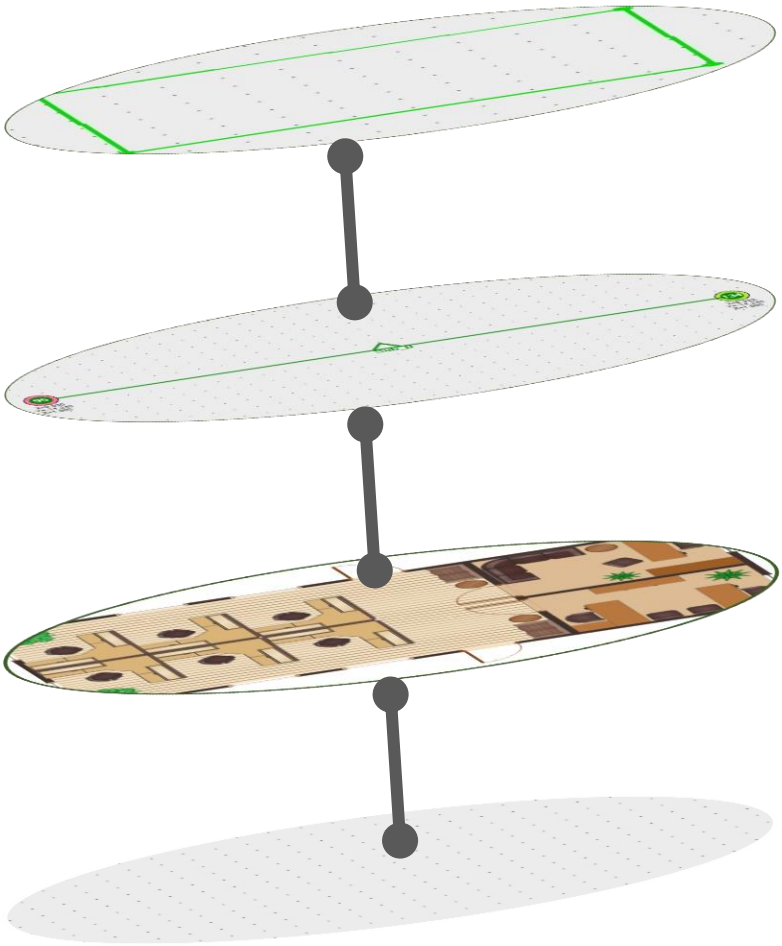
The map consists of several layers. Each layer can be attached to the other.

4) Service zones

3) Beacons and Submaps

2) Floorplan – plan/scheme/picture of a floor where you placed beacons

1) Ether – map grid



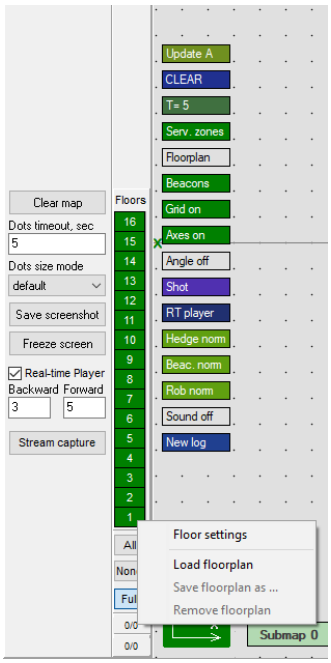
9.6. Floorplan Feature

This chapter describes how to load and use a floorplan in the Dashboard.

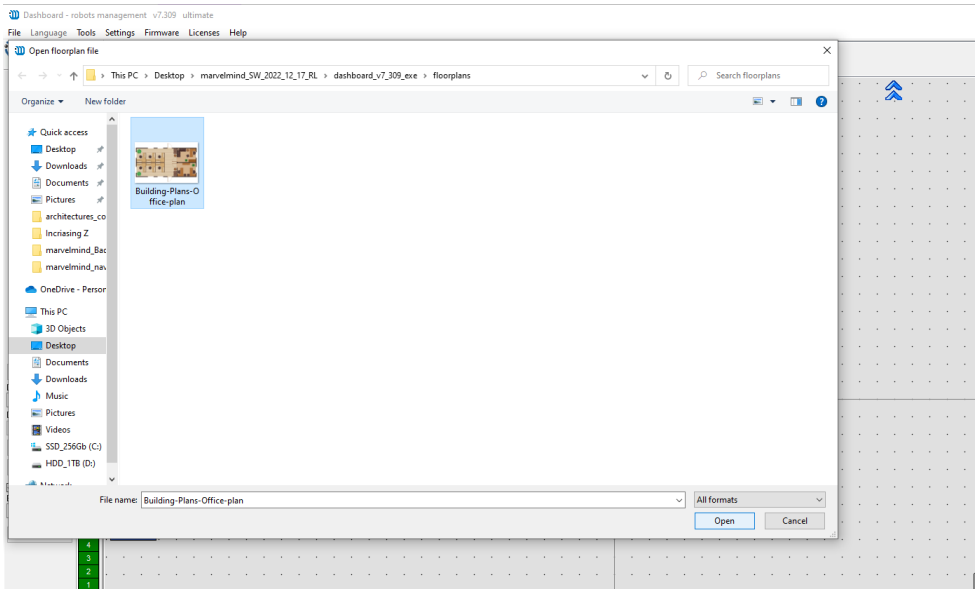
9.6.1. Loading the Floorplan (Substrate)

To load a floorplan:

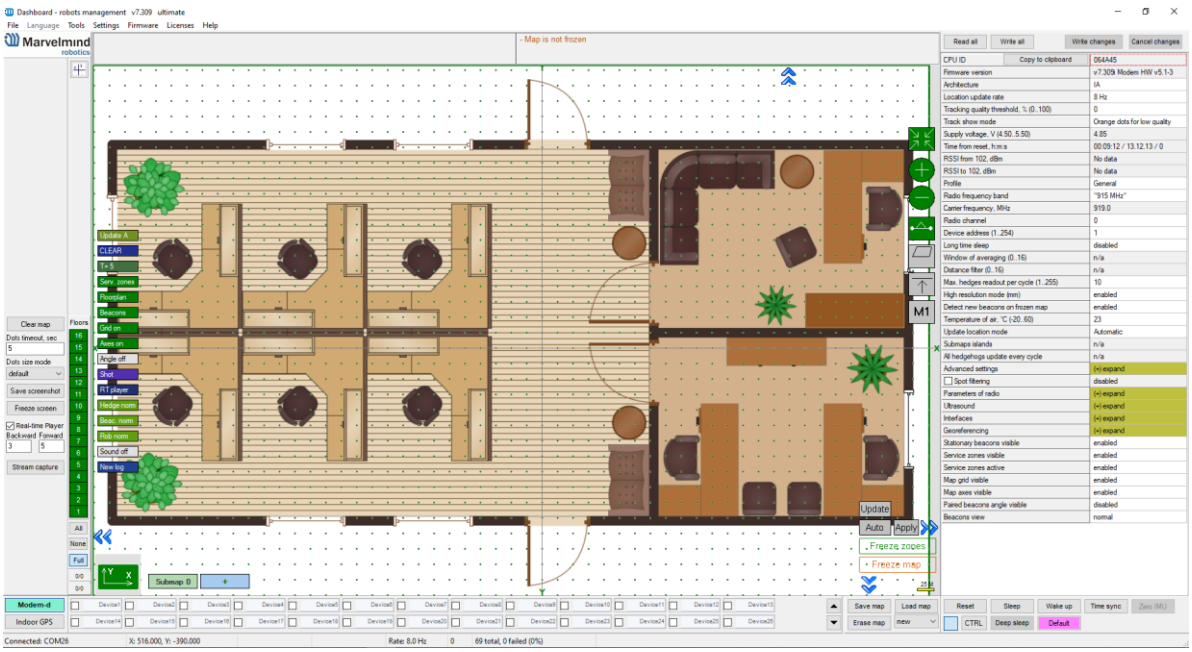
- Right click on the floor



- Load floorplan -> Choose file (.png, .jpeg, .bmp, .tiff).



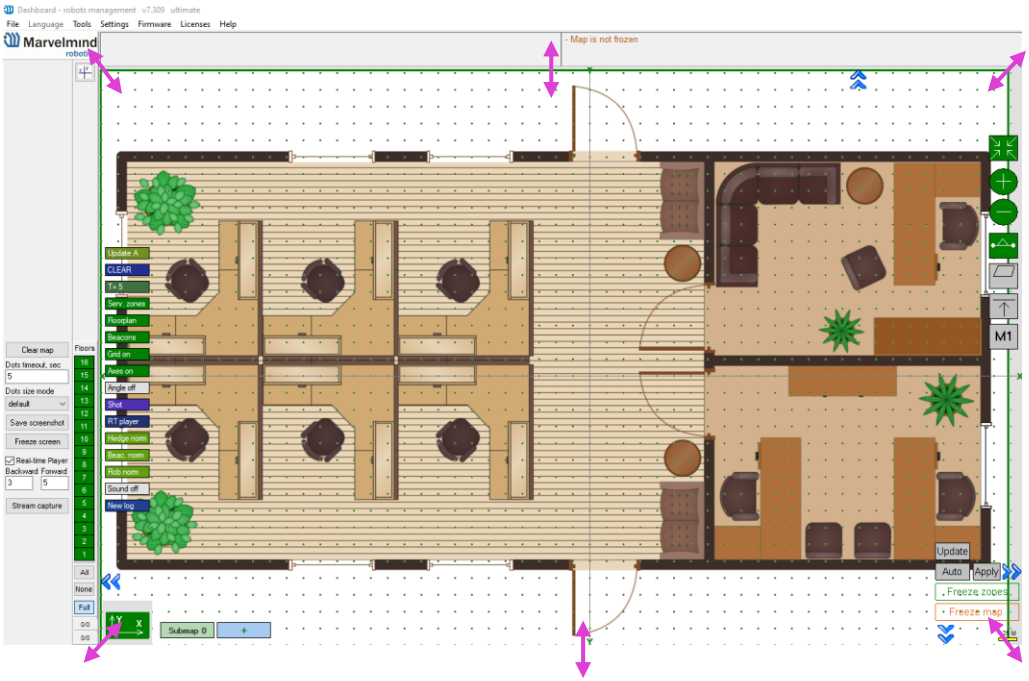
- Floorplan is loaded:



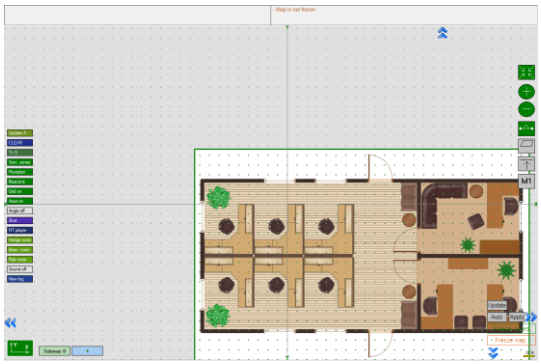
9.6.2. Floorplan Scaling

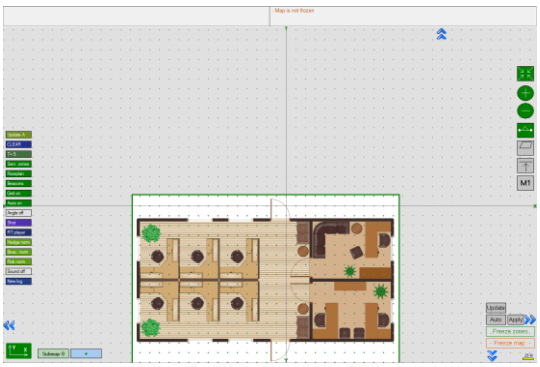
The are two ways how to resize a floorplan in Dashboard.

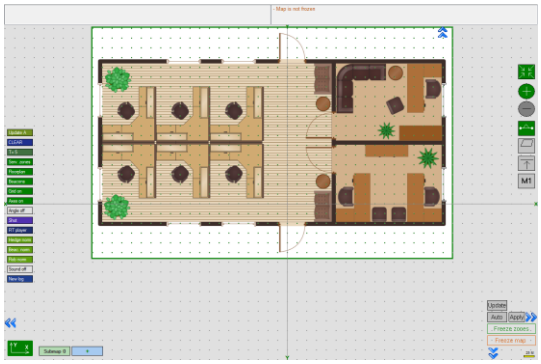
1) **Drag a floorplan from any side of a picture:**



Please note that the plan is scaled evenly, and the image is not deformed:

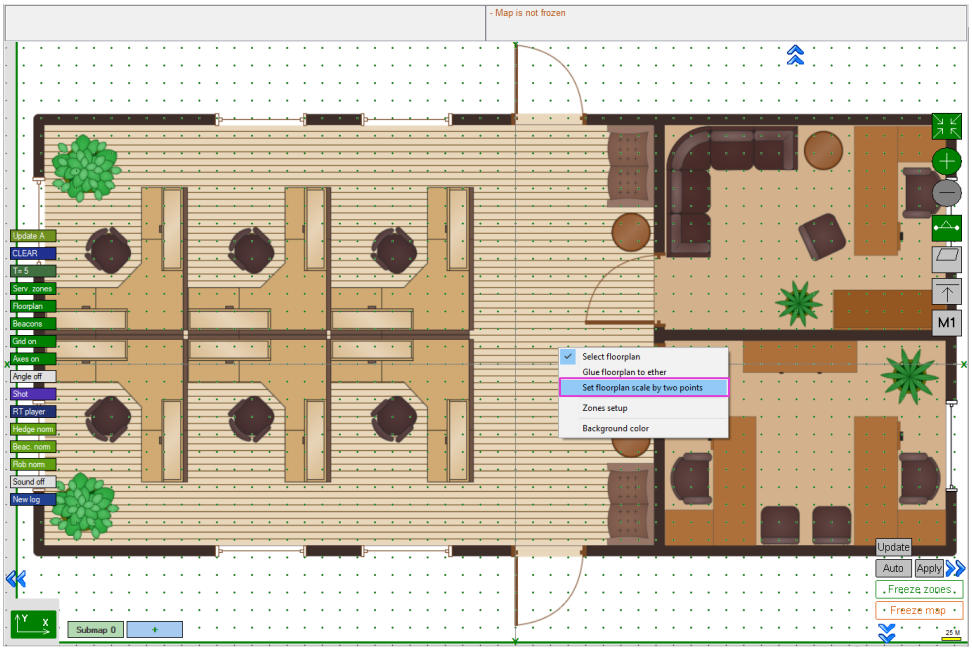




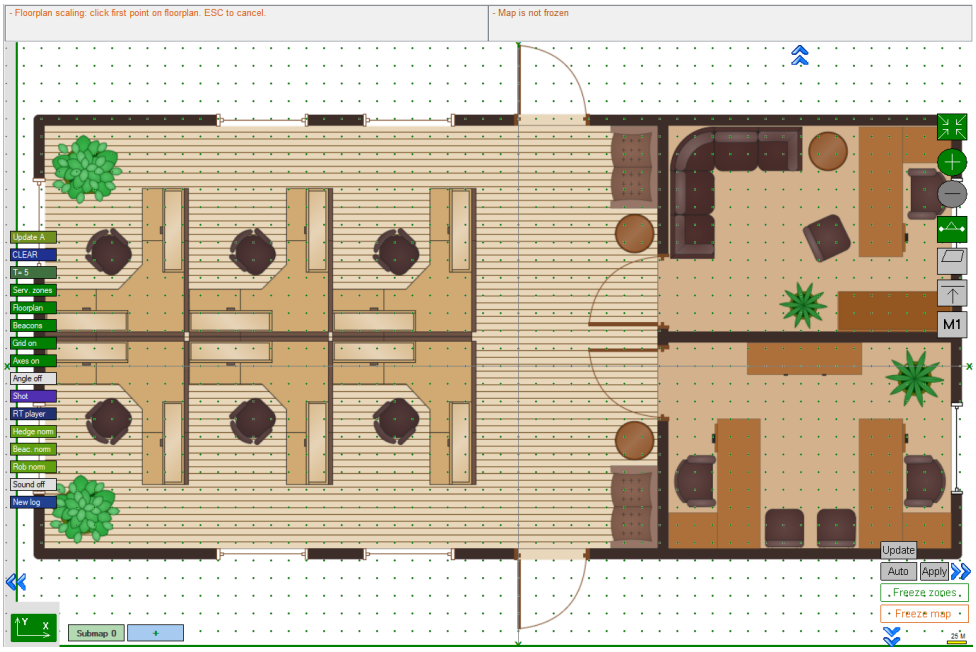


2) Set floorplan scale by two points:

- Right Click on the floorplan => Set floorplan scale by two points:

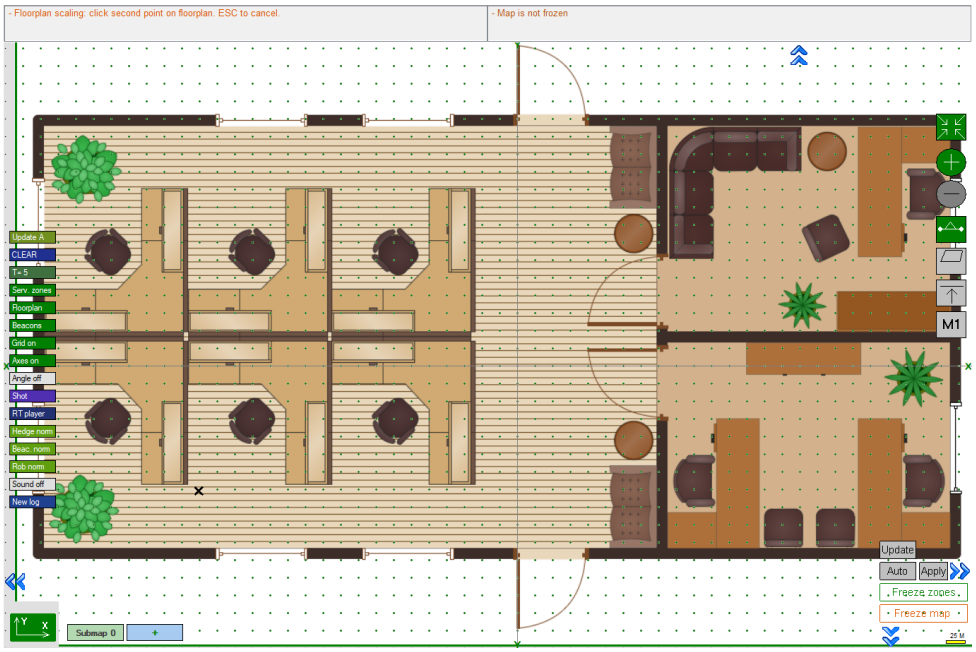


- Click the first point on floorplan (press ESC to cancel):

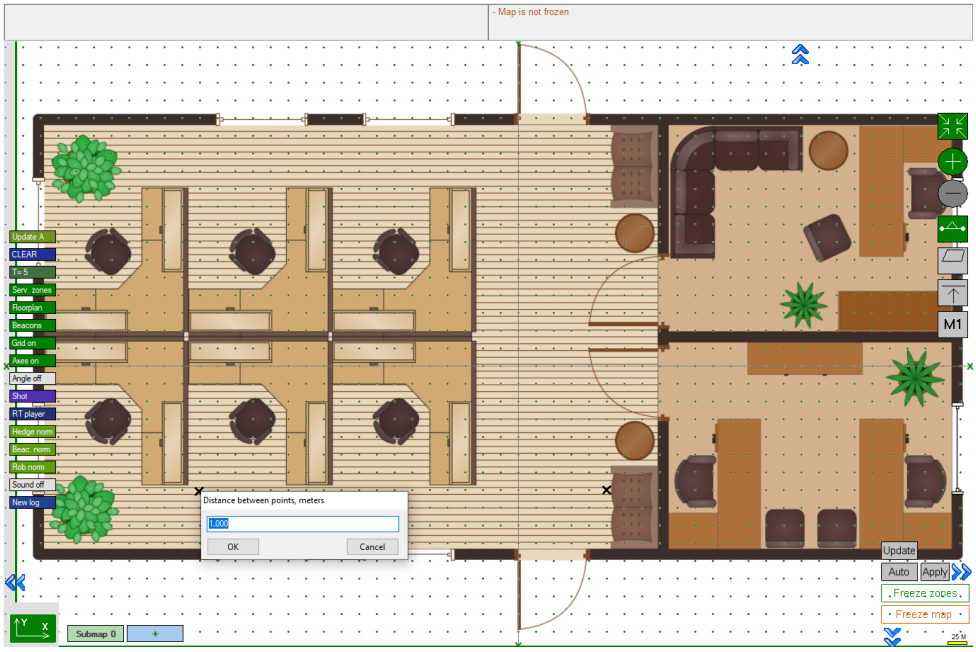


- A black cross will appear at a chosen point:

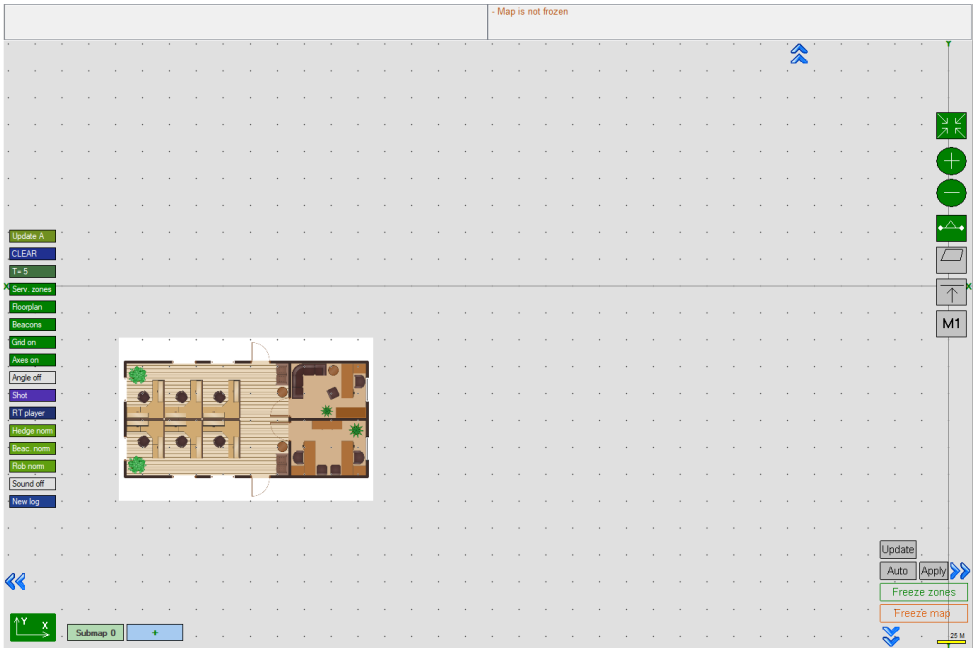
- Click the second point on floorplan:



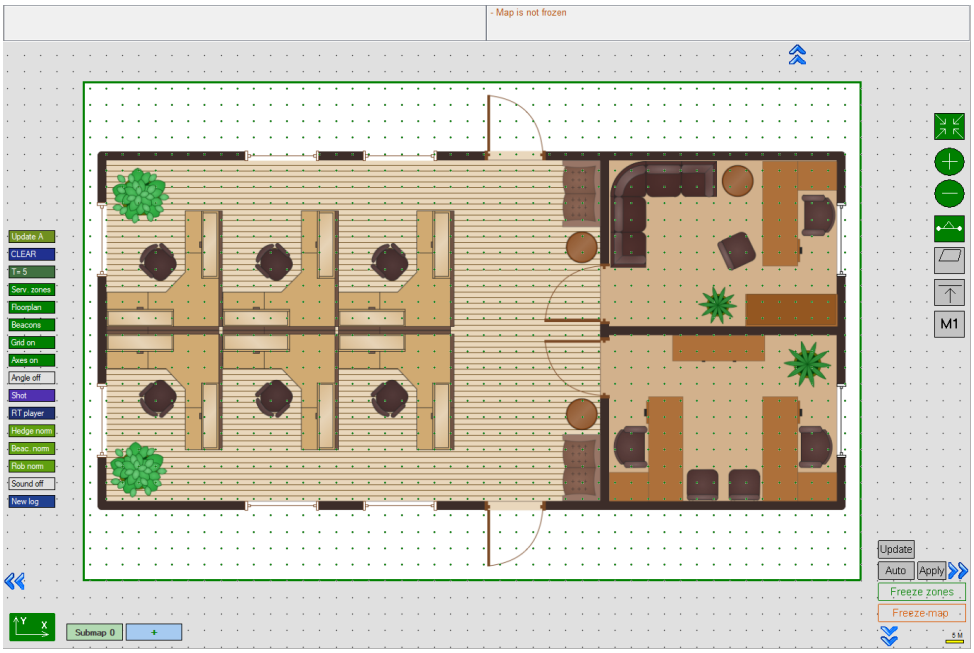
- Enter distance between points:



- The scale of the plan will adjust to the specified parameters:



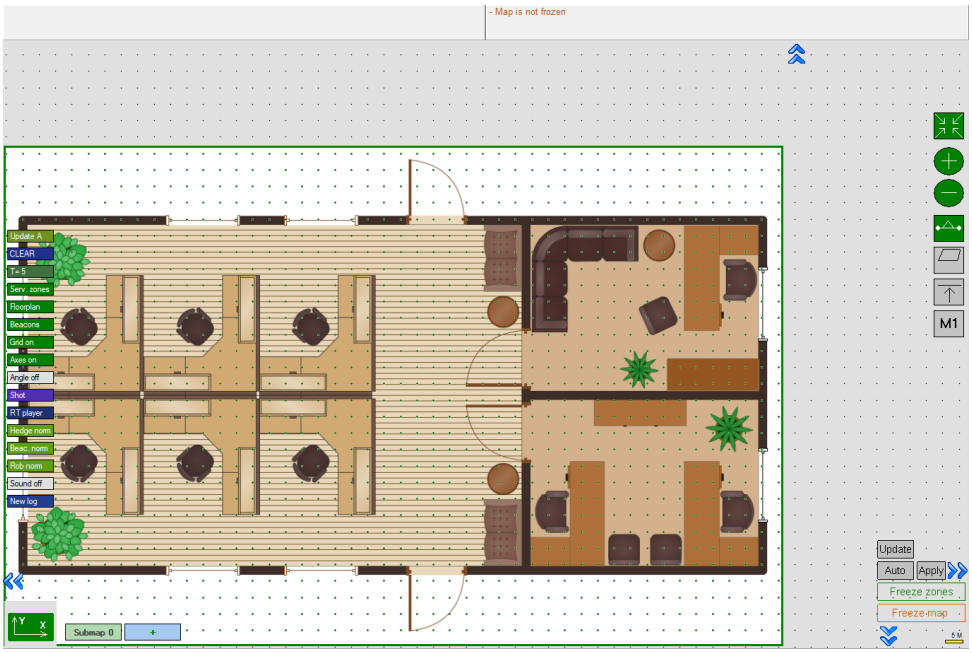
- Change the scale of the Map using mouse roll:



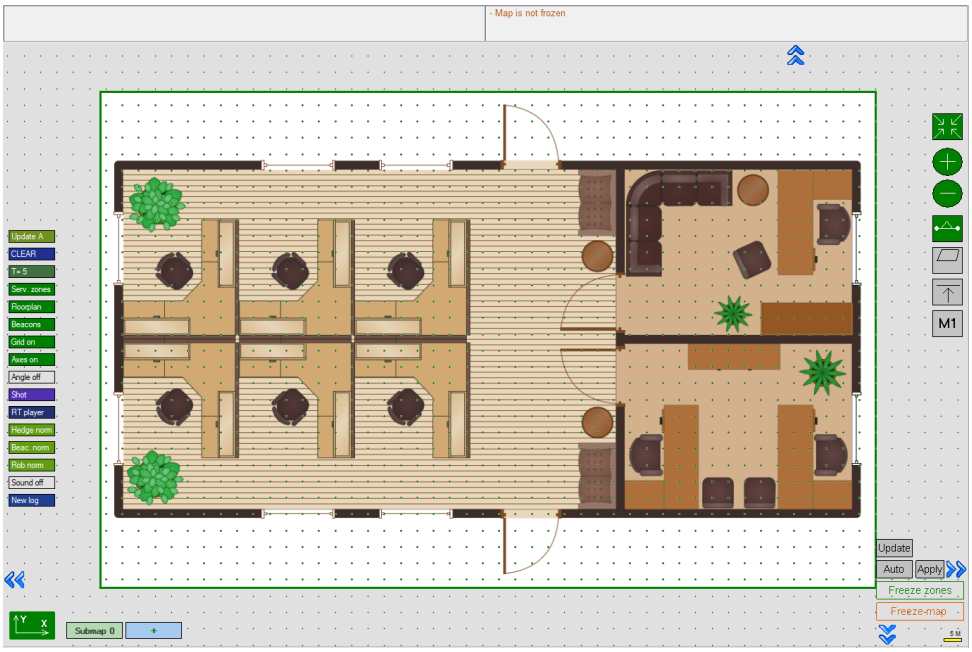
- Scale settings complited.

9.6.3. Move the Floorplan on the Map

- To move the floorplan, click on it with the left mouse button and hold the button down:

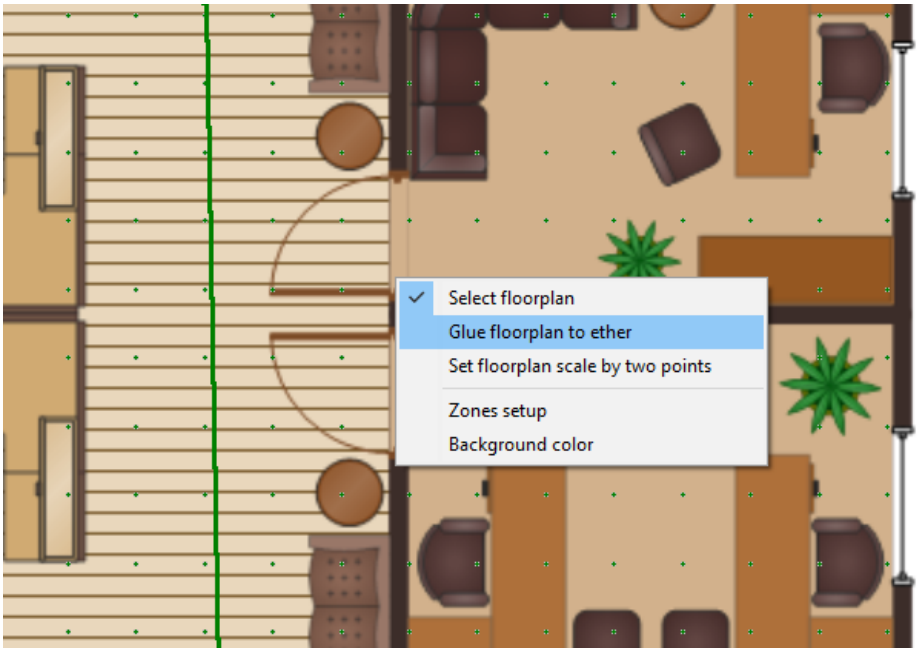


- Drag the plan to the desired location:

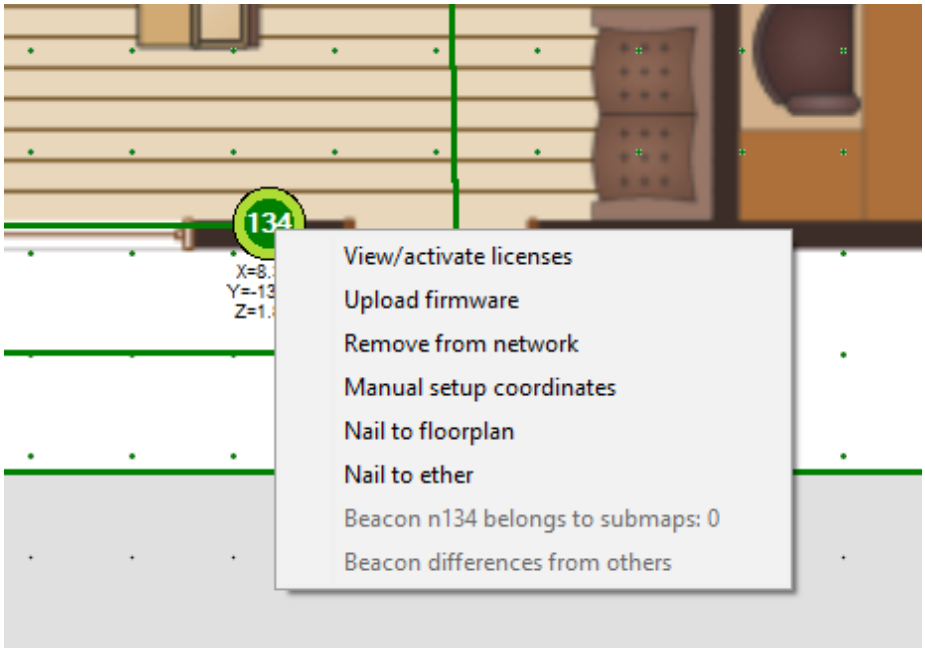


9.6.4. Other Floorplan Settings

- Right-click on a floorplan area to see an additional menu. Press “Glue floorplan to ether” to fix the floor plan's position according to the map grid.



- Right-click a beacon to see an additional menu. You can nail the beacon to a floor plan or an ether here.



9.7. Filters

Those features help to get more stable tracking and avoid “jumps” of the mobile beacons.

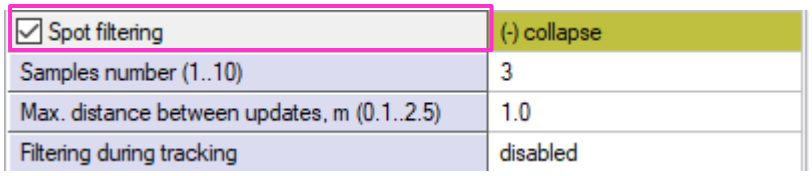
9.7.1. Spot Filtering (for IA Only)

This feature is used to filter mobile beacons “jumps” in the Dashboard.

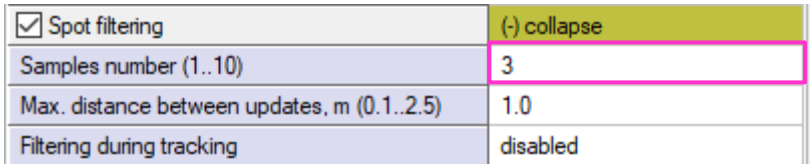
This feature works from the Modem.

How to use:

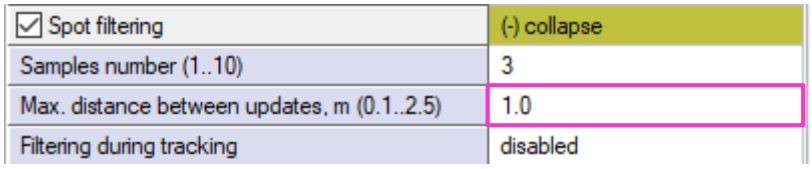
- When the Modem is connected to the PC, choose it in the Dashboard and put a tick next to the Spot filtering parameter. This is number of dots, when filter:



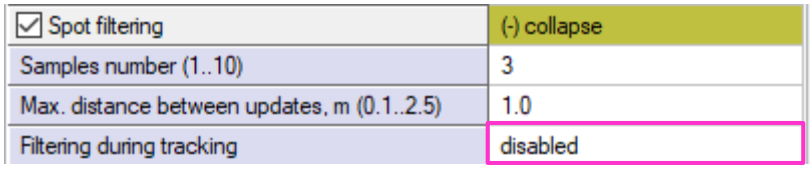
- Insert Samples number (minimum number of dots when filtering starts):



- Insert Max. distance between updates (maximum distance between points):



- Enable Filtering during tracking, for filtering when device moves.



9.7.2. Window of Averaging (NIA Only)

Sliding window size averaging the position of mobile beacons.

How to use:

- Choose Modem when it is connected to the PC and insert the Sliding window size in the “Window of averaging” bar:

Radio channel	0
Device address (1..254)	1
Long time sleep	disabled
Window of averaging (0..16)	0
Distance filter (0..16)	0

Notice that when this feature is on, latency increases.

9.8. Submap Settings

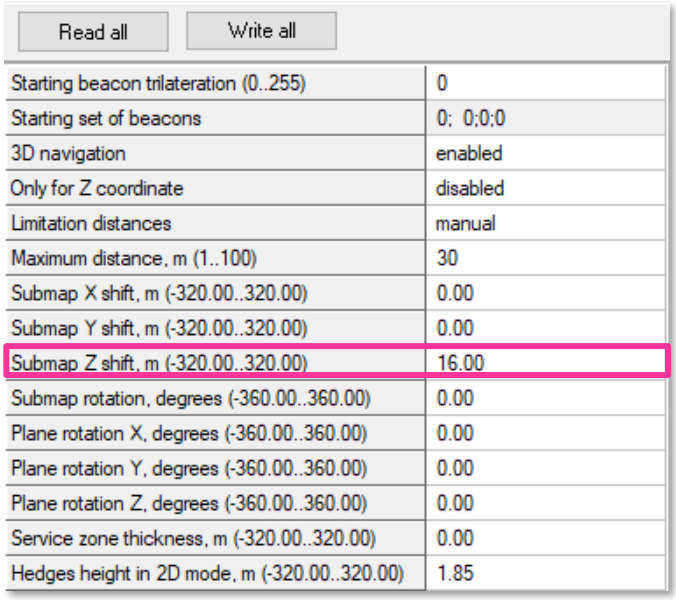
Every submap has its own settings.

Starting beacon trilateration (0..255)	0	Which beacon will have origin (0; 0; 0) coordinates
Starting set of beacons	60; 61;0;0	Addresses of beacons which are building this submap
3D navigation	enabled	3D (X; Y; Z) Tracking mode for this submap
Only for Z coordinate	disabled	To enable "Vertical submap for stable Z" configuration
Hedges height in 2D mode, m (-320.00..320.00)	0.00	Height of hedges for "Vertical submap for stable Z"
Limitation distances	service zone based	Maximum measuring distance limitation mode
Maximum distance, m (1..120)	30	Maximum measuring distance between stationary and mobile
Service zone thickness, m (-320.00..320.00)	10.00	Service zone thickness value in meters
Submap X shift, m (-320.00..320.00)	0.00	Submap X shift value in meters
Submap Y shift, m (-320.00..320.00)	0.00	Submap Y shift value in meters
Submap Z shift, m (-320.00..320.00)	0.00	Submap Z shift value in meters
Submap rotation, degrees (-360.00..360.00)	0.00	Submap rotation value in degrees
Plane rotation X, degrees (-360.00..360.00)	0.00	Plane rotation, X value ("Vertical submaps for stable Z")
Plane rotation Y, degrees (-360.00..360.00)	0.00	Plane rotation, Y value ("Vertical submaps for stable Z")
Plane rotation Z, degrees (-360.00..360.00)	0.00	Plane rotation, Z value ("Vertical submaps for stable Z")
Stationary beacons visible	enabled	Visibility of stationary beacons (Only displaying setting)
Service zone visible	enabled	Visibility of service zones (Only displaying setting)

For example, to correspond your submap to a specific floor, you need to adjust the height:

- Left-click on the submap icon to open the settings - 

- Change Submap Z shift value

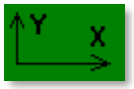


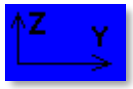
9.9. Axis Rotation Feature (FN0002)

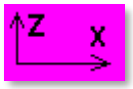
9.9.1. General view

The axis extension enables the rotation of the map. There are 90° gaps between views which helps in multi-floor tracking when a side view is essential.

There are 3 directions of view:



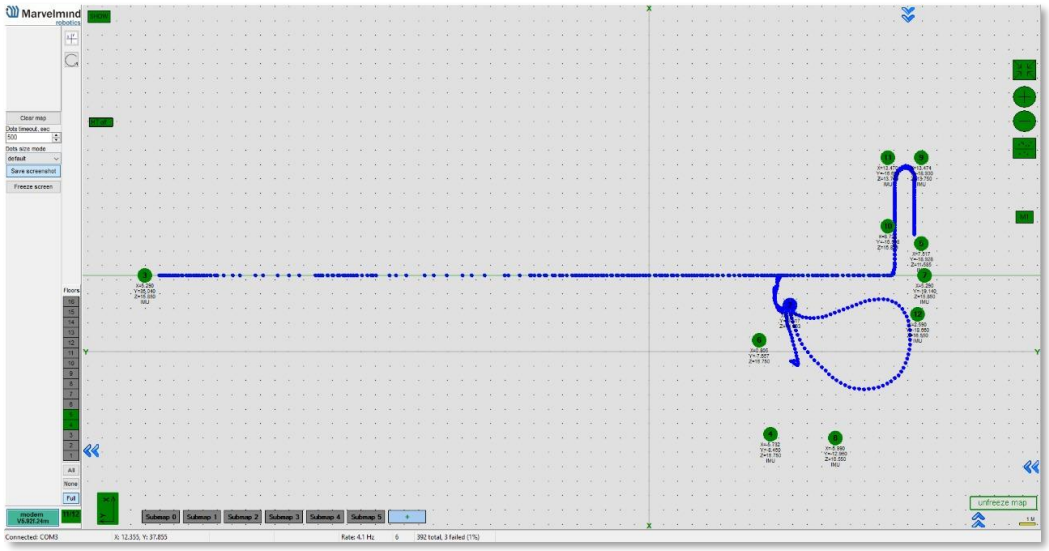




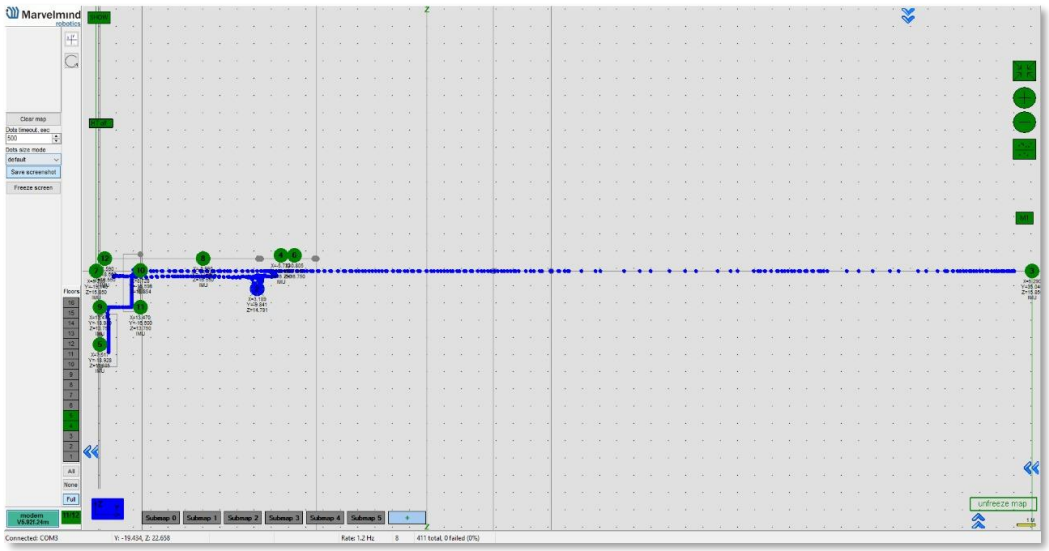
To change the view, click on the icon

9.9.2. Examples of views:

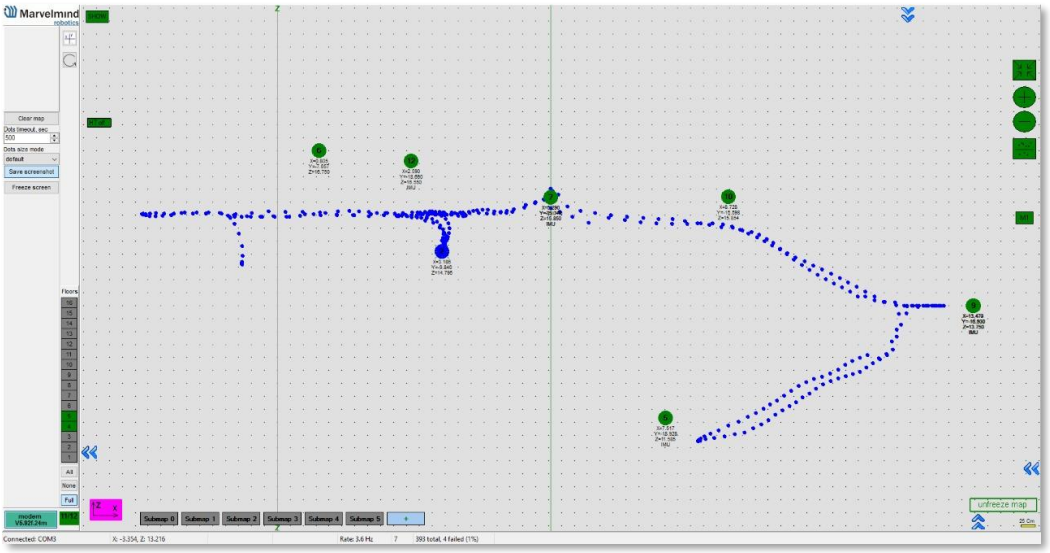
Y, X



X, Y



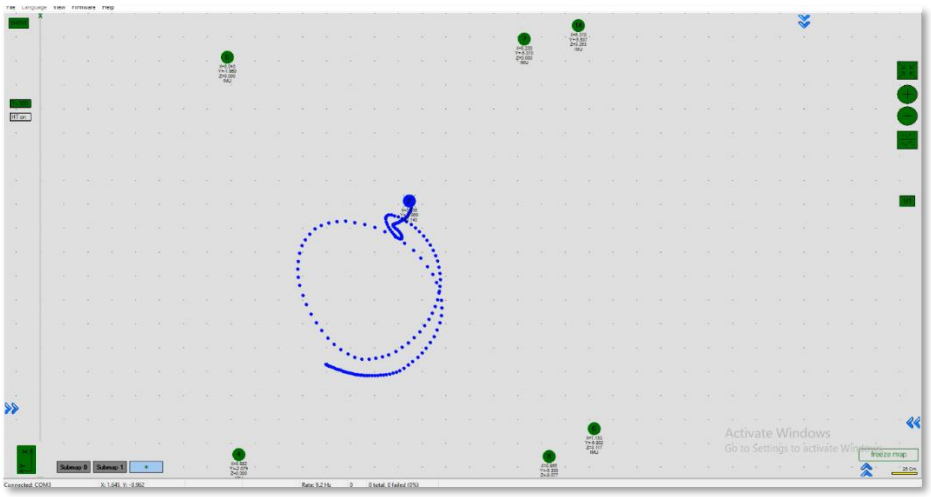
Z, X

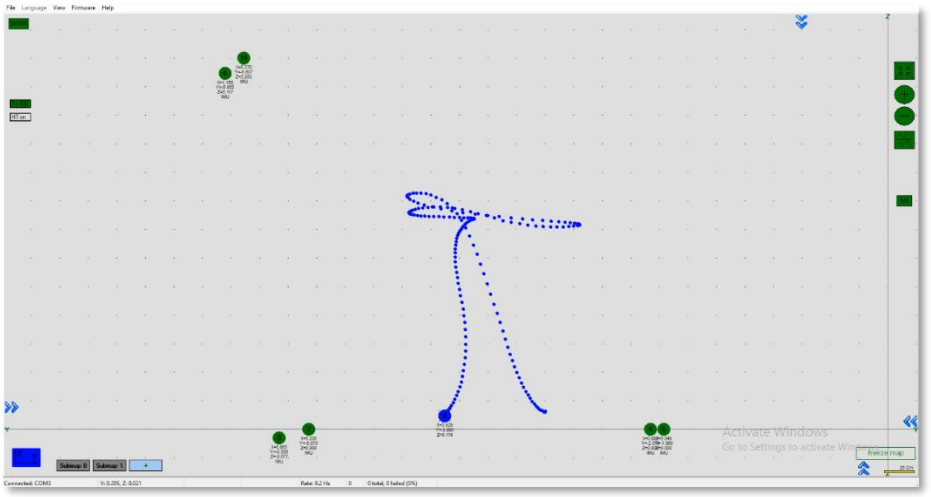

Marvelmind
robotics
Clear map
Data timeout, sec
500
Dots size mode
default
Save screenshot
Freeze screen
Floors
All
None
Full
modem
Submap 0
Submap 1
Submap 2
Submap 3
Submap 4
Submap 5
Unfreeze map

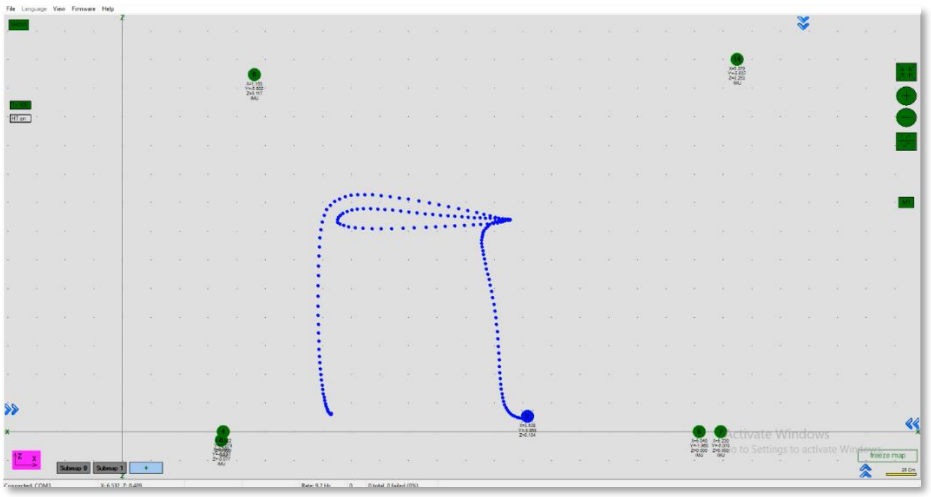
9.10. Vertical Submaps Feature (FN0003)

Vertical submap is a new feature for drone flights or other specific cases. It gives the user an opportunity to get solid Z data for vertical movement

- Example: The drone flight







9.10.1. How to Build Vertical Submap for Stable Z:

9.10.1.1. For this configuration, you need 6 stationary beacons

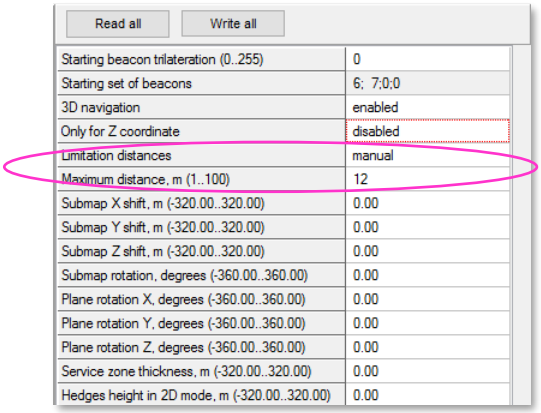
9.10.1.2. Place 4 beacons on the ground, facing each other. (make a square where the edge points are beacons, looking in the center)

9.10.1.3. Place two beacons high on a wall

9.10.1.4. Turn on RX4 only for beacons on the ground and RX4 and RX2 for beacons on the wall

9.10.1.5. Build the first submap (horizontal) consisting of all ground beacons

9.10.1.6. Change the **Limitation distance** to **manual** and input the value in the submap's settings



9.10.1.7. Freeze and lock it

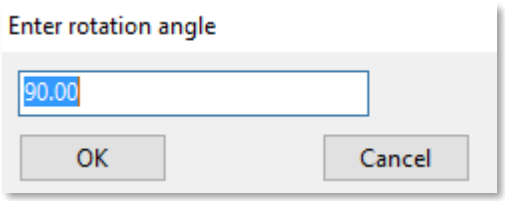
9.10.1.8. Build the second submap (vertical) horizontally consisting of two wall beacons and two ground beacons (neighboring with wall beacons)

9.10.1.9. Now, freeze it

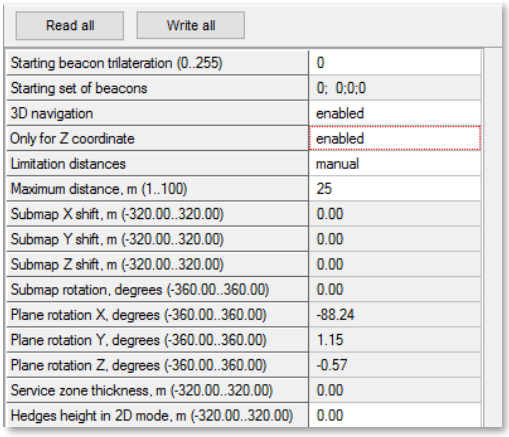
9.10.1.10. Press the axis rotation button 

9.10.1.11. Click on the axis you want to rotate your submap along (when you point the cursor on the axis, it becomes visible and pink-colored)

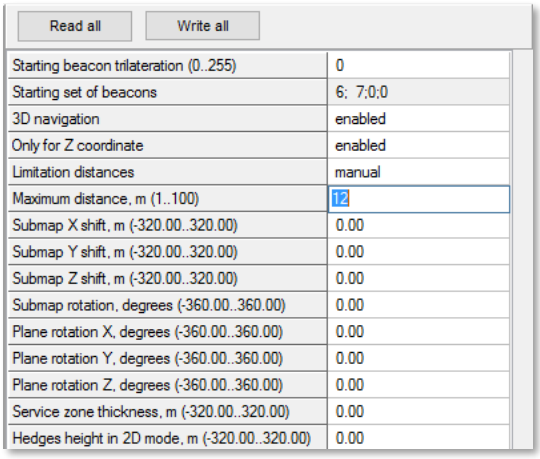
9.10.1.12. Enter the corner value (90° usually)



9.10.1.13. Choose submap 2 and enable “Only for Z coordinates” mode



9.10.1.14. Change the Maximum distance value

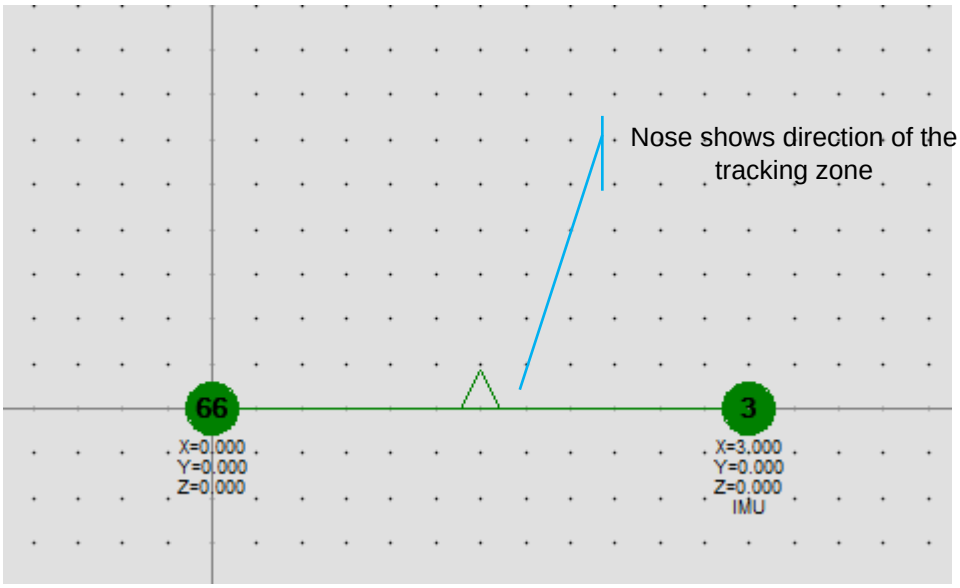


9.10.1.15. Change views and check the map

9.10.1.16. Wake up mobile beacon

9.10.1.17. Track

9.11. Submaps Feature (FN0004)



2D submap example

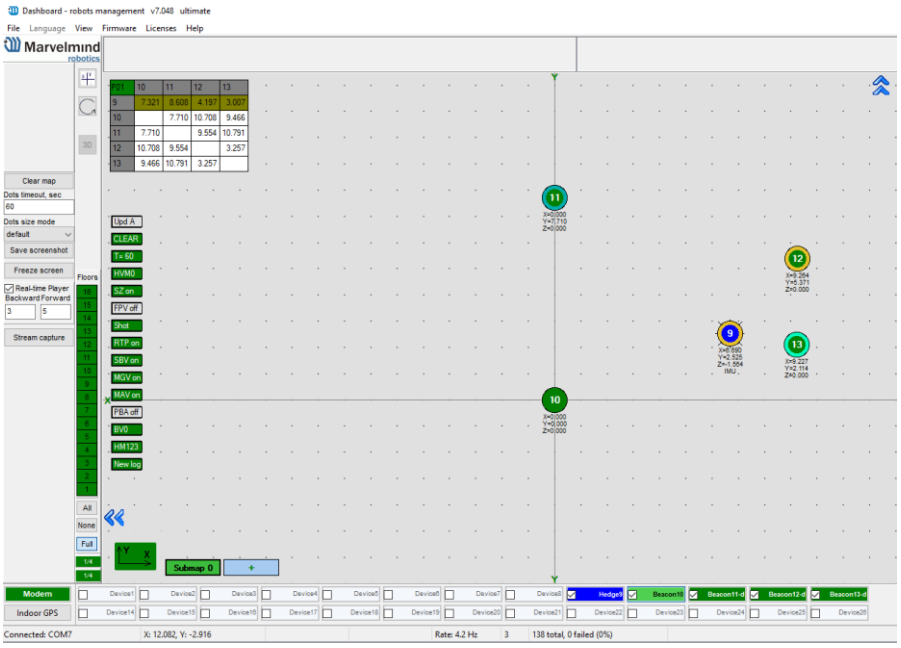
Submaps are a powerful feature that allows building large maps (full business centers, factories, and warehouses with total areas of 10,000, 300,000, or more) based on smaller submaps (30, 1000m2).

A submap is part of the map. It includes a subset of used beacons covering part of the navigation area. The current version of the Marvelmind system can include up to 10 submaps. Please also check our help video.

9.11.1. Starting Submaps

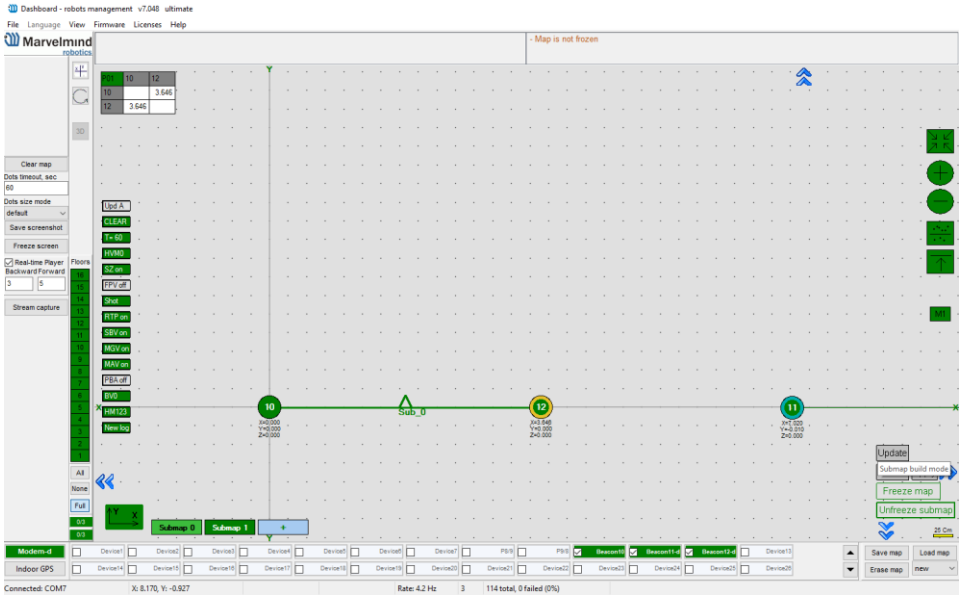
Hedgehogs do not belong to any submap and can move between sub-map areas. Hedgehogs can be served by multiple submaps at the same time. By default, the map consists of a single submap (Submap0)

9.11.1.1. After adding new beacons to the system (waking them up), they appear



in the first not frozen submap or in Submap 0 if all beacons are frozen

9.11.1.2. Pressing the “+” button will add a new empty submap to the system



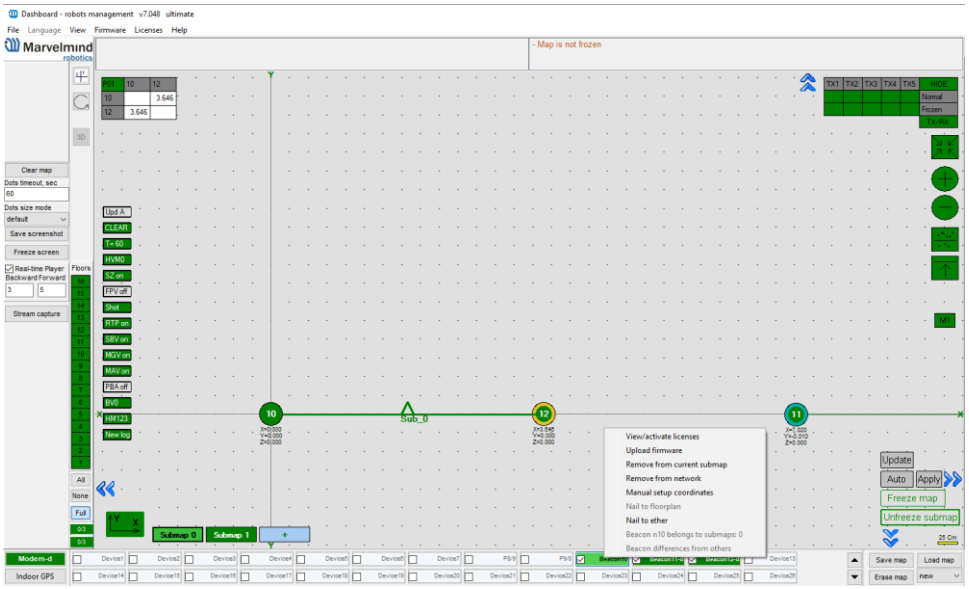
9.11.1.3. Press the button with the submap number (Submap 0, Submap 1 etc.) - select the corresponding submap

9.11.1.4. In this state, if the modem button is pressed, the list of parameters on the right side represents some of the parameters of the selected submap, for example, “Starting beacon trilateration,” “Starting set of beacons,” etc.

9.11.1.5. The system after adding beacons to the Submap 0, adding new submap and the selection of Submap 0

9.11.1.6. Now we have 4 beacons, all in Submap0 (it can be seen near the table of distances)

9.11.1.7. With the submap selected, the context menu of beacons buttons (available by right-clicking) has the functions of adding and removing



the beacons from the submap. In the picture above, we are removing beacon 3 from Submap0." Then we switch to Submap1 and add this beacon to the submap

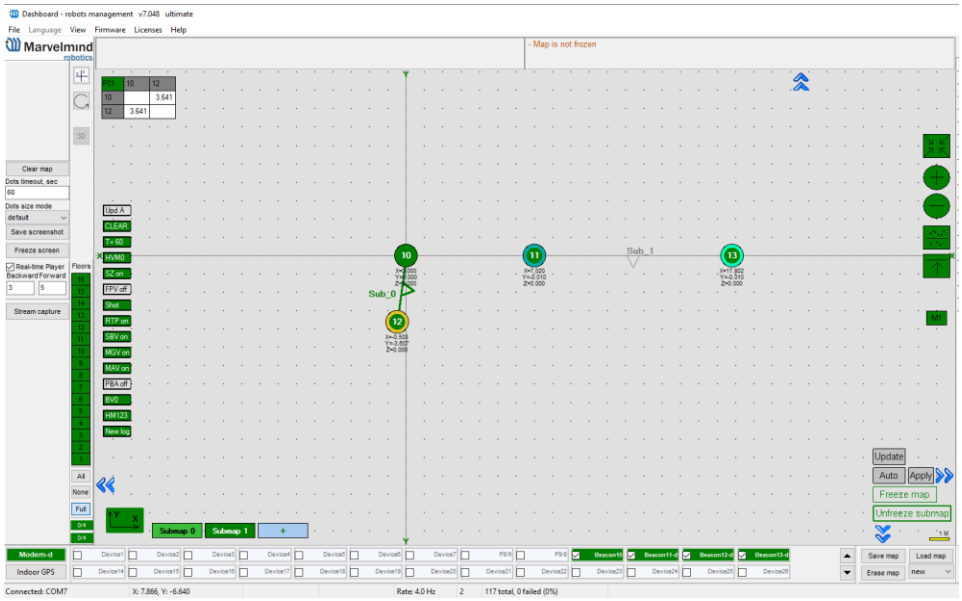
9.11.1.8. When the submap is selected, the beacons that do not belong to the submap are colored **gray**. In the same way, continue with removing beacon 10 from Submap0 and adding it to Submap1

9.11.1.9. Now there are two beacons in Submap1, so this submap is built. "Submap 0" is built as well. Now we can freeze both submaps

9.11.1.10. Pressing the "freeze map" button when the submap is selected will freeze only that submap; pressing the "freeze map" button when the modem is selected will freeze all submaps.

9.11.1.11. Now we have two good submaps, but they are not correctly located relative to each other. On the right side, the parameters of shift and rotation for the selected submap exist; they can be filled in by hand. But a more user-friendly way is to drag and drop the selected submap using the mouse and holding down the CTRL button.

9.11.1.12. The mouse wheel can be used to rotate the submap. The mirroring button can also be used; it affects only selected submaps.



9.11.1.13. After some movement, rotation, and mirroring of submaps, we can locate the submaps close to their real relative location

9.11.1.14. Now the system is ready to use; we can wake up and track the mobile hedgehog

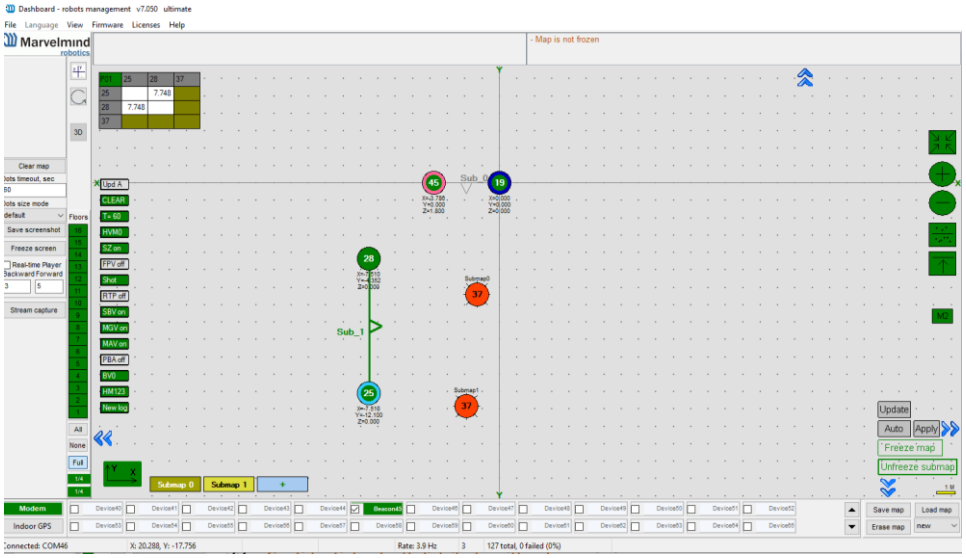
9.11.1.15. In some cases, the hedgehog can be lost between the submaps if any of the submaps does not cover this area.

9.11.1.16. Submaps can be removed from the system by using the context menu of the submap selection button (available with a right click)

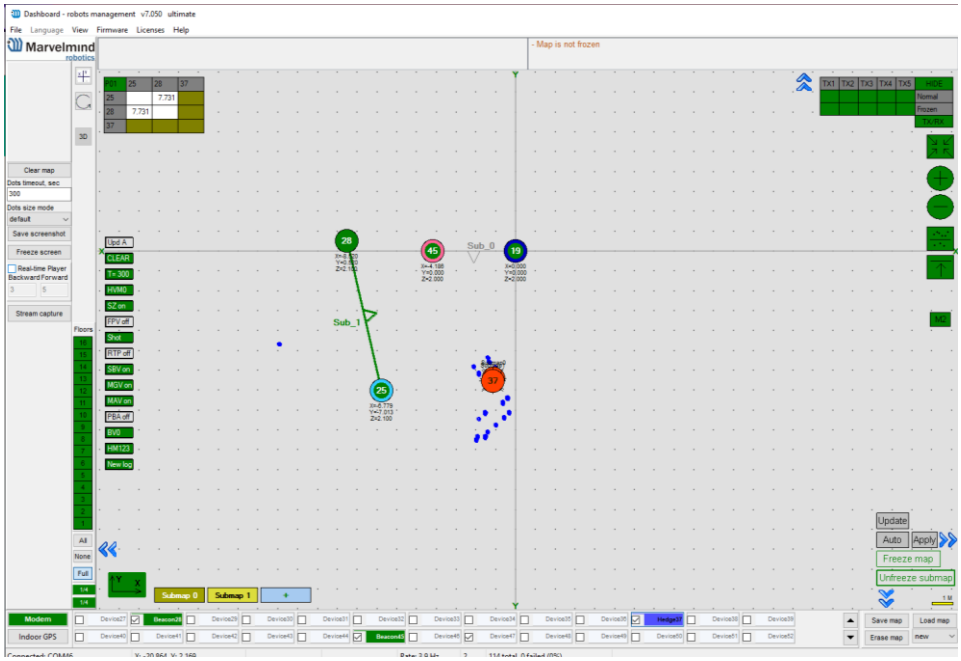
9.11.1.17. The M1/M2 parameter is used for the precise superposing of submaps that do not have common beacons. This means that submaps cannot be aligned automatically.

To align submaps:

- Build the system like in the previous instruction
- Put M2 in “on” mode by clicking the icon. Place the hedgehog near the boundary between two submaps. You will see 2 red hedgehogs blinking; this is how the hedge is seen in two submaps



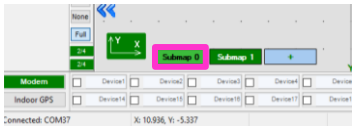
- To align submaps correctly (CTRL + scroll/drag) against each other, until the red mobile beacons are fully overlapped



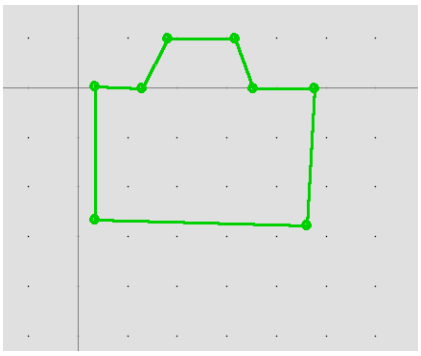
- Replace hedgehog to 1 or 2 points and repeat replacing submap for better superposing
- The next step is to set Service zones where tracking is possible. If a mobile beacon is outside a service zone, it cannot be tracked. If you build a complicated map, you have to make service zones correctly. Service zones must be crossed to provide correct and glide tracking.

9.11.2. How to Create a Service Zone:

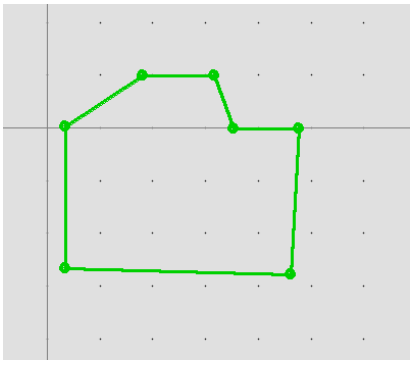
9.11.2.1. Choose submap (click on the submap icon).



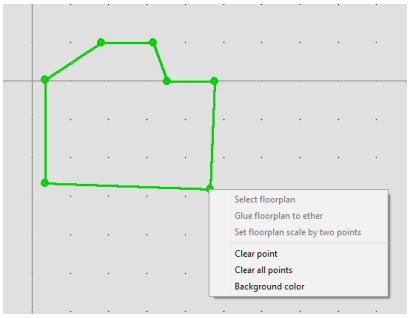
9.11.2.2. Use SHIFT + Left click on the map to create a point.



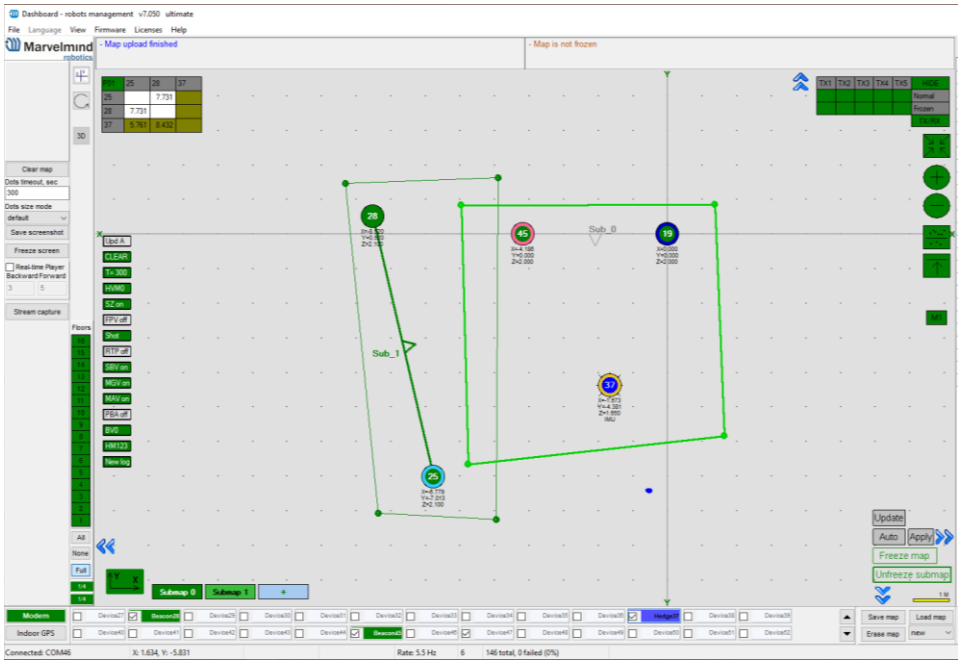
9.11.2.3. Use SHIFT + Left click on the point to delete it.



9.11.2.4. Use Right click on the point and choose “Clear all points” to delete the service zone



9.11.2.5. Put points around the submap and move them to provide a service area for the current submap. Service areas will cross each other. If hedgehogs get lost between two submaps, expand the service area.



Learn more:

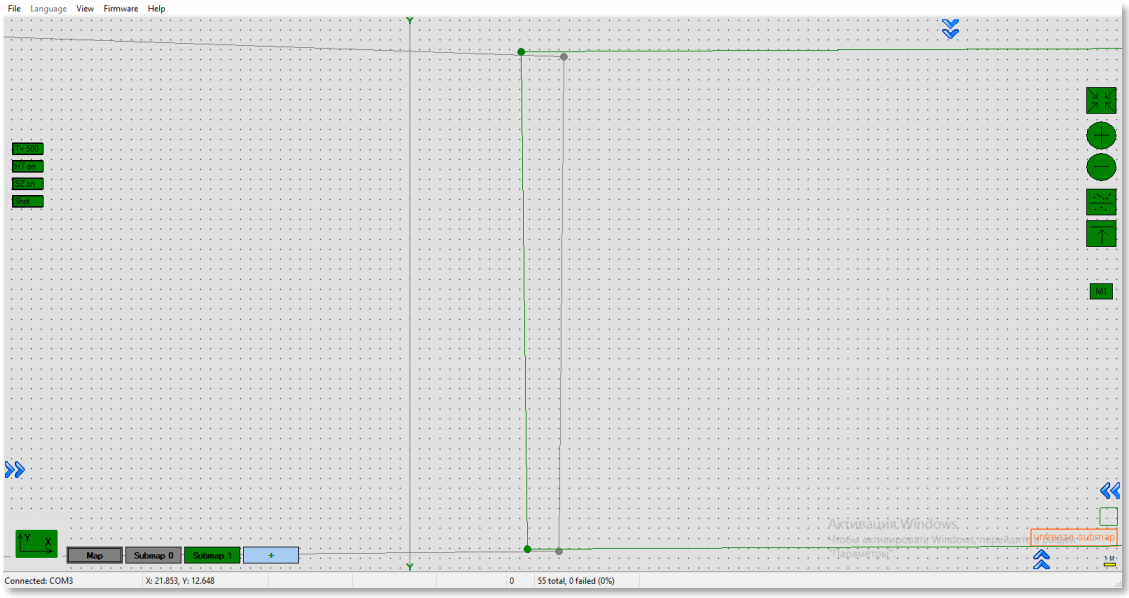
- How to define and edit service zones - How to define and edit service zones, complete instruction
- Help: submaps, service zones, handover zones - This is a long and detailed video giving explanations on:
    - What is a submap
    - What is a service zone
    - What is a handover zone
    - How to build larger maps quickly and successfully – many practical advises

9.12. Handover Zones Setting

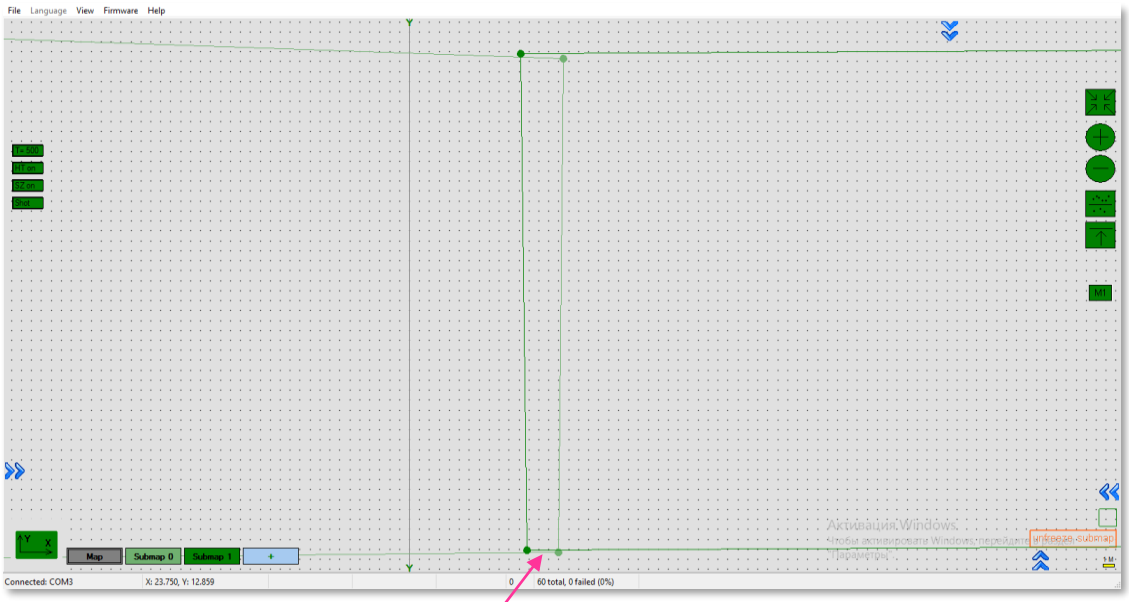
Users must set up handover zones between submaps to guarantee handover quality for complex maps with multi-floor and similar.

How to set handover zones:

- Choose any submap

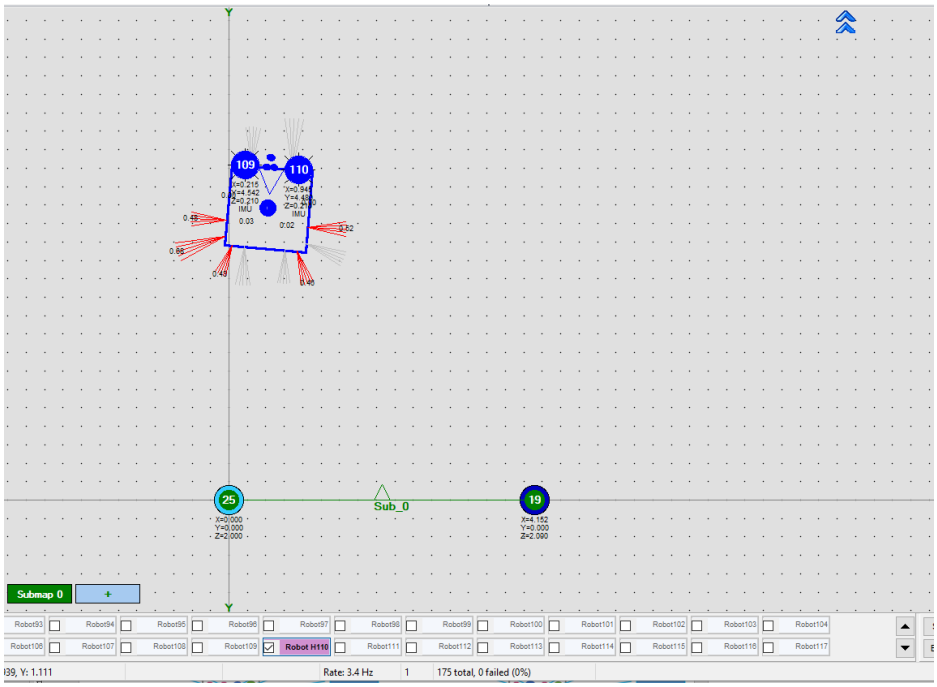


- Use **Alt + Left Click** on the other submap's service zone border (neighboring)
- Now, neighboring service zones are colored green (dark green for the chosen submap and light green for neighboring submaps)



9.13. Paired Beacons (FN0005)

Two hedgehogs can be paired and work together as a single beacon without update rate reduction. In this case, you get not only a location but a direction as well.



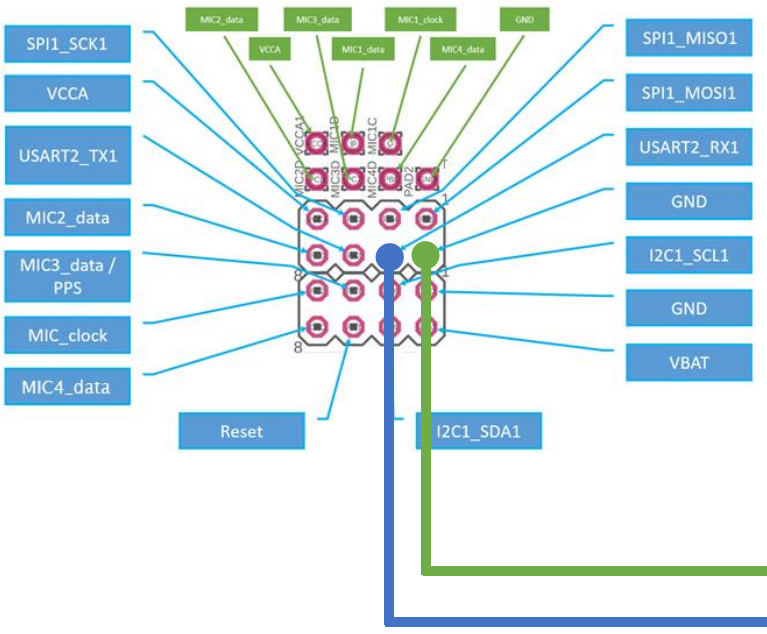
Moreover, each beacon streams out in this mode not only in its own location but also in the direction where the pair is facing. This feature hugely simplifies autonomous driving and flight. Here is an updated protocol with the changes.

Please also check our help video.

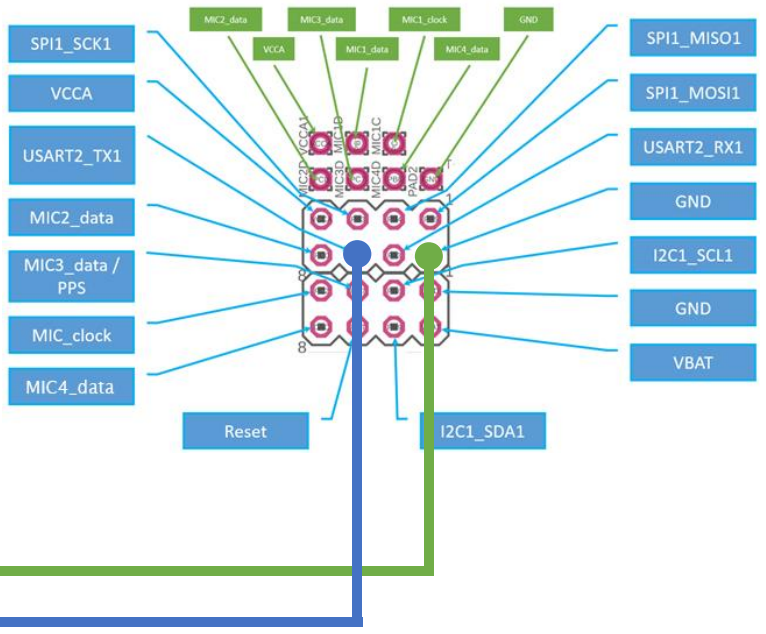
How to pair beacons:

1. (Recommended) To connect beacons via UART, then connect Super Beacons with cable from USART_TX of the Following beacon by address (Smaller address number) to USART_RX of the Leading beacon by address (Larger address number) and from GND to GND of each beacon (Note: Look at the pictures below). Only applicable in IA

Leading Beacon (by address):



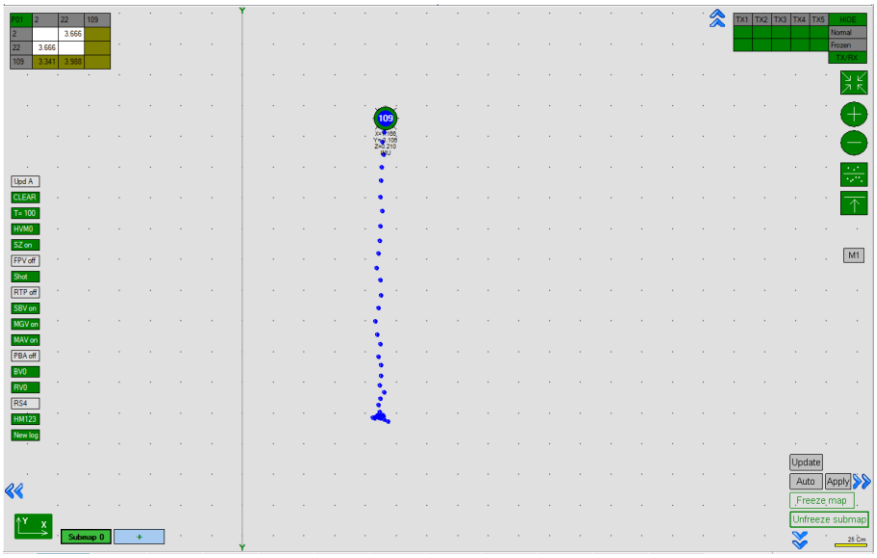
Following Beacon (by address):



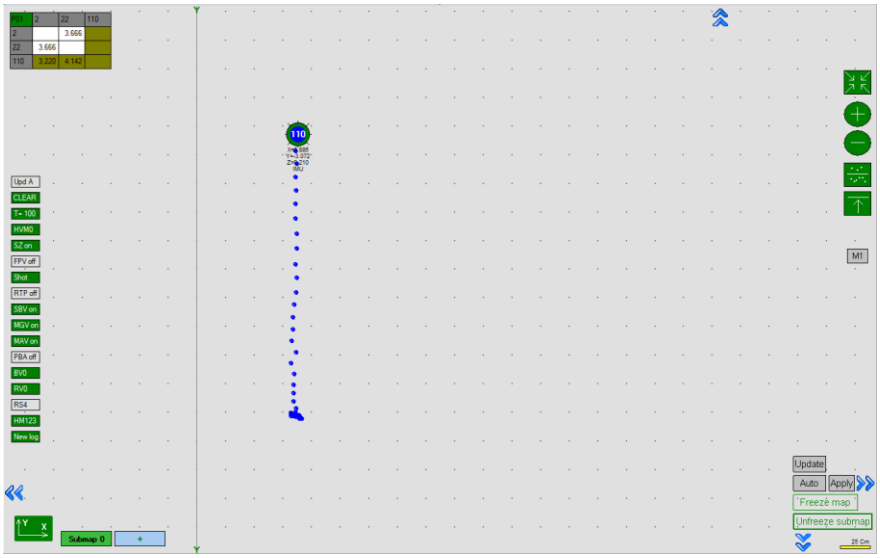
(Only if the distance between the beacons is more than 1 meter) If you want to pair beacons via Radio, do not connect beacons via anything and change “Communication in pair” to “via radio” later.

Switch off the Real Time player before setting up the beacon pair. The Real-Time player smooths the tracking, which can strongly affect the tracking of paired beacons.

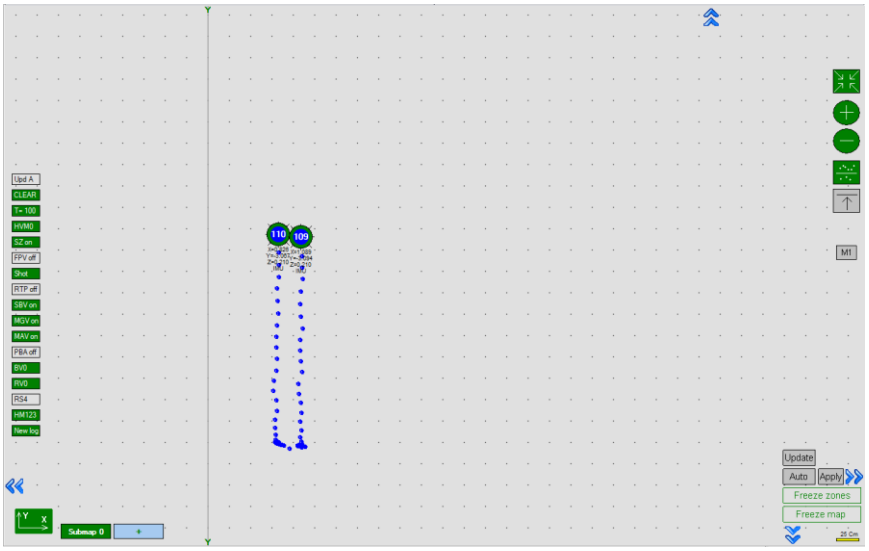
2. Wake up one of the pair's beacons and achieve perfect tracking for a path (remember to freeze the submap before tracking). If tracking is perfect, put this beacon in sleeping mode and move to another beacon from the pair.



3. Wake up a beacon and repeat the path passed with the first beacon. If everything is good, move to the next step



4. Wake up both beacons; do not pair them yet. Repeat the same path for both beacons. If tracking is good, pair the beacons



Beacons must be at least 20 cm apart. The farther apart the beacons are the more accurate the angle. Also, UART is strongly recommended if the base between the beacons is less than 1 meter. If the base is more than 1 meter, the communication can be set up via radio.

The Leading beacon must be on the left of the side where it looks. Its position should be the same as shown in the scheme in Step 1.

5. Choose one beacon and go to the “Pairing mode” parameter, and activate Pairing mode:

Hedgehogs pairing	(-) collapse
Pairing mode	no pairing

6. Choose “via UART” or “via radio”, depending on your connection, in Communication in pairs.

Hedgehogs pairing	(-) collapse
Pairing mode	pair
Address of paired hedge (1..255)	1
Location againist center	left
Base of the pair, cm (1..255)	10
IMU fusion for angle	enabled
Send location of center	enabled
Communication in pair	via radio

7. Write the “Address of paired beacon,” which means the number of the beacon currently selected as a hedgehog is paired with:

Hedgehogs pairing	(-) collapse
Pairing mode	pair
Address of paired hedge (1..255)	109
Location against center	left
Base of the pair, cm (1..255)	10
IMU fusion for angle	enabled
Send location of center	enabled
Communication in pair	via radio

8. Now choose location against the center in parameters relatively the second beacon:

Hedgehogs pairing	(-) collapse
Pairing mode	pair
Address of paired hedge (1..255)	109
Location against center	left
Base of the pair, cm (1..255)	10
IMU fusion for angle	enabled
Send location of center	enabled
Communication in pair	via radio

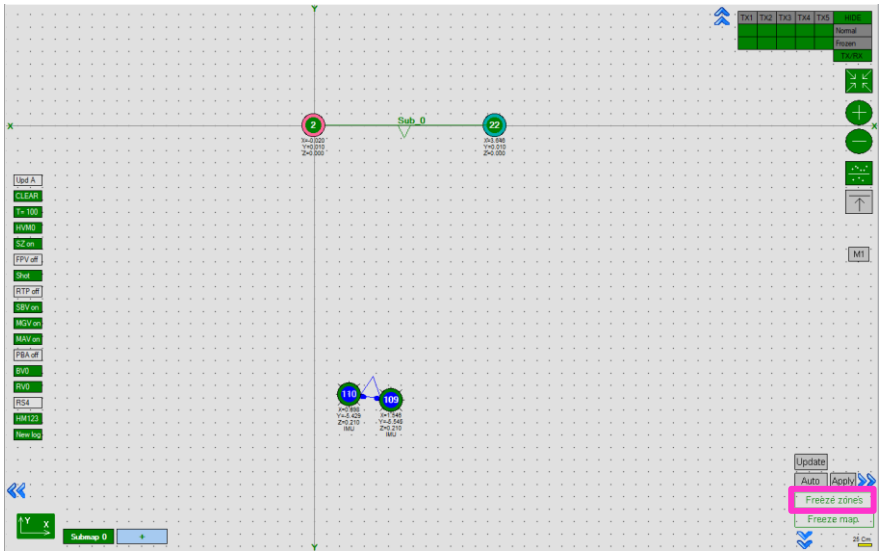
9. Go to the “Base of the pair” parameter and write the actual distance between paired hedgehogs:

Hedgehogs pairing	(-) collapse
Pairing mode	pair
Address of paired hedge (1..255)	109
Location against center	left
Base of the pair, cm (1..255)	30
IMU fusion for angle	enabled
Send location of center	enabled

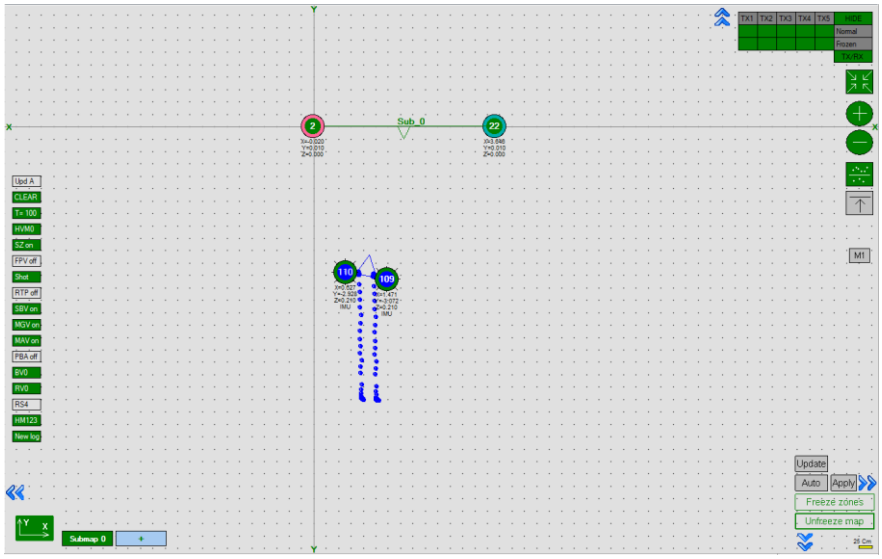
10. Check that all settings are the same for the paired beacon (except Location against center):

Hedgehogs pairing	(-) collapse
Pairing mode	pair
Address of paired hedge (1..255)	110
Location against center	right
Base of the pair, cm (1..255)	30
IMU fusion for angle	enabled
Send location of center	enabled
Communication in pair	via radio

11. Freeze a Map:



12. Pairing completed successfully:



9.14. Paired Microphones

You can also connect an additional microphone and turn on “Paired microphones” mode to get the direction without using a second beacon (only for IA).

How to pair microphones:

9.14.1. Choose a beacon in the beacon panel

9.14.2. Turn on the microphone which you connected additionally

9.14.3. Open “Hedgehogs pairing”

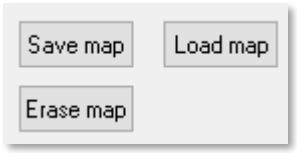
9.14.4. Enter to “Address of paired hedge” address of the beacon that you are setting up

Hedgehogs pairing	(-) collapse
Pairing mode	pair
Address of paired hedge (1..255)	200
Location against center	left
Base of the pair, cm (1..255)	10
IMU fusion for angle	enabled
Send location of center	enabled
Communication in pair	n/a

9.15. Map Settings

Map Settings offer some helpful tools:

- Save map – saves map as *.ini* file into **Dashboard folder/maps**
- Load map – loads map from *.ini* format file
- Erase map – erases map and clears it

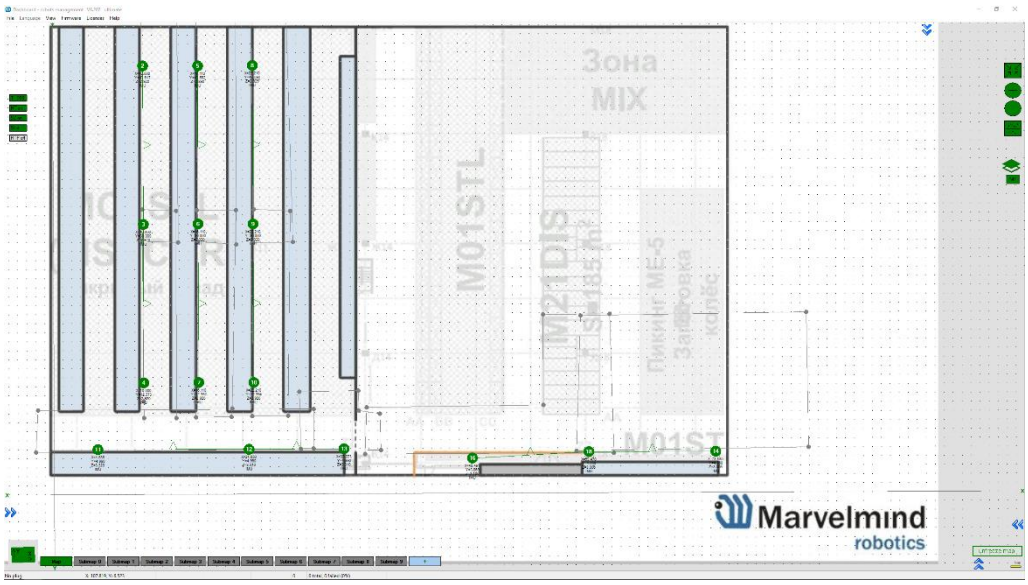


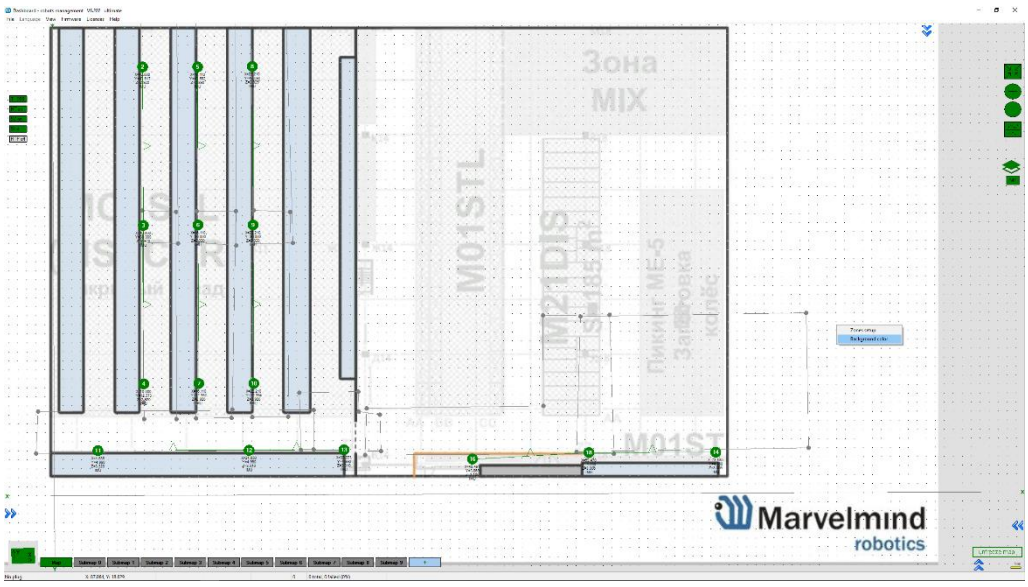
9.16. Background Color

Starting from v6.200 Dashboard supports background color change.

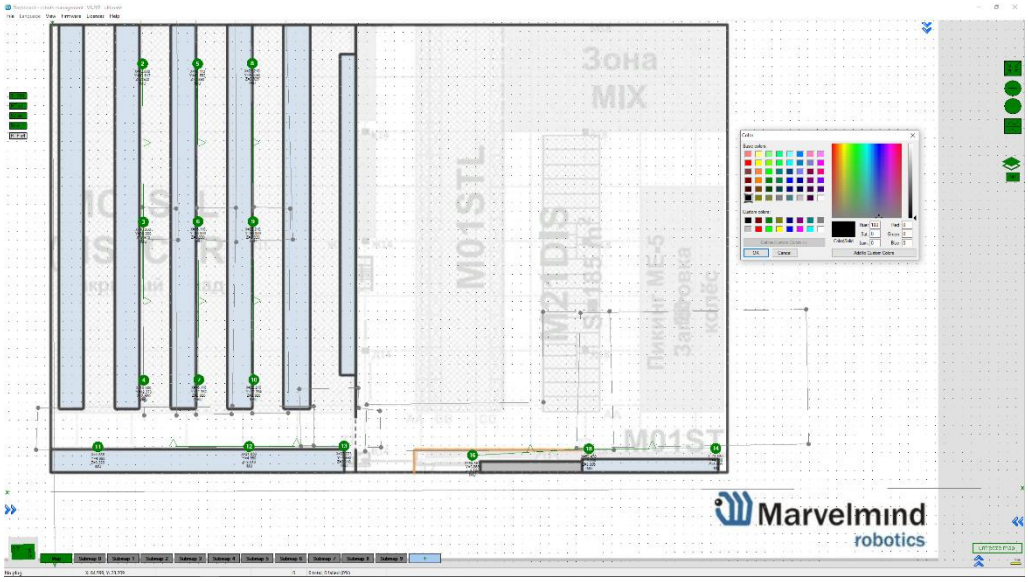
This is a small feature that helps make tracking look better. If you uploaded a floor plan that is white, you can tune the Dashboard's background color to match.

How to choose background color:

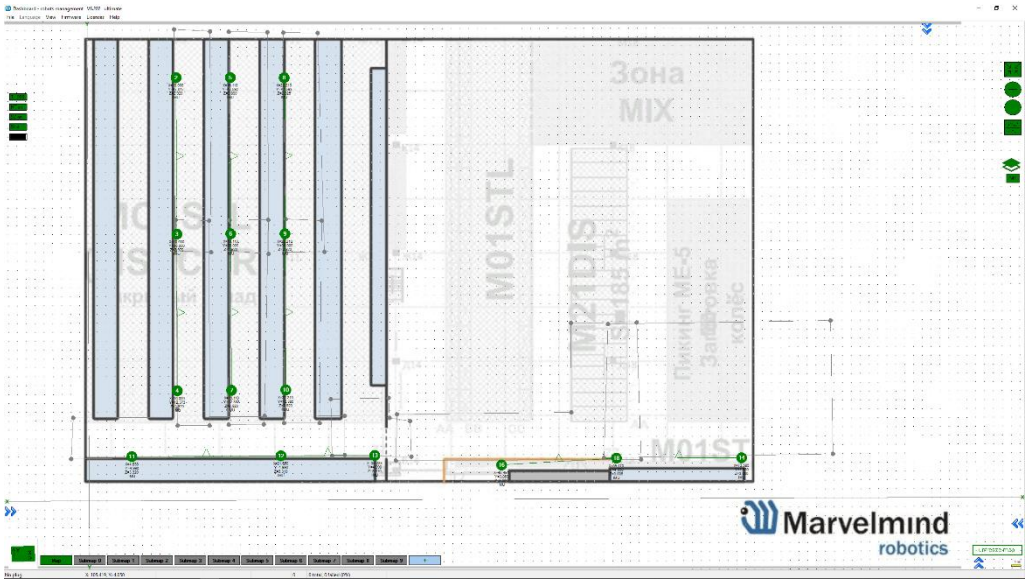
- Load floorplan
- 

- **Right click** on the background
- 

- Choose color and press “OK”

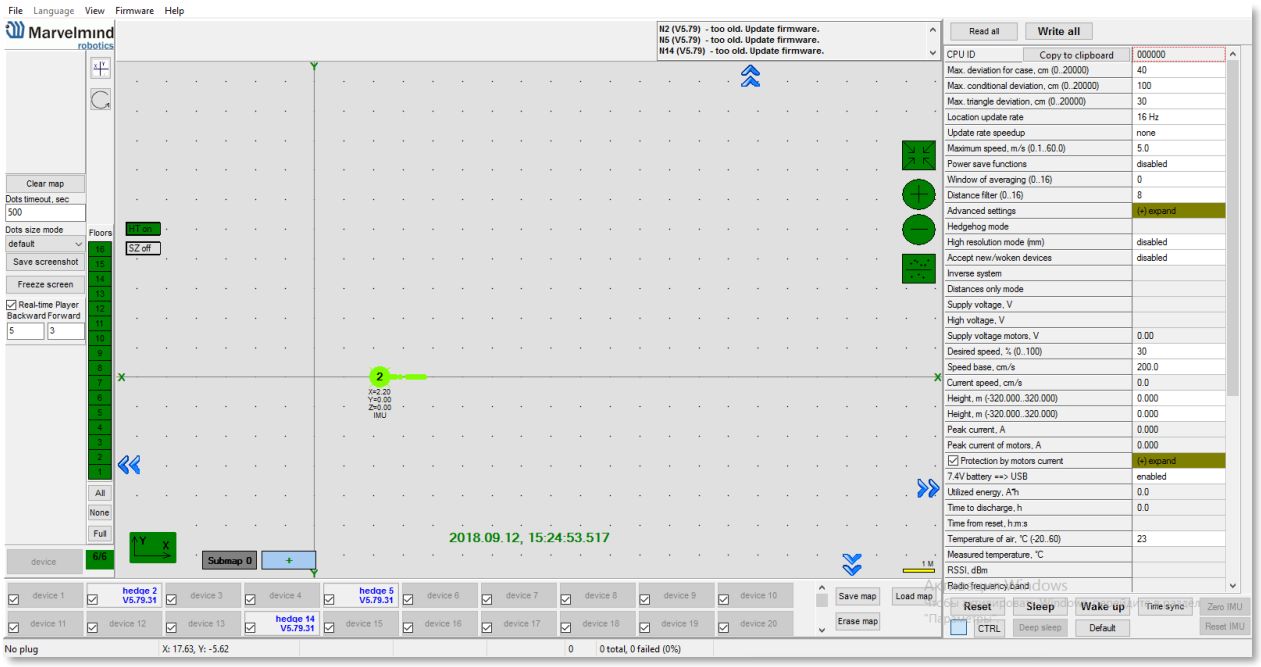


- Color applied. Now, background matches floorplan



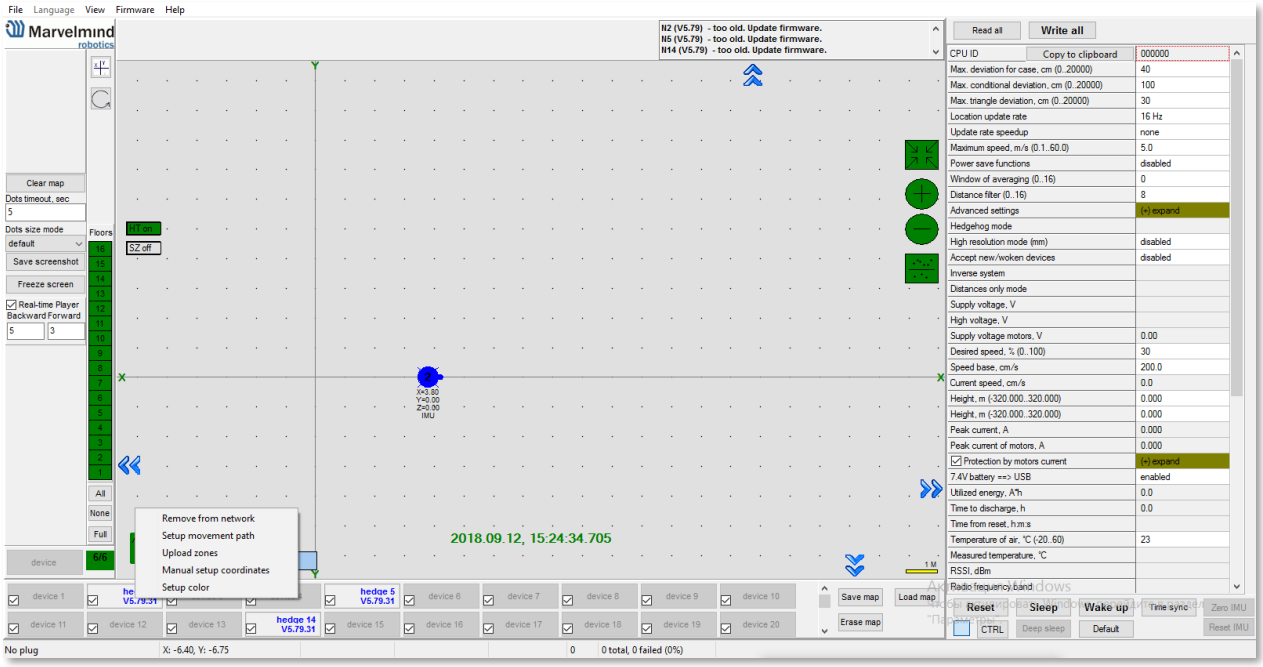
9.17. Hedge Color Change (FN0006)

If you have multiple mobile beacons, you can give each one its own color to make it recognizable on the map

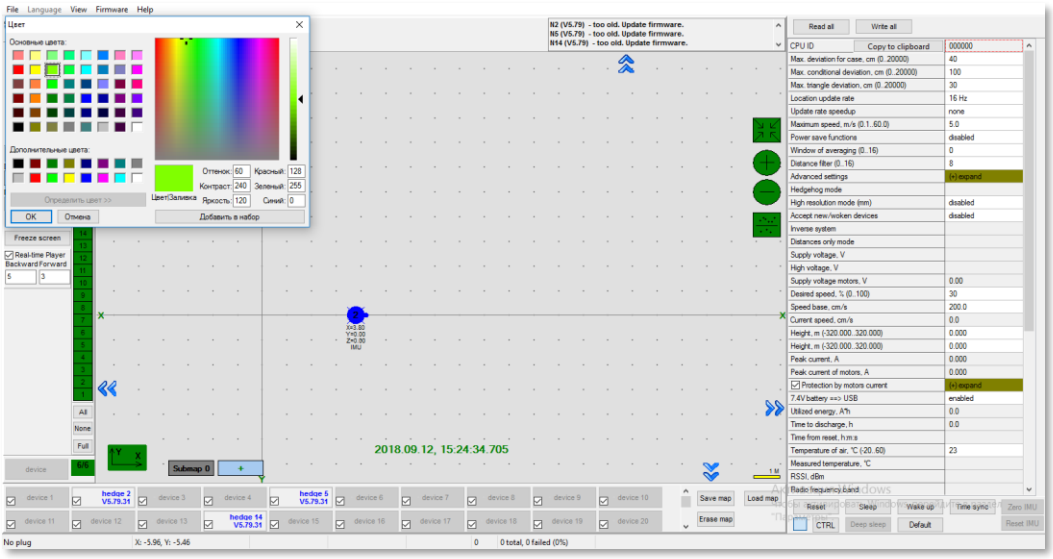


How to change hedgehog color:

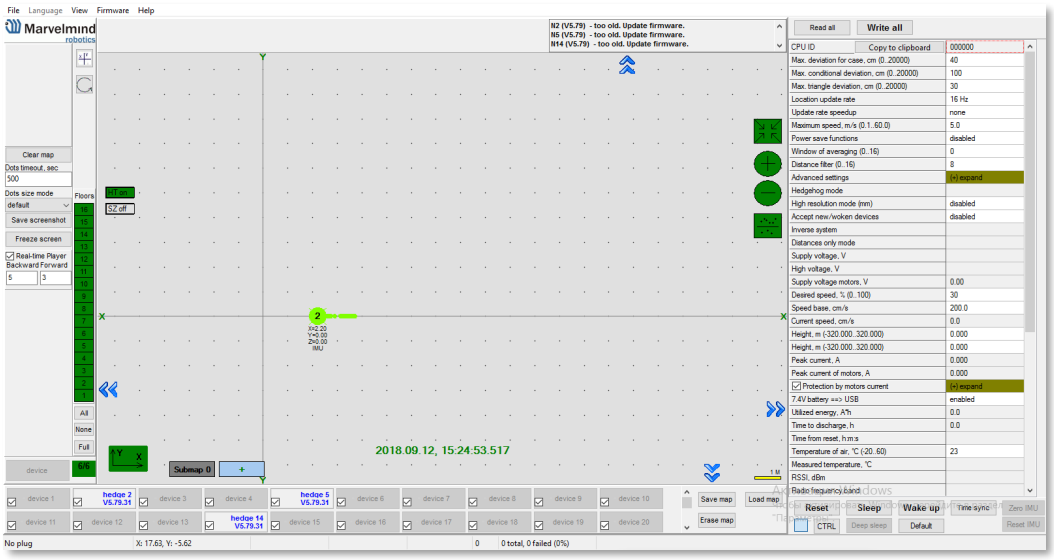
- **Right click** on the hedge in the list of devices -> **Setup color**



- Choose any color which suits you and press **OK**



- Now, the hedgehog and its tracking path will be colored

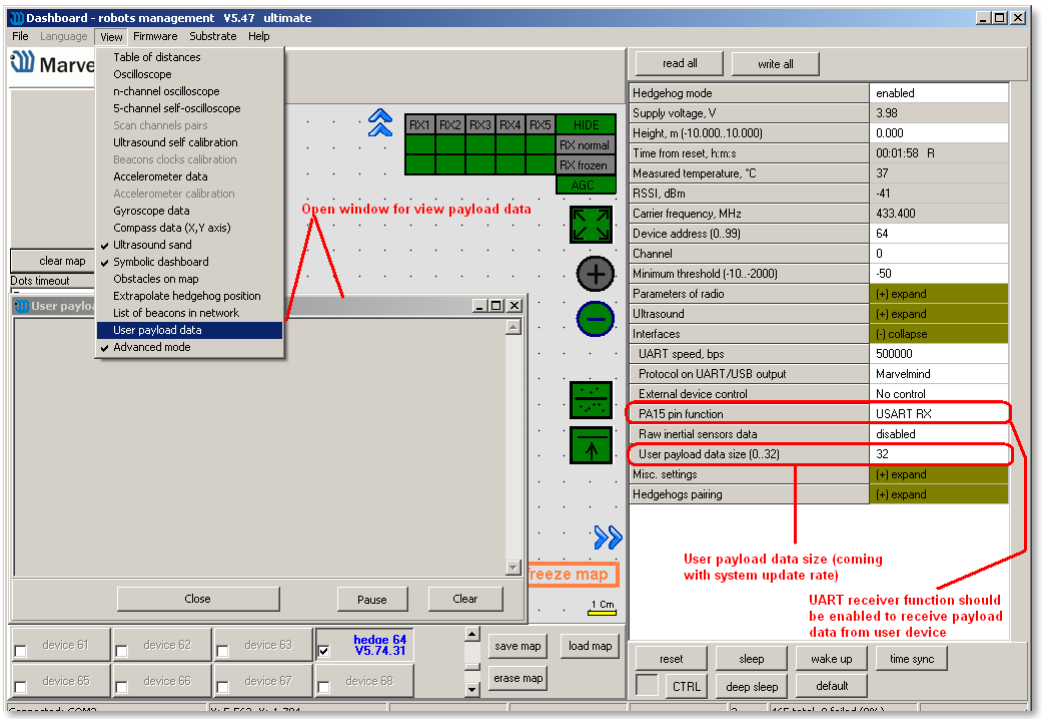


-

9.18. Payload Streaming (FN0007)

Mobile beacon streaming user payload to modem. See the table with speed vs payload.

- All measurements were made with an update rate setting 16 Hz. Distance, radio profile, and payload data size limit the real update rate.
- Additionally, with the MMSW0005 license, the hedgehog payload is recorded in CSV format.



System configuration	Radio profile, kbps	User payload data per cycle, bytes	Real update rate, Hz	User payload maximum data rate (bytes per second)
2 stationary beacons, 3 meters maximum distance	500 (FEC)	0	16	0
		32	16	512
	153 (FEC)	0	16	0
		32	16	512
	38.4 (FEC)	0	9	0
		32	8	256
	38.4 (no FEC)	0	14	0
		32	13	416
4 stationary beacons, 11 meters distance	500 (FEC)	0	14	0
		32	14	448
	153 (FEC)	0	12	0
		32	12	384
	38.4 (FEC)	0	6	0
		32	6	192
	38.4 (no FEC)	0	9	0
		32	9	288

9.19. IMU Feature (FN0008)

This function allows to increase data update rate received from ultrasound beacon with IMU due to sensor fusion up to 100 Hz, using inertial sensors (accelerometer, gyroscope).

9.19.1. Setup IMU Feature

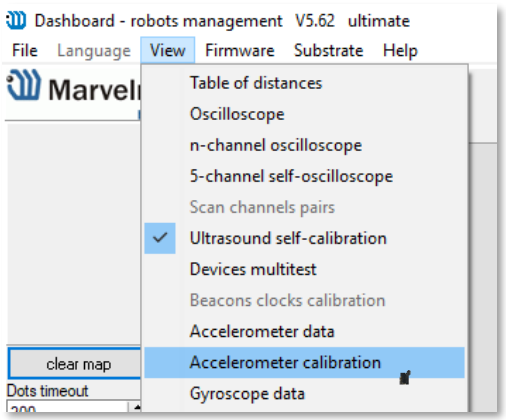
Accelerometer calibration

Required:

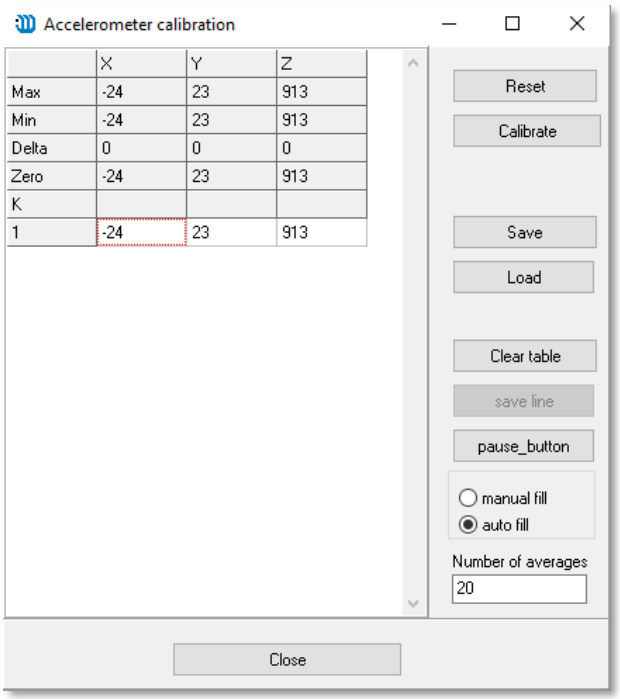
- Starter set
- Hedgehog with IMU
- SW and firmware version 5.85 or newer
- Ultrasound Update rate 4Hz or higher

Before you start using the feature, check whether the accelerometer has been calibrated

- Check if the hedge was not calibrated before. Was damaged or fell down
- Put the hedgehog on a flat surface (antenna directs up) and connect to your PC. Run the Dashboard
- Go to view => Accelerometer calibration in the open window, click autofill, and clear the table.

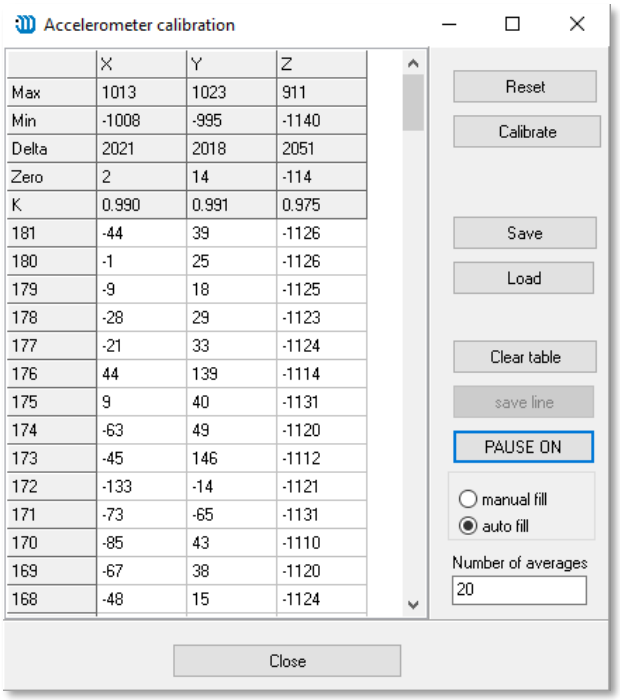


- After all values will refresh. Next, click Pause (shift + space)



Then take the beacon (hedgehog) and tilt it to each side towards the ground (about 6 times). Rotate a little. You need to achieve x y z values:

- When antenna directs down **z ≈ - 1000** => antenna directs up **z ≈ 1000**
- So, one of the axis values always will be - + 1000. Others ⩽ **10** (preferably less than 10, but 25 is also permissible)
- Every time before calibrating the hedgehog click **Pause**
- The accelerometer calibrator will choose the best value for each axe. At the end, click **Calibrate** and close the window
- Calibration is needed to determine the **g** value for each accelerometer axe



Start the system:

Set up the system as usual. It is described in the paragraph Setting up the system.

After the ultrasound tracking has started, select the hedgehog in the Dashboard, go to the menu **Interfaces** (on the right), and enable **Processed IMU data**. After that, it is recommended to bring the hedgehog to real estate and press the ZERO IMU button (right-bottom) for additional sub-calibration of the gyro. After 5 seconds, the hedgehog will begin streaming the processed IMU data.

9.19.2. Using Data in the Python Library Example

To work with data, you must use a ready-made library or develop software tools that work with the described protocol.

You can find examples in our software package.

Our company provides ready-made libraries for working with IMU in the following languages:

- python
- c ++
- java

An example with 3D imaging of a path on IMU with a frequency of 100Hz in real time, here: https://marvelmind.com/pics/marvelmind-imu-tracker.zip

9.20. IMU Axis Positioning

Super-Beacon IMU axis positions

HW v4.9 IMU axis positions

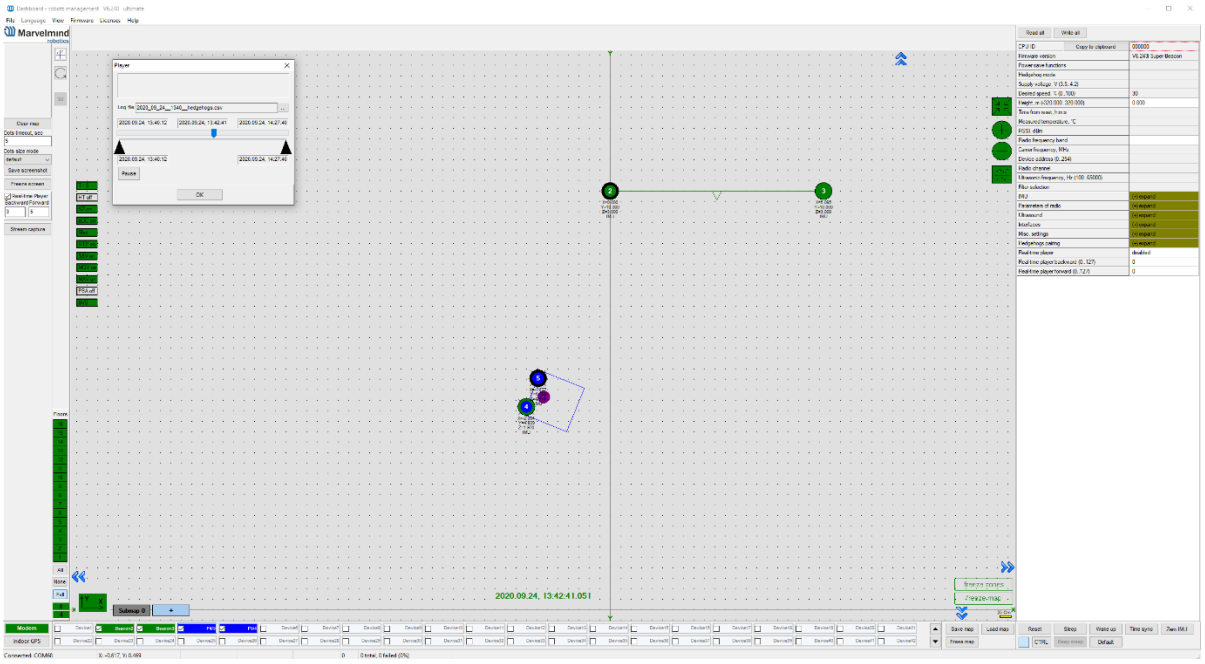
Mini-TX IMU axis positions

Mini-RX beacon IMU axis positions

9.21. Player Feature (FN0009)

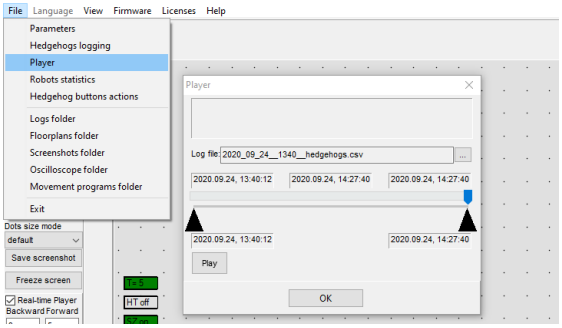
This function is used to view the distance passed, the copter's flight, etc. The player displays statistics on the maximum and average speed and the path traveled.

Starting with Dashboard v6.240, log files are written in .csv format



How to use Player:

- Go to File=>Player

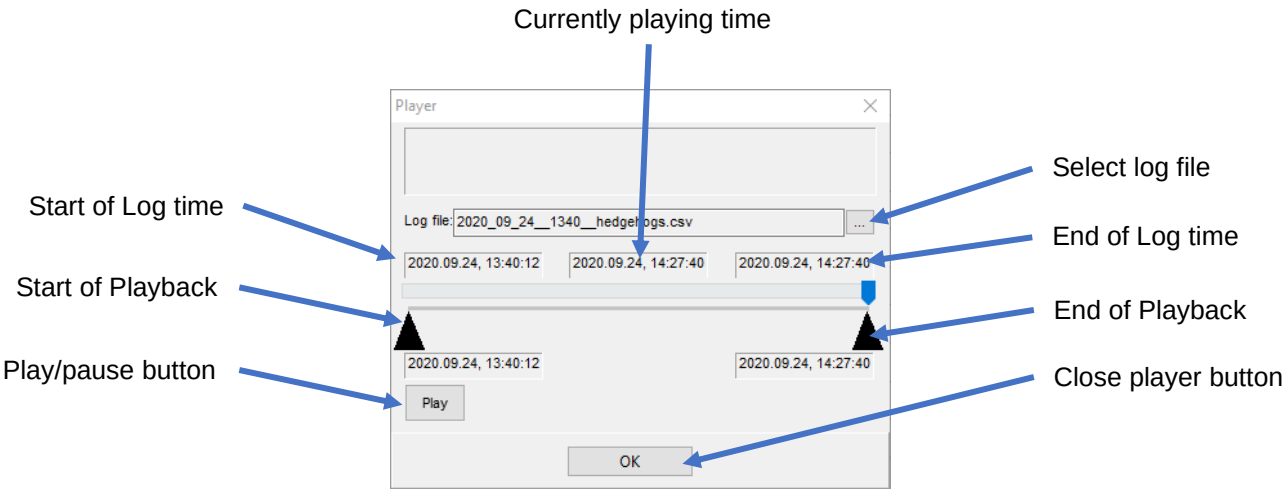


This is how the starting player menu looks like

Select log – opens a saved log file
Play – launch the playback

- Click the **Select log** button and choose the file
- Now the log is loaded. Important: To record the log file, click **Save map** to save all the beacons' locations and attach all the beacons to the log. The log file was also created while Freeze map pressing.

At the top of the player, you can see 7 outputs:



Limited area - the distance between black triangles under the slider. You can move triangles, zoom, and place the cursor on the slider + mouse wheel. Triangles limit the area in which the player works, and the statistics are calculated

9.22. Absolute Distance Calibration

In case of frequent temperature changes, sometimes absolute calibration is a helpful tool to provide accurate tracking.

There are two types of absolute calibration:

- One is based on a reference points—the known absolute coordinates of some points
- Another is based on the submap—the user knows the absolute distance between beacons in the submap

The next two chapters explain these methods in detail, including the instructions.

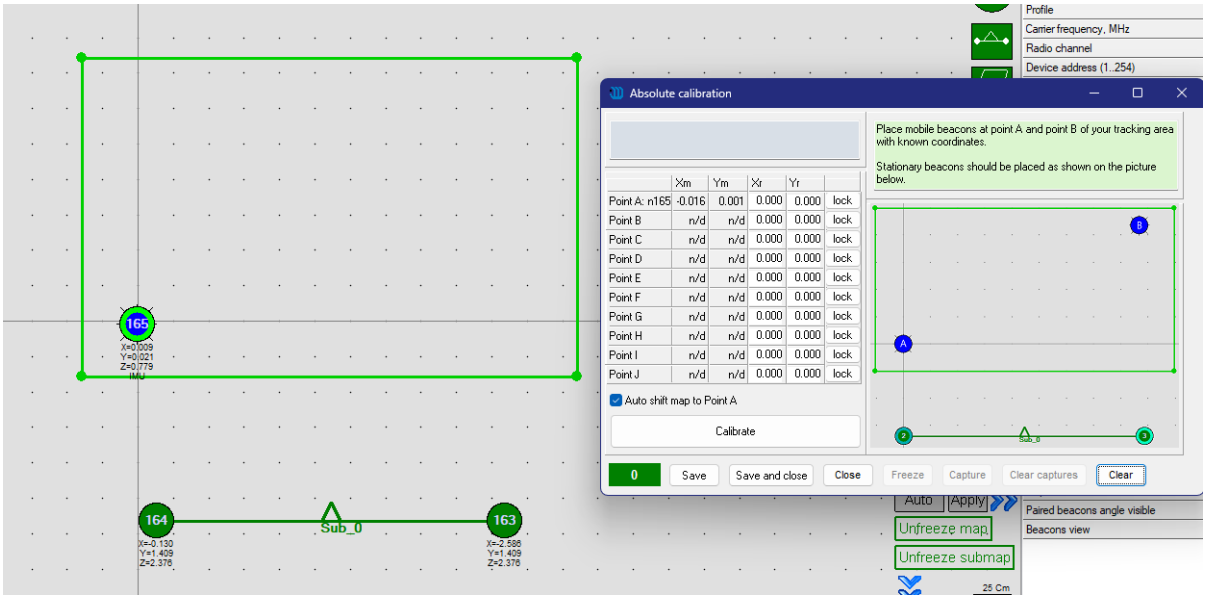
9.22.1. Absolute Distance Calibration Based on a Reference Points

The user places the mobile beacons at reference points and applies calibration to force the system to correct the location measurement so that the reported location corresponds to absolute values.

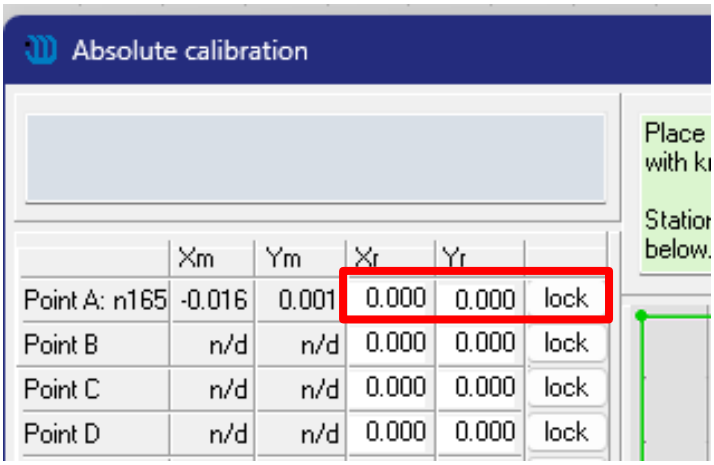
It is very important to use as many points as possible for calibration (ex. 4 points in the corners of a submap + 1 in the center). This will provide more accurate and better tracking.

Below are instructions on how to get absolute distance calibration based on a reference points:

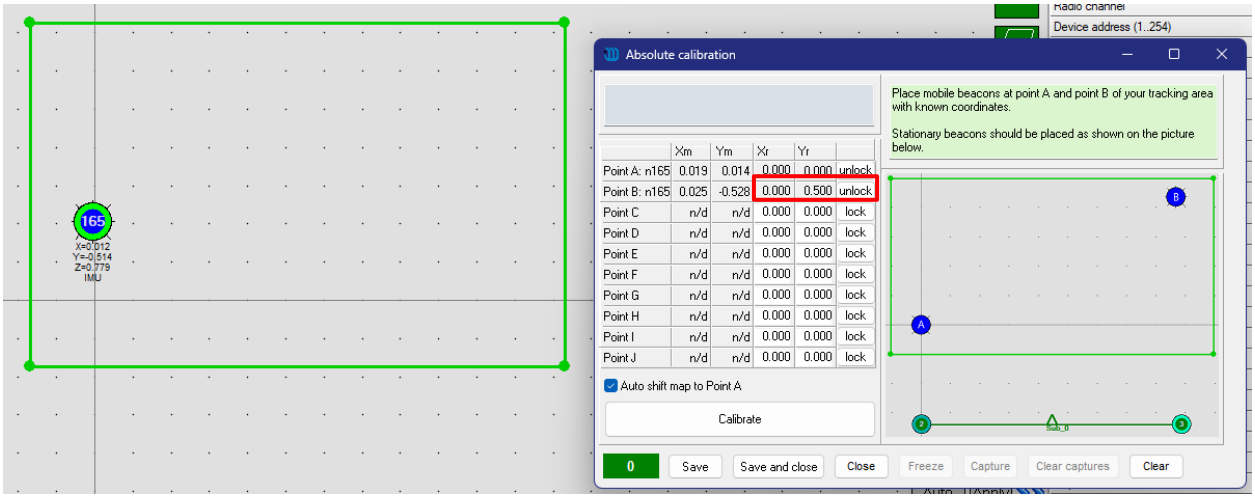
1. Open Tools -> Absolute calibration



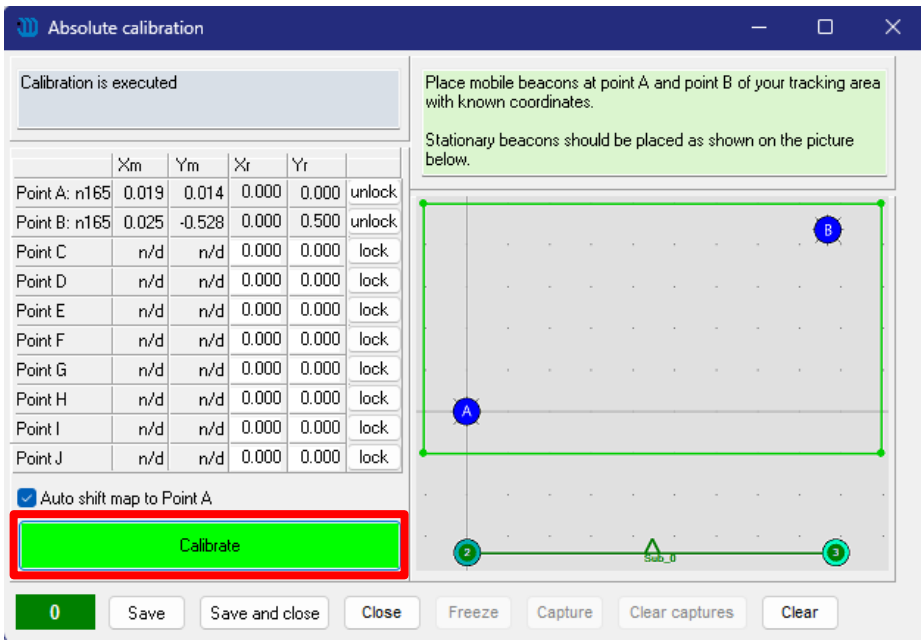
2. Enter coordinates for a first point (the initial point where the beacon currently is) and press the “lock” button



3. Move the hedgehog to the second point, enter its coordinates, and press the “lock” button



4. After two points, you can press the “Calibrate” button



	Xm	Ym	Xr	Yr	
Point A: n165	0.019	0.014	0.000	0.000	unlock
Point B: n165	0.025	-0.528	0.000	0.500	unlock
Point C	n/d	n/d	0.000	0.000	lock
Point D	n/d	n/d	0.000	0.000	lock
Point E	n/d	n/d	0.000	0.000	lock
Point F	n/d	n/d	0.000	0.000	lock
Point G	n/d	n/d	0.000	0.000	lock
Point H	n/d	n/d	0.000	0.000	lock
Point I	n/d	n/d	0.000	0.000	lock
Point J	n/d	n/d	0.000	0.000	lock

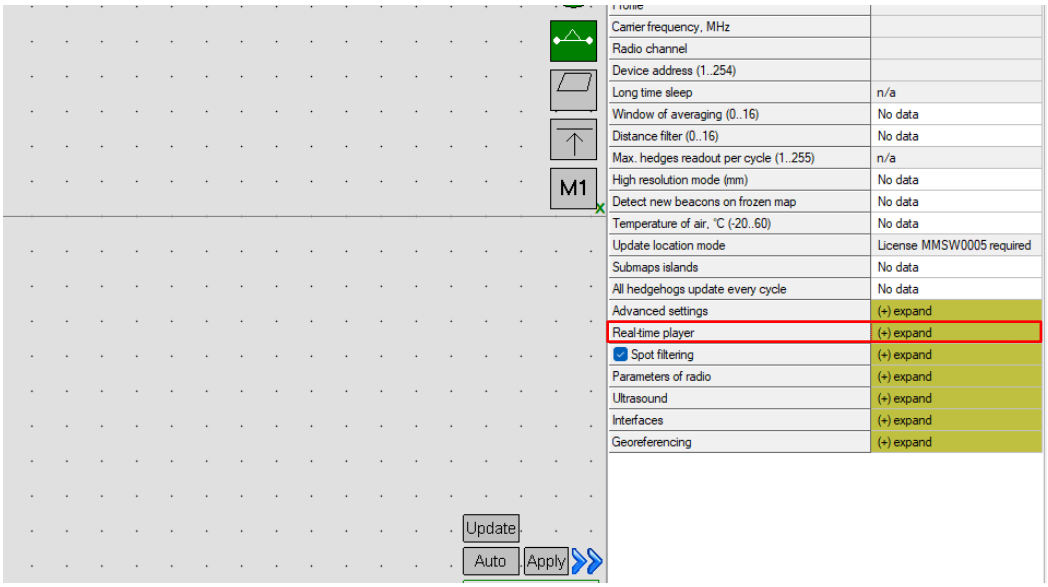
5. The absolute distance calibration file will be loaded to the modem

Note that the more points there are, the more accurate tracking will be.

9.23. Real-Time Player Feature (FN0010)

The real-time player is a feature that smooths the tracking path. As it looks backward and forward, it has a specific latency based on the selected parameters.

Real-time player has two layers, RTP_1 and RTP_2. For more accurate smoothness RTP_2 can be enabled.



Real-time player	(-) collapse
RTP_1	enabled
Forward_1 (0..50)	5
Backward_1 (0..50)	3
Use for direction	disabled
Show raw track	disabled
RTP_2	disabled
RTP_2 Auto	disabled
Forward_2 (0..50)	10
Backward_2 (0..50)	10
Sigmoid length (5..999)	100
Tmin, sec (1.0..10.0)	3.0
Colored	disabled
Jump filter threshold, % (5..999)	50

Enables Real-time player 1

Amount of dots which player ‘looks’ forward to provide smooth tracking

Amount of dots which player ‘looks’ backward to provide smooth tracking

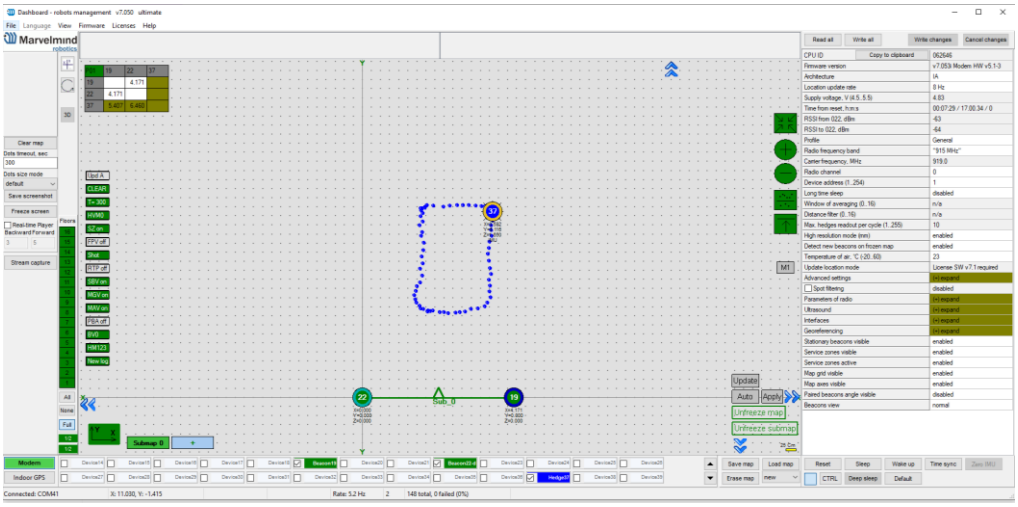
Enables Real-time player 2

Amount of dots which player ‘looks’ forward to provide smooth tracking

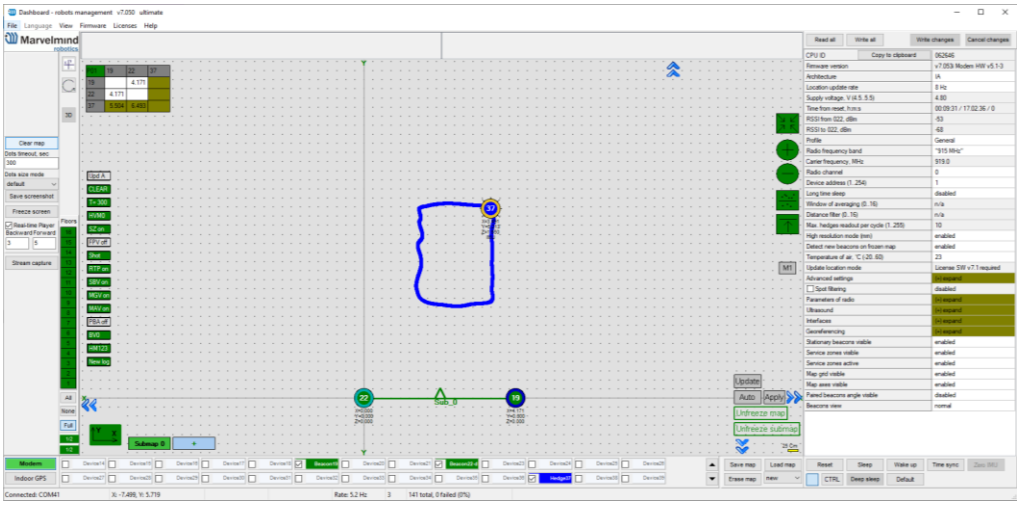
Amount of dots which player ‘looks’ backward to provide smooth tracking

Tracking examples:

- Real-time player **turned off**



- Real-time player **turned on**



9.24. CSV Format

In the CSV log file for dashboard versions V7.000+, each event is recorded as one CSV line and different events correspond to different line formats. At the same time, the line's starting is equal for all line types.

Here is an example of several lines from the CSV log file:

```
T2021_11_04__173001_581,user,41,17,14,4.675,2.714,0.250,2,975,100
T2021_11_04__173001_581,user,41,17,15,4.665,2.708,0.250,2,975,114
T2021_11_04__173001_581,user,41,17,26,4.073,1.987,0.250,2,3462,128
T2021_11_04__173001_581,user,41,17,27,4.075,1.987,0.250,2,3462,141
T2021_11_04__173001_581,user,41,17,28,3.588,1.979,0.250,2,3496,155
T2021_11_04__173001_581,user,41,17,29,3.592,1.978,0.250,2,3496,169
T2021_11_04__173001_701,user,43,15,nl
T2021_11_04__173001_728,user,43,27,nl
T2021_11_04__173001_756,user,43,29,nl
```

Standard part of the line includes the first 3 fields:

"T2021_11_04__173001_581" – timestamp for data from this line: 2021.11.04, 17:30:01.581.

"user"—username (reserved for future_. The dashboard will support logging in users in future versions.

"41" – ID of the line type. Different line types have different formats in the following fields.

There are some common special codes in data fields:

"nl" – no license. Some license is required to fill out this field.

"na" – not applicable. There is no relevant data for this field. For example, the X, Y, and Z coordinates fields will contain "na" if the mobile beacon is not successfully located.

For more information, see Chapter 9 in our Marvelmind Interfaces manual.

10. Interfaces

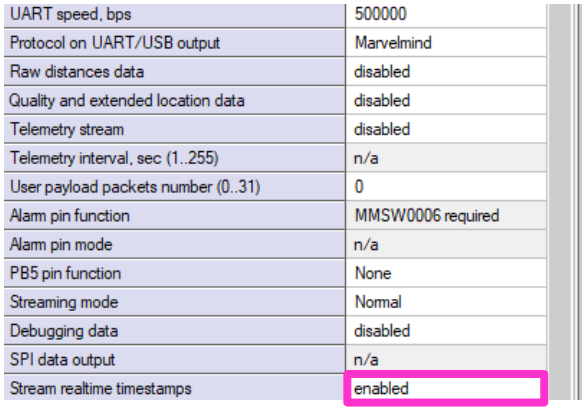
Indoor “GPS” system supports many external interfaces that can feed measured location data to an external system (robot, copter, VR, etc.).

There are two different ways to obtain the mobile beacons’ location data from the system:

- **From the mobile beacons**
  - Each mobile beacon knows its position and does not know the positions of the other mobile beacons
- **From modem**
  - Knows the position of every mobile beacon in the system

Data from the mobile beacons and the modem can be obtained simultaneously if necessary.

Starting from software version v7.200, real-time timestamps are enabled by default. If you need an old streaming format with local timestamps for compatibility with older software, you can disable this option in the device settings in the dashboard:



UART speed, bps	500000
Protocol on UART/USB output	Marvelmind
Raw distances data	disabled
Quality and extended location data	disabled
Telemetry stream	disabled
Telemetry interval, sec (1..255)	n/a
User payload packets number (0..31)	0
Alarm pin function	MMSW0006 required
Alarm pin mode	n/a
PB5 pin function	None
Streaming mode	Normal
Debugging data	disabled
SPI data output	n/a
Stream realtime timestamps	enabled

A list of the supported interfaces is shown below.

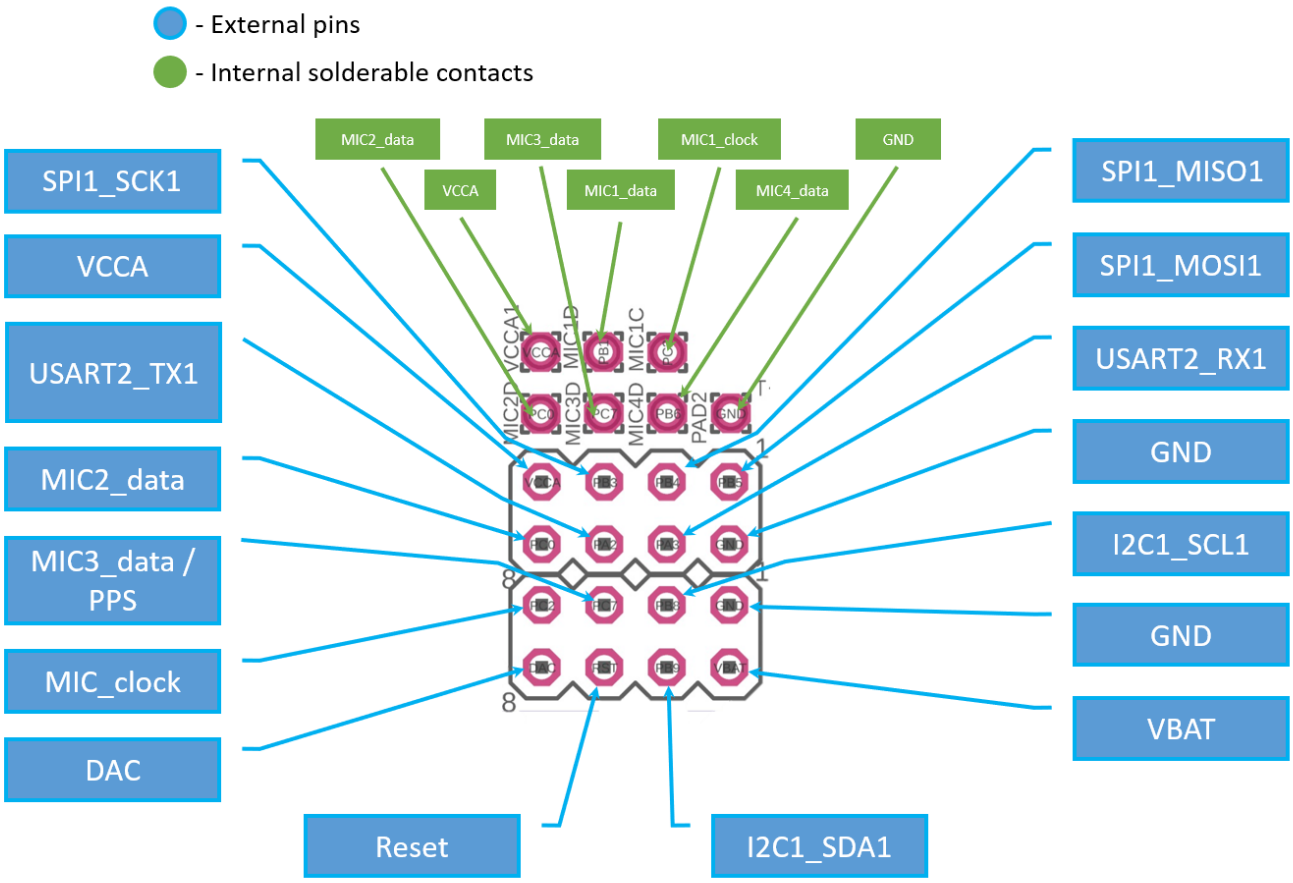
More information on the interfaces can be found here.

Supported interfaces

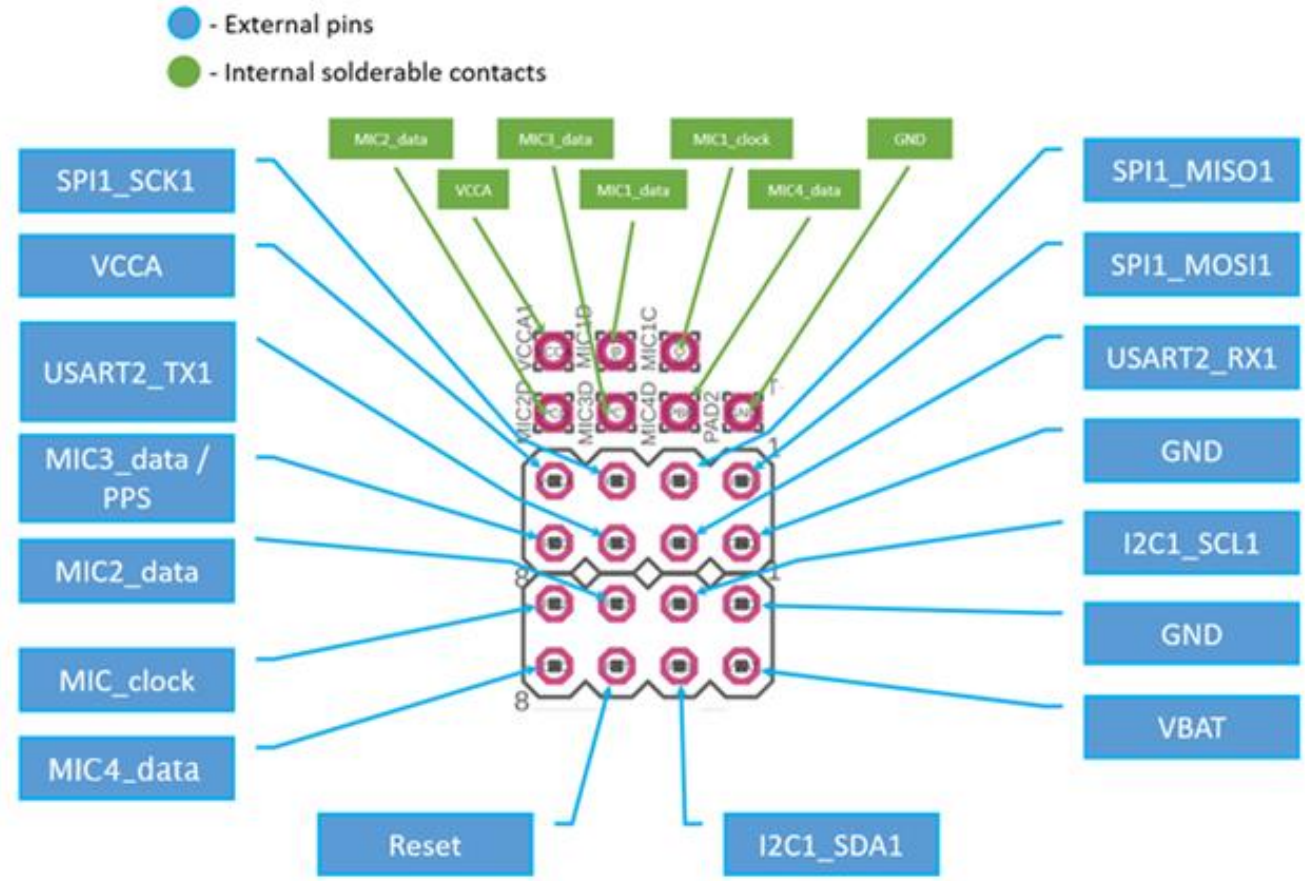
- **Mobile beacon:**
  - UART
  - SPI
  - Virtual UART via USB
  - NMEA
- **Modem:**
  - UART
  - SPI
  - Virtual UART via USB
- **Integrated with:**
  - Windows (PC & tablets)
  - Linux
  - Mac OS
  - Android (beacon)
  - ROS (beacon)
  - Raspberry (beacon)
  - Arduino (beacon)
  - PixHawk (beacon)
- **Sample code:**
  - C
  - Python

10.1. Super-Beacon External Interface Pinout Top View

4x4 pinout for Super-Beacon:

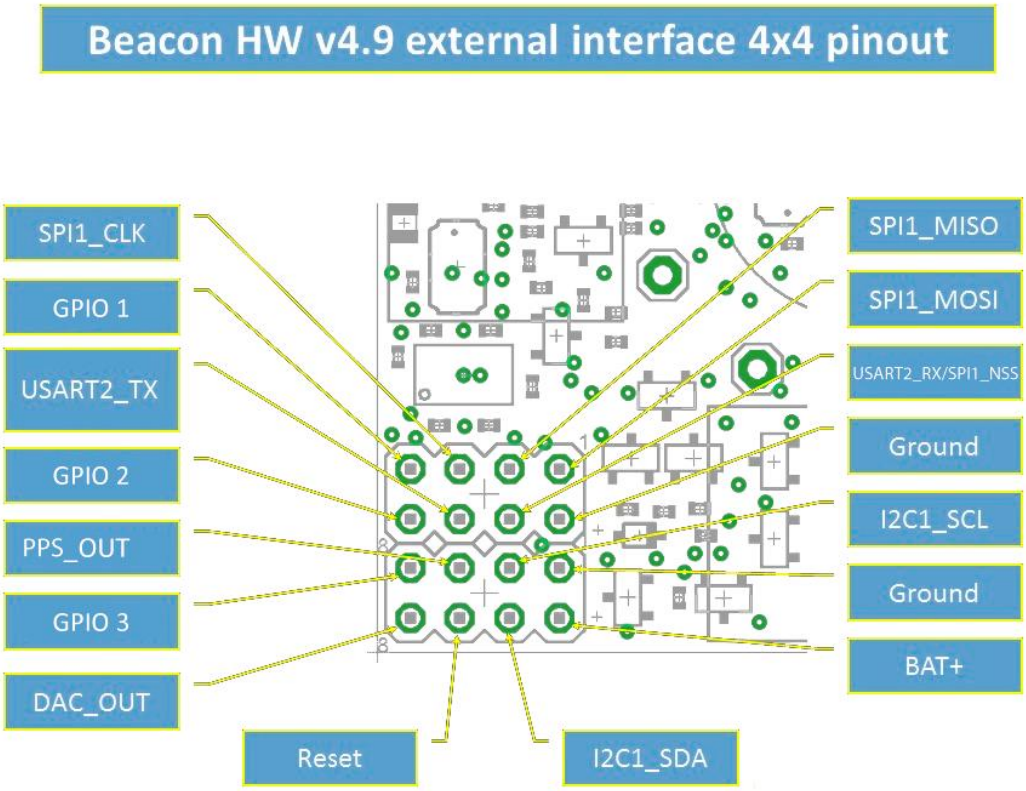


4x4 pinout for Super-Beacon-2:

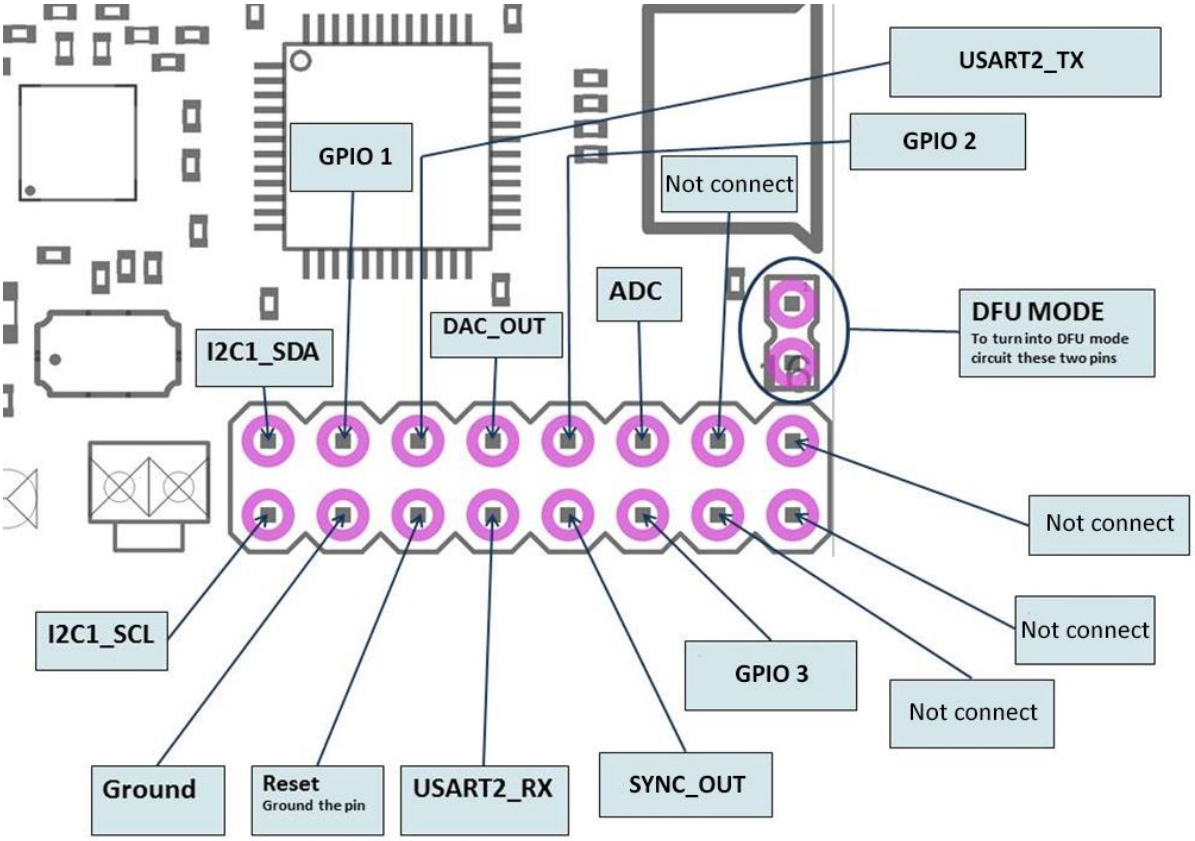


Marvelmind robotics

10.2. Beacon HW v4.9 External Interface 4x4 Pinout Top View



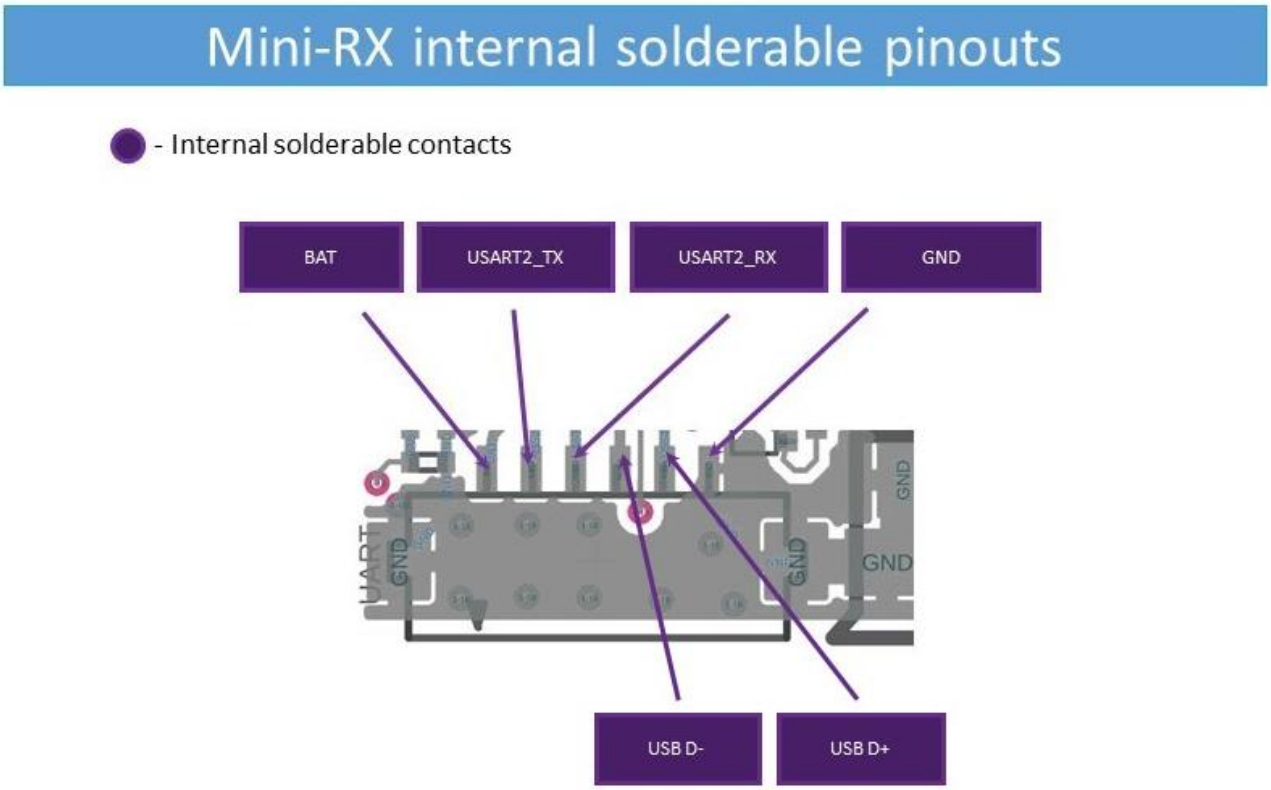
10.3. Modem HW v4.9 External Interface Pinout Top View



10.4. Mini-RX Internal Solderable Pinouts

Use it only if you are sure that you can solder it correctly.
Do not forget to turn off the beacon with DIP switches.
If you solder badly and kill the beacon, the Marvelmind team won't be responsible.

To get UART data streaming from beacon Mini-RX, you must solder to the pins on the board.

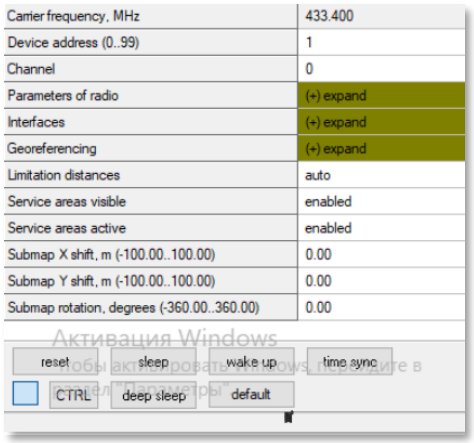


*BAT - you can disconnect the internal battery and supply here an external power source of 3.5V-5.2V to the point with a current up to 50mA

11. Advanced System Settings and Optimization

Start using advanced settings only when you are confident with the system.

If you run into trouble, connect the beacon or modem to the PC via USB and use the **DEFAULT** button. It will upload “factory settings” to the board while keeping the device address untracked.



11.1. Radio Profiles Compatibility

In this section, we present different HW versions of different products:

	38 Kbps	100 Kbps	200 Kbps	400 Kbps *	500 Kbps
Modem HW v4.9	Supports	**Supports**	Doesn't Support**	Doesn't Support**	Supports
Modem HW v5.1	Supports	Supports	**Supports**	Supports	Supports
Modem HW v5.1-3	Supports	Supports	**Supports**	Doesn't Support**	Doesn't Support**
Super-Modem	Supports	**Supports**	Doesn't Support**	Supports	Supports
Super-Modem-2	Supports	Supports	**Supports**	Supports	Supports
Super-Modem-3	Supports	Supports	**Supports**	Doesn't Support**	Doesn't Support**
Beacon Mini-RX	Supports	**Supports**	Doesn't Support**	Supports	Supports
Beacon Mini-RX-2	Supports	Supports	**Supports**	Supports	Supports
Beacon Mini-RX-3	Supports	Supports	**Supports**	Doesn't Support**	Doesn't Support**
Super-Beacon	Supports	**Supports**	Doesn't Support**	Supports	Supports
Super-Beacon-2	Supports	Supports	**Supports**	Supports	Supports
Super-Beacon-3	Supports	Supports	**Supports**	Doesn't Support**	Doesn't Support**
Super-Beacon-4	Supports	Supports	**Supports**	Supports	Supports
Industrial Super-Beacon	Supports	**Supports**	Doesn't Support**	Supports	Supports
Industrial Super-Beacon-2	Supports	Supports	**Supports**	Supports	Supports
Industrial Super-Beacon-3	Supports	Supports	**Supports**	Doesn't Support**	Doesn't Support**
Beacon HW v4.9	Supports	**Supports**	Doesn't Support**	Doesn't Support**	Supports
Beacon Mini-TX	Supports	**Supports**	Doesn't Support**	Doesn't Support**	Supports
Beacon Mini-TX-2	Supports	Supports	**Supports**	Supports	Supports

*400 kbps is used in Japan instead of 500 kbps

**Won't be available because of specific radio chip configuration

Bold and Underlined is a default radio profile for a specific device

Examples of different configurations:

Starter Sets consist of different devices, so you check what types of devices you have, and it will depend on which radio profiles you can use

Example 1 – Modem HW v5.1 and Super-Beacon-2

	38 Kbps	100 Kbps	200 Kbps	400 Kbps *	500 Kbps
Modem HW v5.1	Supports	Supports	Supports	Supports	Supports
Super-Beacon-2	Supports	Supports	Supports	Supports	Supports

This table shows that in this configuration, you can use all profiles because both devices support them.

Example 2 – Modem HW v.5.1 and Super-Beacon-3

	38 Kbps	100 Kbps	200 Kbps	400 Kbps *	500 Kbps
Modem HW v5.1	Supports	Supports	Supports	Supports	Supports
Super-Beacon-3	Supports	Supports	Supports	Doesn't Support	Doesn't Support

From this table, we can see that in this configuration, you can use 38 kbps and 100 kbps radio profiles because Super-Beacon-3 doesn't support 400 kbps and 500 kbps (they won't be available because of the specific processor configuration).

Example 3 – Modem HW v.5.1-3 and Beacon Mini-RX-3

	38 Kbps	100 Kbps	200 Kbps	400 Kbps *	500 Kbps
Modem HW v5.1-3	Supports	Supports	Supports	Doesn't Support	Doesn't Support
Beacon Mini-RX-3	Supports	Supports	Supports	Doesn't Support	Doesn't Support

From this table, we can see that in this configuration, you can use 38 kbps and 100 kbps radio profiles because Modem HW v5.1-3 and Beacon Mini-RX-3 don't support 400 kbps and 500 kbps (they won't be available because of the specific processor configuration).

Example 4 – Modem HW v.5.1, Super-Beacon-2 and Beacon Mini-RX-3

	38 Kbps	100 Kbps	200 Kbps	400 Kbps *	500 Kbps
Modem HW v5.1	Supports	Supports	Supports	Supports	Supports
Super-Beacon-2	Supports	Supports	Supports	Supports	Supports
Beacon Mini-RX-3	Supports	Doesn't Support yet*	Supports	Doesn't Support	Doesn't Support

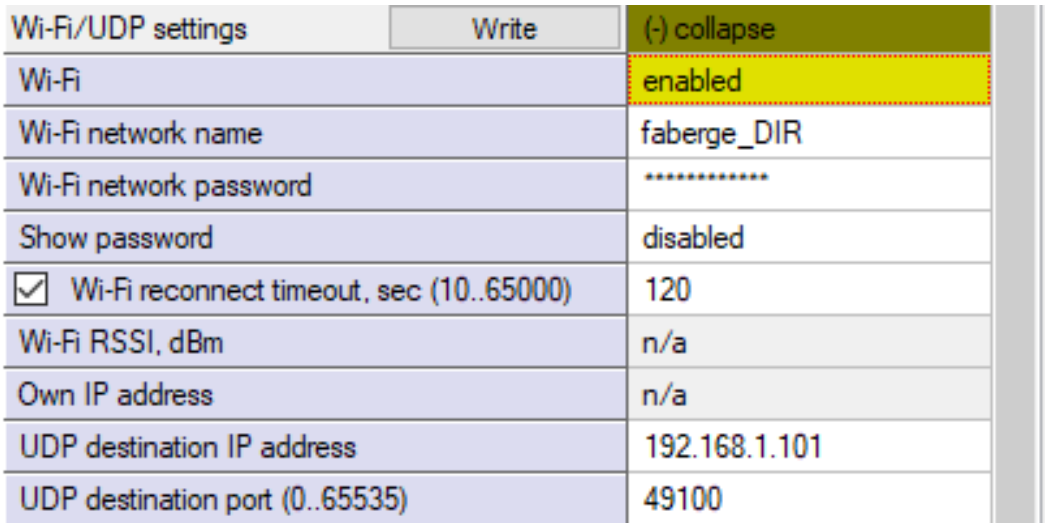
From this table, we can see that in this configuration, you can use 38 kbps and 100 kbps radio profiles because Beacon Mini-RX-3 doesn't support 400 kbps and 500 kbps (they won't be available because of the specific processor configuration).

11.2. Wi-Fi Settings for Super-Modem

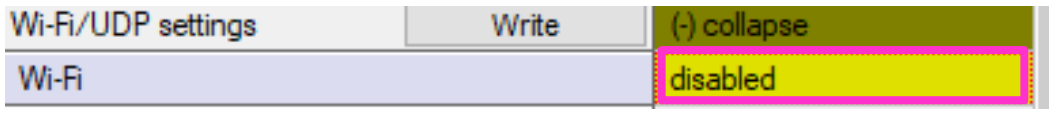
You can use Wi-Fi for coordinate streaming to other PC. In this chapter we explain how to do that. For more information see chapter 5.1.

11.2.1. Wi-Fi Settings Menu in Dashboard

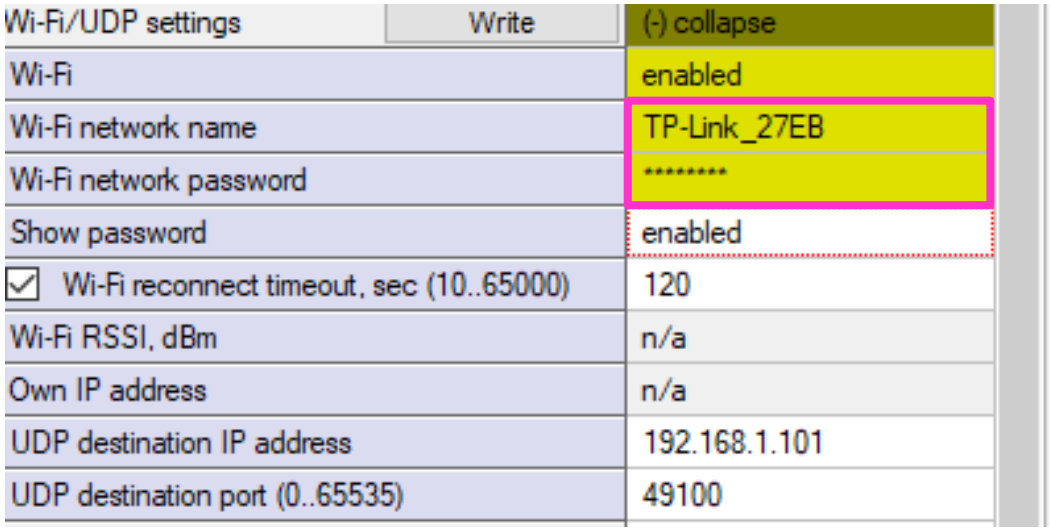
- When Super-Modem connected to PC via USB, expand “Wi-Fi/UDP settings” in settings bar.



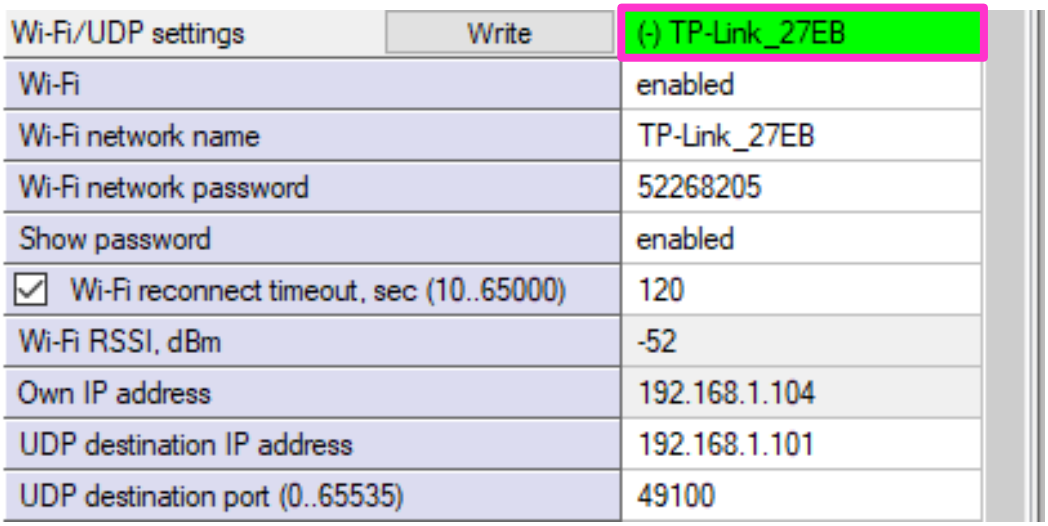
- Enable Wi-Fi



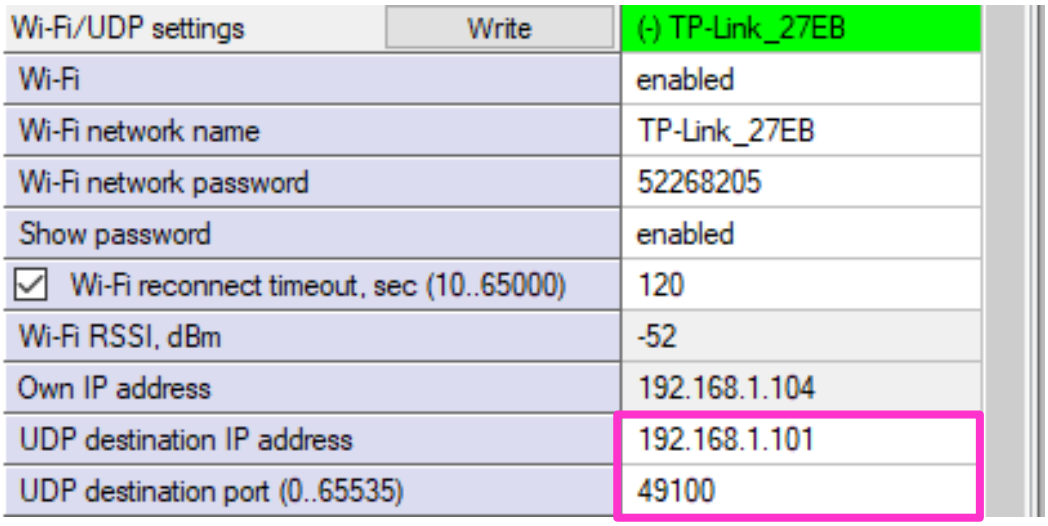
- Insert Wi-Fi network name and Wi-Fi network password of your wireless connection and press “Write” button



- After this, “Wi-Fi/UPD settings” bar turns to green and shows your network name.



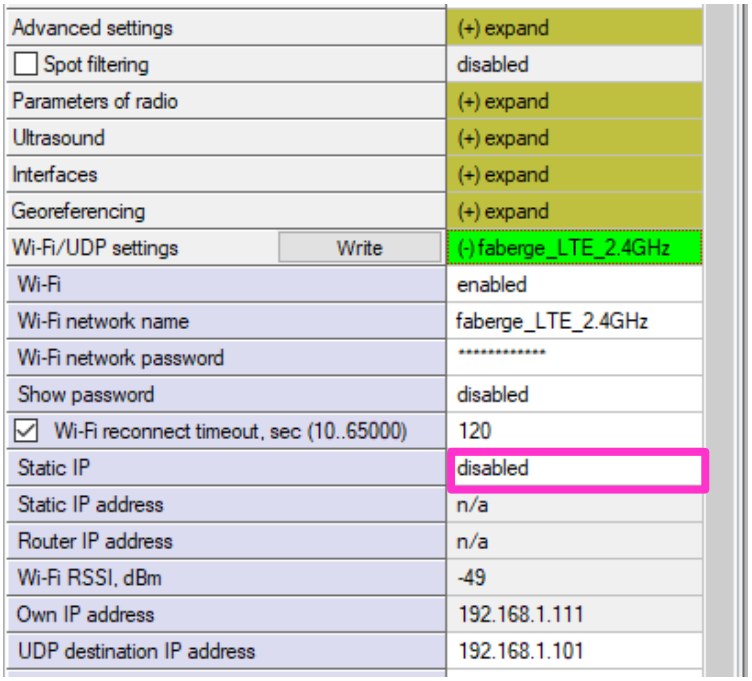
- Insert UDP destination IP address and UDP destination port of device to which you will stream coordinates and press write button.



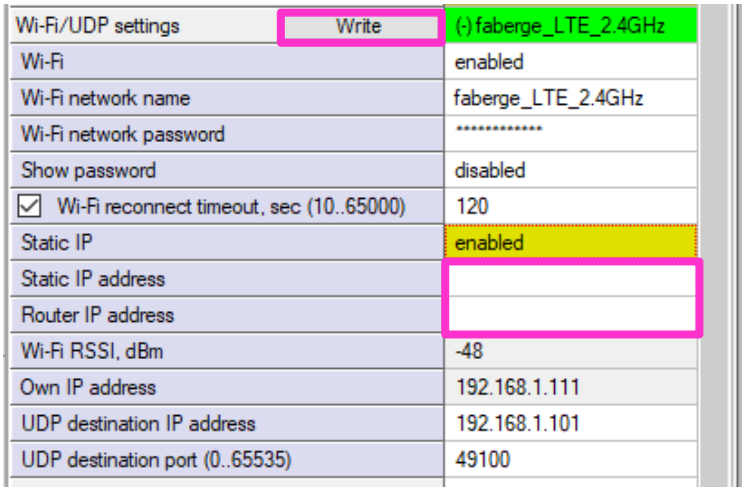
- Wi-Fi settings completed.

11.2.2. Static IP

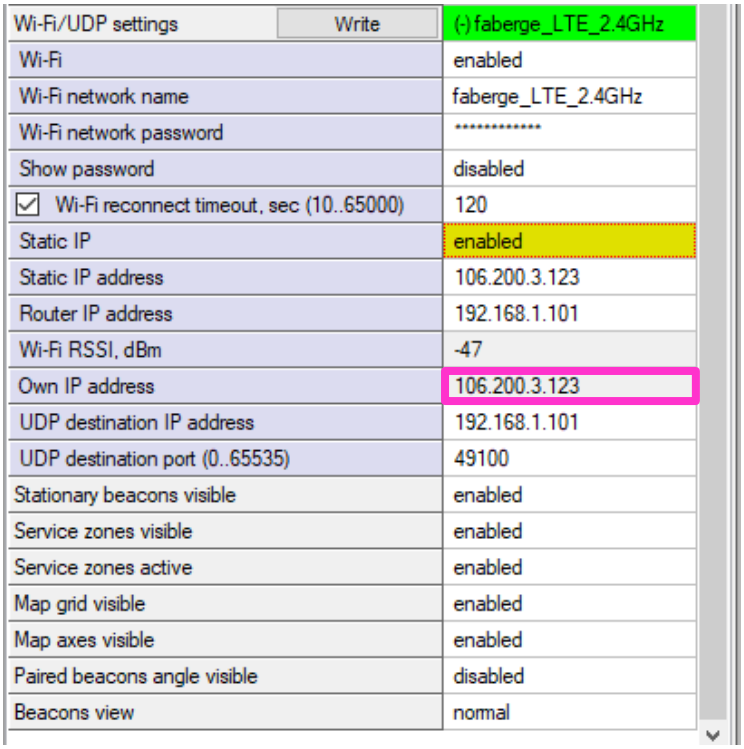
- When Wi-Fi enabled, enable Static IP and wait around 10 sec:



- Enter IP address in IPv4 format (An IPv4 address has the following format: **x . x . x . x** where x is called an octet and must be a decimal value between 0 and 255.) and IP address of router that using for Wi-Fi connection. Press Write button:



- If everything done correctly, Own IP address will change:



Wi-Fi/UDP settings	Write	(-) faberge_LTE_2.4GHz
Wi-Fi		enabled
Wi-Fi network name		faberge_LTE_2.4GHz
Wi-Fi network password		**********
Show password		disabled
☑ Wi-Fi reconnect timeout, sec (10..65000)		120
Static IP		enabled
Static IP address		106.200.3.123
Router IP address		192.168.1.101
Wi-Fi RSSI, dBm		-47
Own IP address		106.200.3.123
UDP destination IP address		192.168.1.101
UDP destination port (0..65535)		49100
Stationary beacons visible		enabled
Service zones visible		enabled
Service zones active		enabled
Map grid visible		enabled
Map axes visible		enabled
Paired beacons angle visible		disabled
Beacons view		normal

- Static IP settings completed.

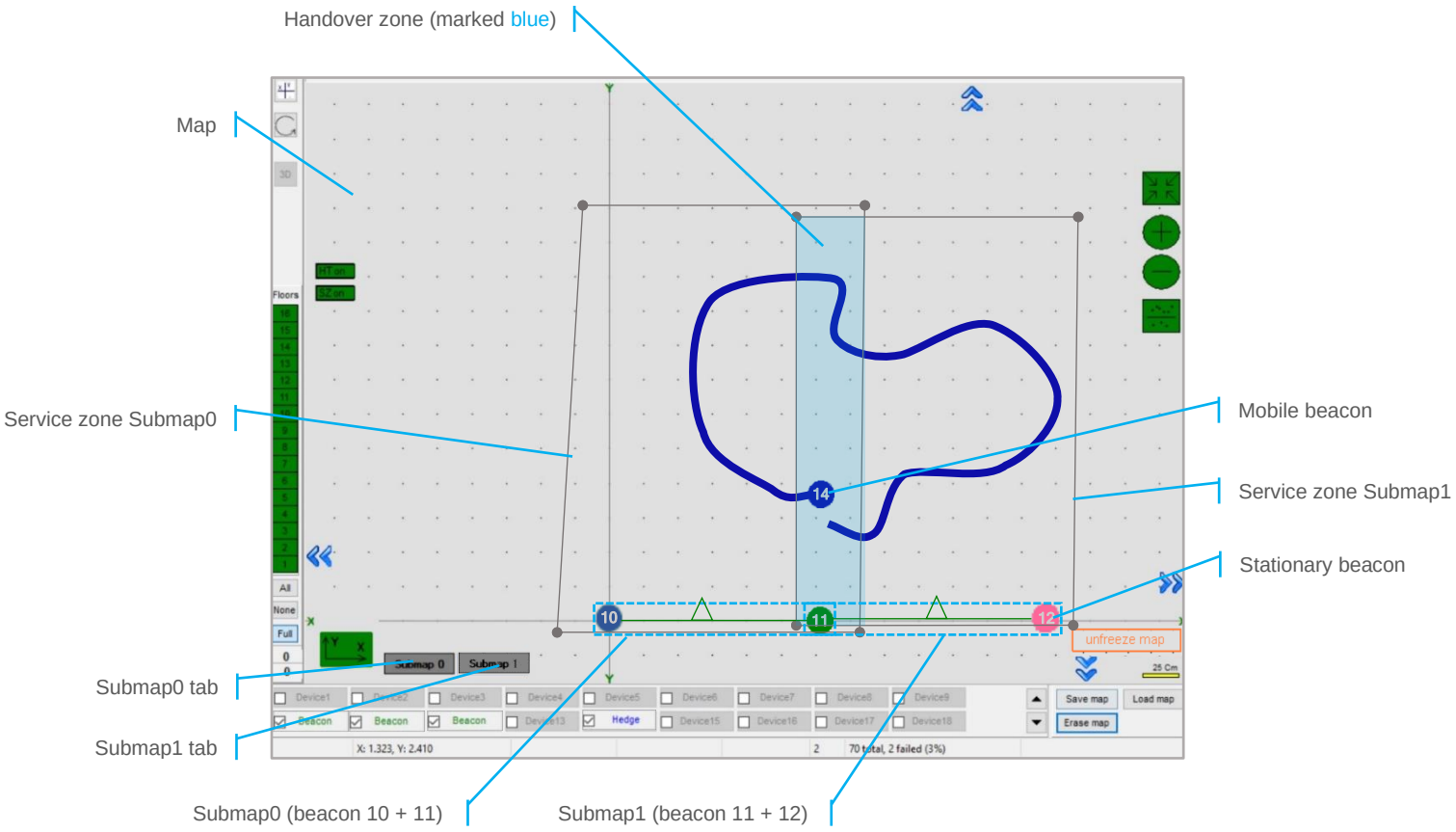
11.3. Building Big Maps in Inverse Architecture (IA)

This chapter is applicable only for Inverse Architecture

11.3.1. Introduction

In this chapter, we describe building big maps in **IA**. It differs from classic NIA map building because we have more than 1 ultrasonic frequency, and we need to ensure that they do not interfere. Please, read carefully.

A **map** is a system unit that includes **submaps, stationary beacons,** and **service zones**. The positioning of **mobile beacons** is ensured by ultrasonic signals from the stationary beacons of this submap.



The main parameters of a submap are its **size, frequencies,** and **TDMA position** of stationary beacons. These parameters allow mobile beacons to be positioned and determine in which submap they are located.

Check before start:

8 basic steps from unpacking to autonomous drive/flight

Step-by-step guide on how to build complex maps

Detailed explanation of complex map building:

Building submaps: Part 1

Building submaps: Part 2

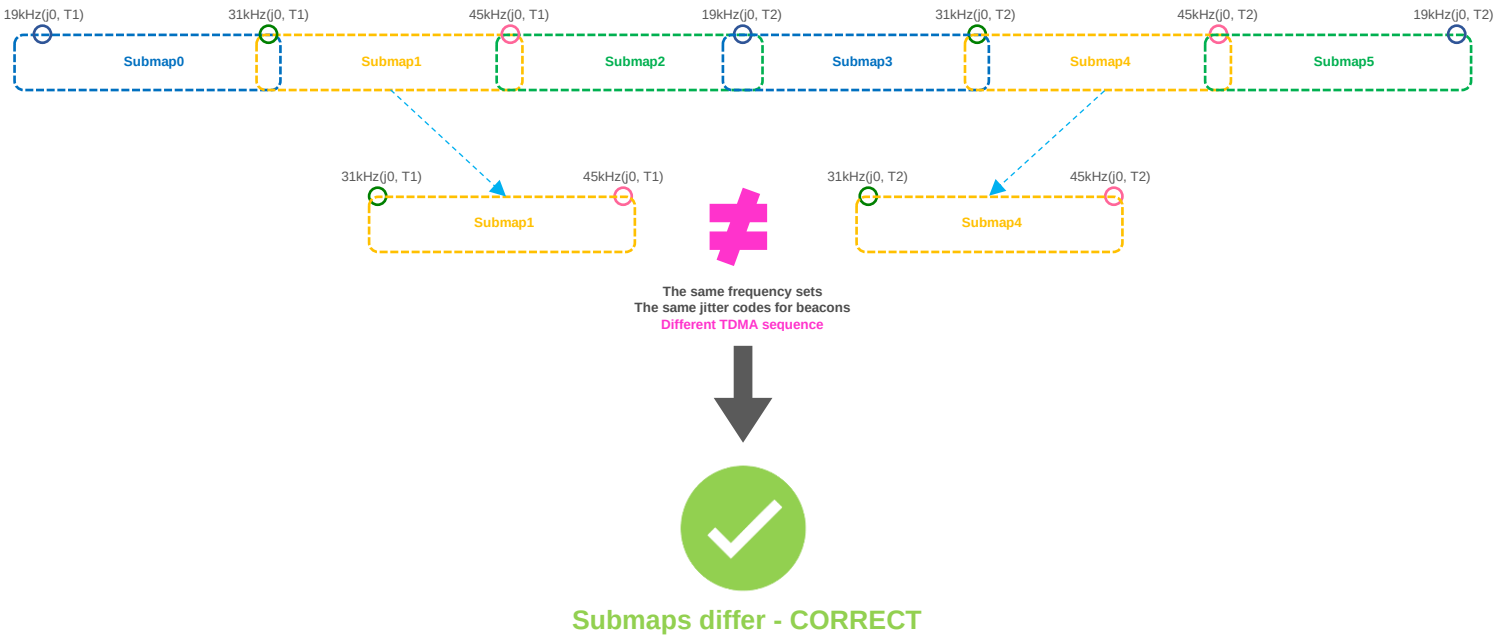
11.3.2. TDMA Sequence

As we have only 5 ultrasonic frequencies, when we build big maps and when ultrasonic signals interrupt each other, we must use TDMA. In this case, submaps that cannot be used together will work alternately. Please notice that the update rate falls by a multiple of the TDMA sequence. If you have an 8Hz basic update rate without TDMA, 3 TDMA sequences will make it 8/3Hz.

> *TDMA is the mode of sequential radiation when, for each stationary beacon, the number of the cycle in which it should emit and the number of cycles of radiation after which these numbers are repeated is set*
>
> We have 3 TDMA types:
>
> - **Type 1** - TDMA as NIA multiple beacons' working algorithm
> - **Type 2** - Full-overlapping TDMA (For better coverage in 2D). See more in the TDMA chapter
> - **Type 3** - TDMA for huge IA maps building (described below)

To build huge maps in IA, we need **TDMA Type 3.**

- Example 1:



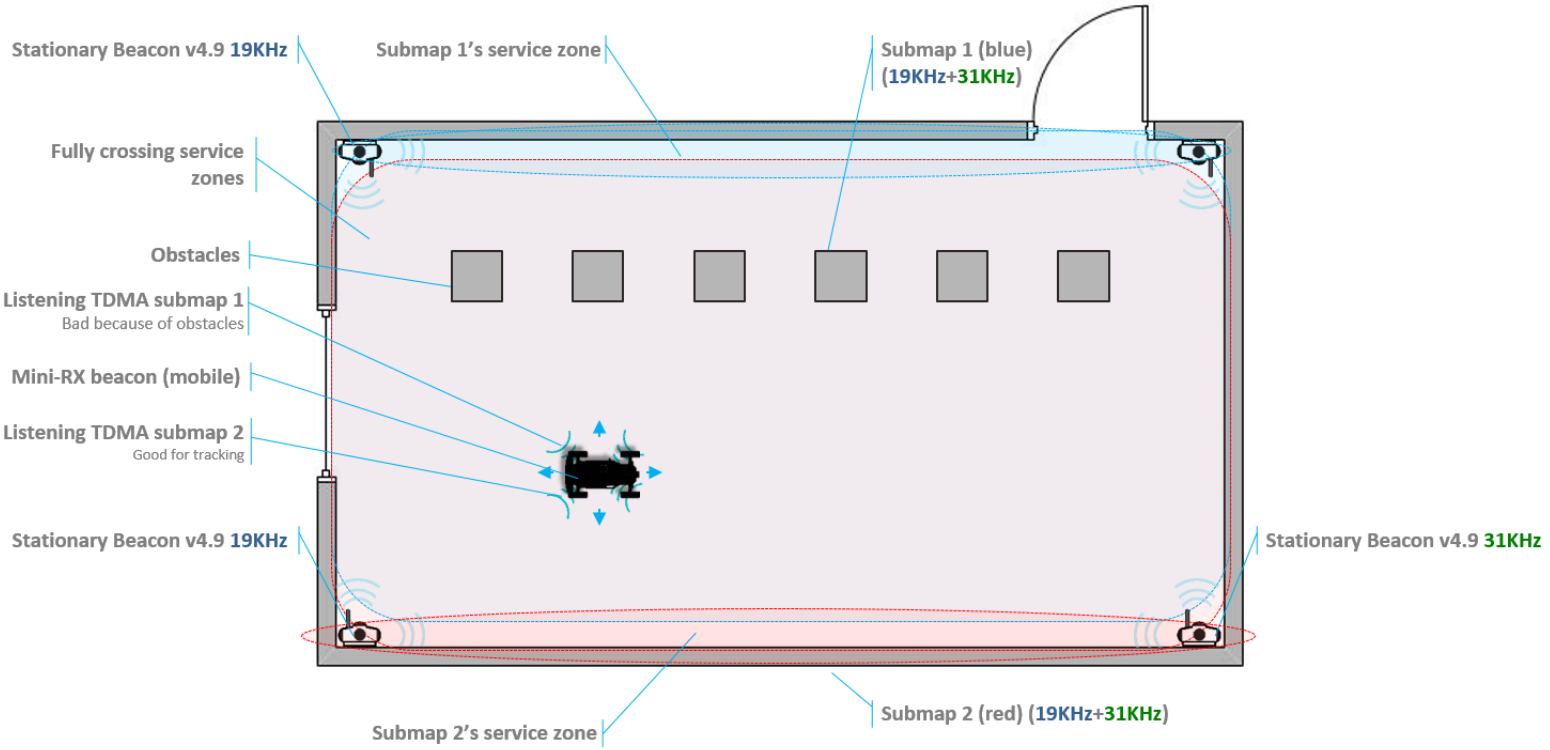
- Example 2:

For example, a **100x100 meter map in an open-spaced area** consists of 55 submaps; the vertical rows of submaps are the same but operate in different TDMA loops using **TDMA type 3.** In this example, we used different colors for every TDMA position in sequence. TDMA 1(red) submaps emit first, TDMA 2(green) submaps emit second, TDMA 3(blue) submaps emit third:

Moreover, the map consists of 6x11 = 66 stationary beacons, i.e., 11 beacons of each frequency combined into submaps: 19-31kHz, 31-45kHz, 45-19kHz, 19-37kHz, 37-25kHz.

11.3.3. TDMA Type 2 - Full-Overlapping Submaps

The steps below describe how to run IA with the TDMA feature, which helps improve tracking quality in complex situations.



Suitable for IA only. Use IA Software

Stationary beacons should have different frequencies

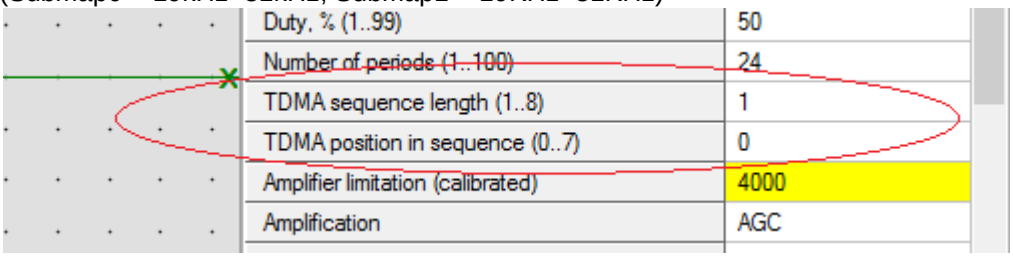
When you work with two TDMA submaps, the update rate reduces twice.

11.3.4. Mount stationary beacons according to the TDMA chapters in the Placement manual.

11.3.5. Wake up beacons included in Submap0. Enter the values in the table "distance between beacons" and freeze them. If necessary, set the shift, rotation, height, etc. Draw a service zone (More info: Submaps feature description).

11.3.6. Wake up beacons included in Submap1. If the submap uses beacons from other submaps, you must add them to the current one. Draw a service zone, fully crossing with Submap0's service zone.

11.3.7. If submaps with the same set of frequencies intersect, it is necessary to use TDMA. (This is the mode of sequential radiation when for each stationary beacon, the number of the cycle in which it should emit and the number of cycles of radiation after which these numbers are repeated is set)
For example, in the room, there are beacons 19kHz, 45kHz, and two 31kHz and submaps, respectively 19kHz+31kHz and 31kHz+45kHz, both include beacon 31kHz therefore, for all beacons, the length of the TDMA sequence is set to 2, while the position in the TDMA sequence for beacons in 19kHz+31kHz submap is set to 0, and for beacons in 31kHz+45kHz submap is set to 1. As a result, the radiation of beacons in submaps occurs sequentially, first the 19kHz+31kHz submap, then the 31kHz+45kHz submap.
You can also use absolutely the same set of frequencies in submaps (Submap0 = 19kHz+31kHz, Submap1 = 19KHz+31KHz)



11.3.8. Activate mobile beacons.

11.3.9. Freeze the entire map. Now, you can work with it.

11.3.10. If you have any jumps, that can mean that you have the wrong submaps' positions. Unfreeze all and try to move it until you get their correct positions.

TDMA modes:

The system supports two modes of TDMA:

- **Mode 1 (Adaptive)**: The Hedge determines which submap sees it better at the moment and tracks in it. It can give better tracking, but in bad conditions, it may cause mistracking
- **Mode 2 (Classic)**: Hedge tracks in two submaps one by one. It can give solid 50/50 tracking in conditions where one submap can't see the hedge at all. After measurements, Real-Time Player makes tracking smooth, filtering out mistracking

Each mode has its pros and cons. Try them both and choose the best suit for your case.

How to change modes:

- Choose hedge
- Go to **Ultrasound -> TDMA mode**
- **Left-click** to change

Ultrasound	(-) collapse
Mode of work	Normal
Analog power in sleep	enabled
Power after transmission	turn off
Transmitter mode	PWM
Frequency, Hz (100..65000)	31000
Duty, % (1..99)	55
Number of periods (1..100)	33
TDMA mode	TDMA mode 1
Amplification	manual
Receiver amplifier (0..4095)	200
Time gain control	disabled
Mode of threshold	automatic

11.4. Increasing Update Rate

The update frequency is affected by 2 main parameters:

1) Radio profiles

2) Room dimensions (tracking areas)

If you need to tune the update rate of tracking, do the following:

1) Radio profiles:

There are 3 radio profiles available: 38kbps, 153kbps, 500kbps:

- **38kbps** is the slowest but can cover a greater distance
- **153kbps** - average speed, overcomes the average distance (**default**)
- **500kbps** is the fastest but works at a shorter distance

Accordingly, to raise the update rate, we recommend switching to 500kbps.

How to:

- In the settings bar of each system device (including modem), change the Radio profile parameter to 500kbps (or any you need). It is situated on the right side of the Dashboard screen.

  Tip: Change the beacons' profile before modems to avoid losing your beacons. It allows you to do it remotely

2) Room dimensions (tracking areas)

The update rate also has a linear dependence on tracking distance (distance between stationary and mobile beacon):

- **Longer** distance – **lower** update rate
- **Smaller** distance – **higher** update rate

If you have a room 10x10m, change the maximum distance setting. This will limit the system to the maximum measurement distance.

How to:

- Go to the submap settings (click on the submap icon)
- Change maximum distance value in meters (20 is a default)

  Tip: Do not enter a very small value; use a 1-2 meter margin. Also, do not use 20 meters if you have a small tracking area. Tune carefully.

Learn more here: How to increase location update rate?

11.5. Reducing Location Update Latency

The exact latency depends on many factors:

- IA or NIA
- From the modem or the beacon
- IMU sensor fusion or regular ultrasonic only
- Radio profile
- Realized update rate
- Any averaging or Real-time player enabled or not

The range is:

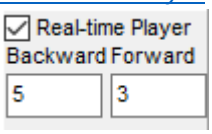
~ 12ms for data from a mobile beacon via USB with IMU fusion enabled and not averaging at all

~ 150ms with 30m-submap and update rate in ultrasonic of 7Hz and not averaging

~ 2 seconds with the same settings as in (b), but Real-Time Player with settings 16, i.e., it takes into account up to 16 previous readings before giving out the new one

What affects delay:

- *Real-Time Player in the Dashboard* (For **NIA**)



- *Real Time Player in the hedge* (For **IA**)

Real-time player	disabled
Real-time player backward (0..127)	3
Real-time player forward (0..127)	5

- Window of averaging and Distance filter settings in modem (For **NIA**)

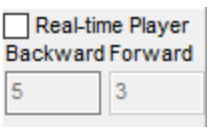
Window of averaging (0..16)	4
Distance filter (0..16)	3

- Prefiltration coefficient and Ultrasonic filtering settings in hedge (For **IA**)

Prefiltration coefficient (0..127)	0
Ultrasonic filtering (0..255)	40

How to decrease latency:

- *Turn* off the *Real-Time Player* (works for **IA** and **NIA)**



- Change the *Window of averaging and Distance filter* settings value to 0 (**For NIA)**:
- Choose **Modem -> Window of averaging** (in the right tab) **-> Enter 0 value**
- Choose **Modem -> Distance filter** (in the right tab) **-> Enter 0 value**

- Change the *Prefiltration coefficient and Ultrasonic filtering* settings value to 0 (**For IA)**:
- Choose your mobile beacon. Go to **Ultrasound -> Prefiltration coefficient -> Enter 0 value**
- Choose your mobile beacon. Go to **Ultrasound -> Ultrasonic filtering -> Enter 0 value**
- Complete. Latency reduced

Learn more here: How to increase location update rate?

11.6. How to Place Beacons

Avoid placing beacons on long sound-conducting objects

This is very rare but may happen under some exceptional circumstances.

The best practice is to place beacons (stationary and mobile) in places that would not result in the transfer of ultrasound energy from the beacon's board/case directly to the place it is attached via a medium other than air. For example, solid attachment of a beacon to a long horizontal metal tube may result in the following:

- Sound emitted from the beacon propagates directly to the metal tube.
- Propagation losses inside metal are much smaller than in the air. Moreover, the tube may act as a low-loss waveguide.
- If the tube is solid enough and long enough, there may be an unusual effect where the receiving beacon receives the signal sooner than expected, i.e., sooner than the distance divided by the speed of sound in the air. That happens because the speed of sound in metal is much higher than the speed of sound in the air. The ultrasound signal may even look stronger than the actual signal propagated through the air due to the lower amount of losses of ultrasonic in metal than in the air.
- It is good practice to place beacons on something relatively soft or something that does not conduct sound.

Place beacons in a way that provides the proper ultrasonic coverage. One beacon must be in the line of sight of at least two beacons. Try to locate them under ceilings to avoid shadows, walls, etc.

- Optimal settings for stationary beacons in small and big rooms.
- Use 30–50 ultrasonic pulses for larger places and the default 5 pulses for smaller places.
- Optimal settings for noisy environments.

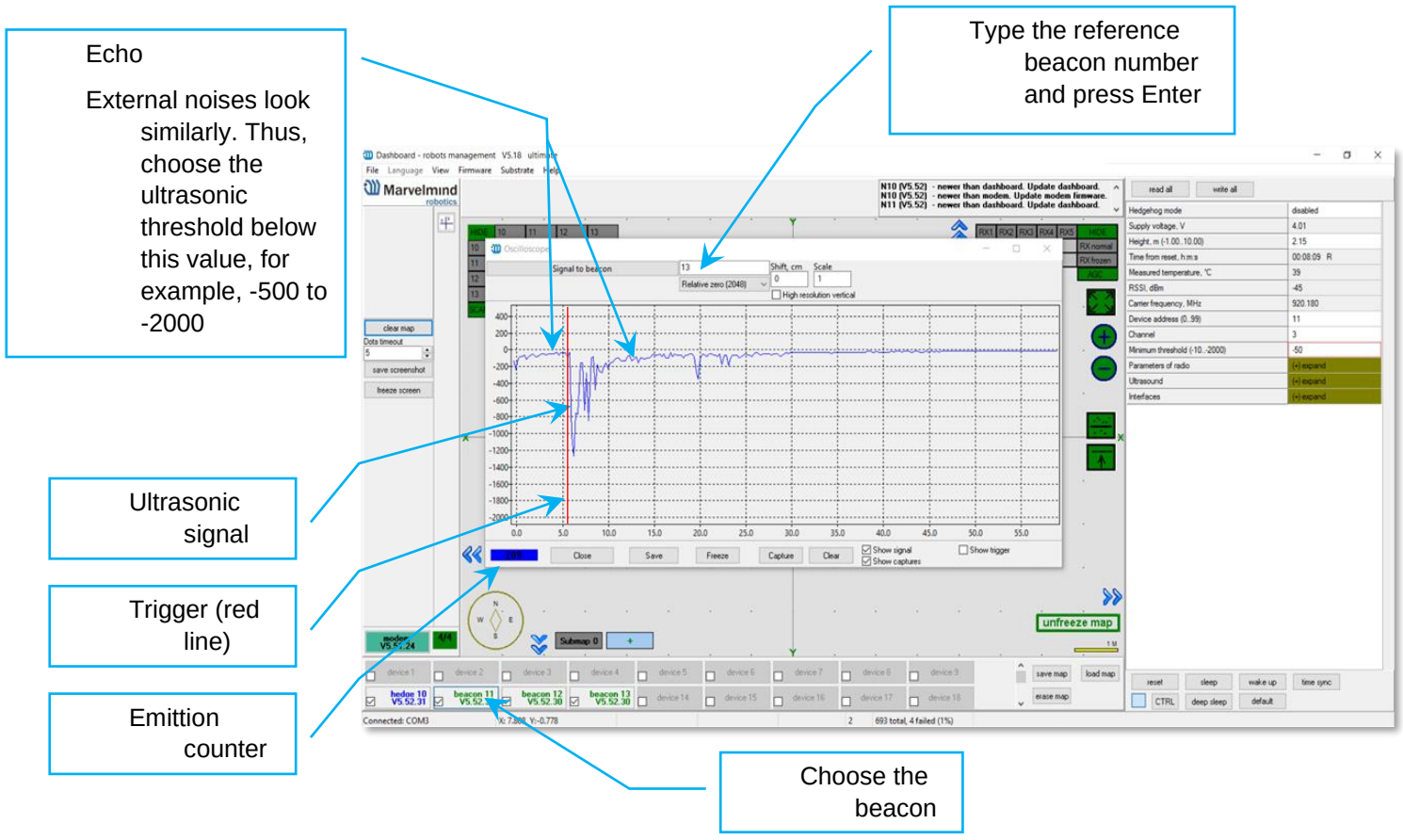
There are several ways to reduce impact:

- Mobile beacons can be placed close to the noise source without harm, but stationary beacons should be placed further from the noise because they are receiving the ultrasound. In contrast, the mobile beacon is emitting the ultrasound.

Learn more about placing the beacons here: How to increase accuracy of precise indoor positioning system

11.7. Using the Oscilloscope

- Monitor the ultrasonic signal from one beacon to another
- Use **Dashboard => View => Oscilloscope** to monitor ultrasonic signals from one beacon to another
- It is a potent tool because it also gives information on the background noise, signal level, echo, etc. This tool makes it easy to set up the proper ultrasonic threshold on the Dashboard.



11.8. Proper Ultrasonic Signal Detection

This chapter is mostly related to HW v4.9 beacons. Super-Beacons Industrial Super-Beacons have high-power digital microphones for noise filtering and proper signal detection. Anyway, if you have problems with signal detection, read this chapter, no matter which beacons you use
These recommendations are suitable only for NIA

Marvelmind Indoor Navigation System uses proprietary multi-frequency for ultrasonic signals and employs additional filtering to combat external noise. This also makes the system relatively immune against the “usual suspects.” However, if the external noise is too strong, its source is too close, or it’s emitting a solid signal on frequencies close to 19, 25, 31, 37, 45kHz, or white noise, the system functionality can be affected.

When external noise is high, identify the source. Usual sources include:

- Ultrasonic-based volume or movement detection alarm systems
- Other robots using ultrasonic
- Parktronics
- Sources of very strong white or impulse noise (air guns, air press, cutters, vacuum cleaner, etc.)
- Rotors of drones/copters

The best things to do in this case:

- Identify the beacons that are affected. Usually, they are those that are the closest to the source of noise. Try to reposition them
- Manually reduce the gain of the affected stationary beacons so that the signal from the mobile beacon would have a 1000–1800 amplitude. That would give the best signal-to-noise ratio. Don’t make the gain too high. The noise will be amplified, but the desired signal will be saturated, and the signal-to-noise ratio will be poor
- Input distances between beacons manually. More information – Table of distances

The gain settings may be very non-linear. There is almost no change from 4000 to 3000. But around 2500, the gain starts reducing very quickly (1200 for some HW versions). By setting the gain manually, it is possible to find the optimal gain to obtain the highest signal-to-noise ratio so the system can work even in very challenging external conditions.

When the map is formed, only the mobile beacon emits noise, whereas stationary beacons do not. Thus, it does not matter how close the mobile beacon is to the source of the noise. However, it matters how close the stationary beacons are to those sources. Select the positions of the stationary beacons accordingly—place them further away from the noise sources.

11.9. System Accuracy Evaluation

Accuracy of distance measurement:

- Marvelmind navigation system can measure distances between beacons with an accuracy of +/- 2cm if the correct ultrasound speed is used.
- The ultrasound speed depends on temperature, pressure, and humidity. Other factors have an insignificant effect.
- The main factor is temperature. In the temperature range of -20…+50 °C, the speed of ultrasound changes to about 0.6 m/ (s* °C). It gives a distance error of about (0.6 / 340) *100% ~ 0.17%/ °C. So, caused by incorrect temperature setting, the absolute error of distance measurement is 0.17% of the real distance between beacons. For example, a distance of 30 meters and 5 °C error gives 0.85%*30 ~ 0.25 meters' error. Marvelmind system allows the air temperature to be set up in the system settings.

Accuracy of position measurement:

- Marvelmind system uses a trilateration algorithm to calculate position by distances. The inaccuracy of position calculation is related to the inaccuracy of distance measurement and the geometry of the relative location of stationary and mobile beacons
- Basic trilateration formulas are given in this article: https://en.wikipedia.org/wiki/Trilateration
- As you see, the position of mobile beacons **X**, **Y**, and **Z** is calculated from the positions of 3 stationary beacons, which are set by values of **d**, **i**, **j**. One of the beacons was shifted to the (0,0) position to simplify the formulas in the article. In formulas for **X** and **Y**, we see **d** and **j** as denominators. This means that with low values of **d** and **j, a** slight error of this value can cause a significant position error
- Please see the picture of the beacons in the article - in more simple words, it means that if one of three beacons is close to the line connecting the other two beacons, it gives increased inaccuracy of locating mobile beacon

For example:

- assume d= 10, i= 5, j= 0.1, r1= 7, r2= 7, r3= 4.8
- We get x= 5, **y= 2.4375**, z = 4.25
- If we suppose that j=0.101 (0.1 cm error), we receive x= 5, **y= -0.06**, z= 4.89
- You see a huge Y error

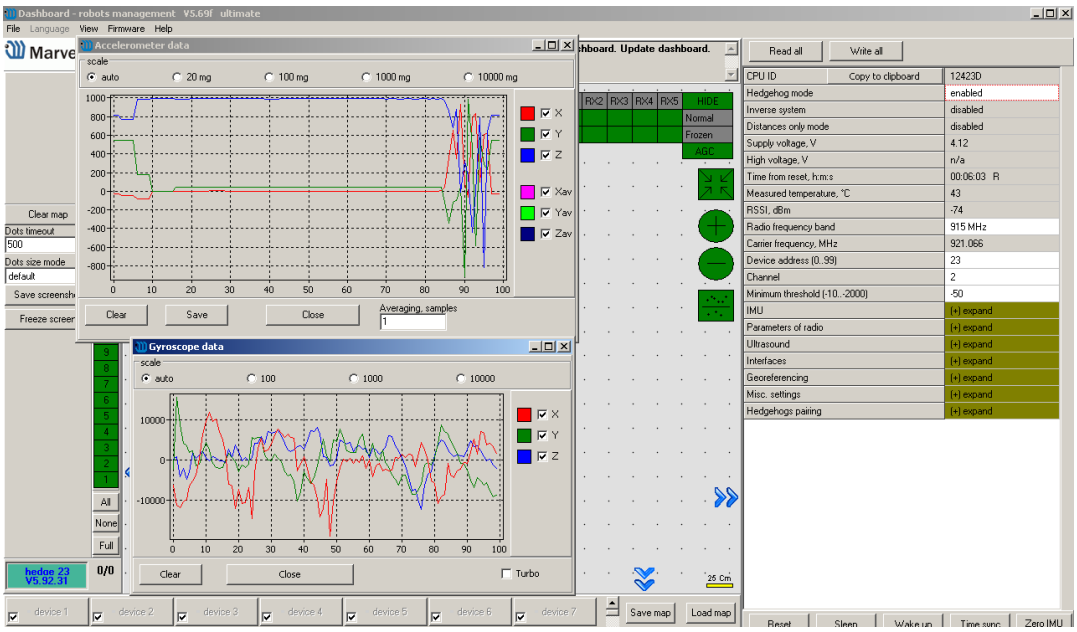
Another example for Z. Assume a mobile beacon is relatively close to a plane of stationary beacons:

- d= 8, i= 4, j= 6, r1= 5.02, r2= 5.02, r3= 3.01
- This gives X=4, Y= 3.01169, Z= 0.36
- If we suppose r3= 3.0 (1 cm error), we receive X=4, Y= 3.016, Z= 0.44. Error on Z is about 8 cm

Also, with r1= 5, r2= 5, r3= 3, Z will be 0. As you see, a low change in distances causes a significant change in the Z value near the plane.

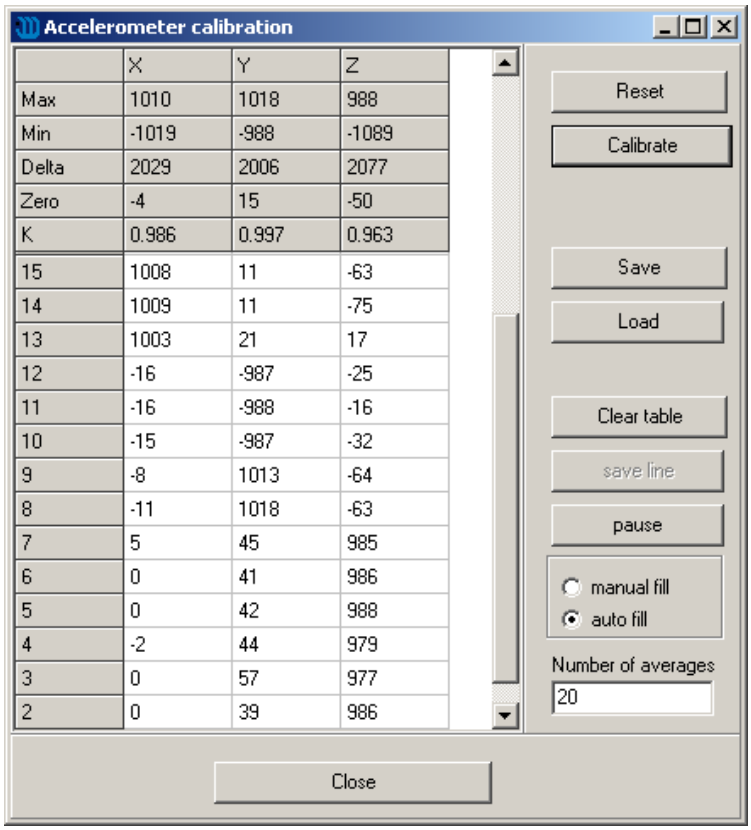
Learn more about accuracy here: Absolute vs. relative accuracy

11.10. Calibration of the accelerometer



To calibrate an accelerometer on your beacon with IMU, you can do the following steps:

- Connect the mobile beacon via USB to the Dashboard
- Make sure that the beacon has IMU on board: open the ***View / Accelerometer menu*** and ***view/gyro data***. In the presence of IMU graphics in these windows should display the angular velocity and acceleration when moving the mobile beacon (turn it in hands).
  Close the window of the accelerometer and gyro data.
- Open the calibration window: ***View / calibrate the accelerometer***



	X	Y	Z
Max	1010	1018	988
Min	-1019	-988	-1089
Delta	2029	2006	2077
Zero	-4	15	-50
K	0.986	0.997	0.963
15	1008	11	-63
14	1009	11	-75
13	1003	21	17
12	-16	-987	-25
11	-16	-988	-16
10	-15	-987	-32
9	-8	1013	-64
8	-11	1018	-63
7	5	45	985
6	0	41	986
5	0	42	988
4	-2	44	979
3	0	57	977
2	0	39	986

- When calibrating, it measures the data of the free fall (gravity of the Earth) corresponding to each of the three axes X, Y, Z. The initial ones from these calculations remember the correction shifts indicated in the table as "Zero" and the correction factors indicated as "K"
- The switch at the right bottom of the window should be in the **AutoFill** position
- Before starting the calibration, click the **Reset** button at the top of the window - zeroing the current calibration results

To calibrate: slowly, without jerking, manually turn the beacon in each of the 6 positions and keep it still for 1-2 seconds:

  - The starting position - the beacon lies on the table; the antenna is pointing upwards (calibration Z +)
  - The beacon is turned upside down, the antenna pointing down (calibration Z-)
  - The beacon is on the end, the sensor RX1 is pointing towards the table (calibration Y +)
  - The beacon rests on the end, and the RX3 sensor points toward the table (calibration Y-)
  - The beacon rests on the end, the RX2 sensor is directed towards the table (calibration X +). In order not to interfere with the USB connector, the beacon can be placed on the edge of the table so that the cable hangs down
  - The beacon rests on the end, and the RX5 sensor points toward the table (calibration X-)

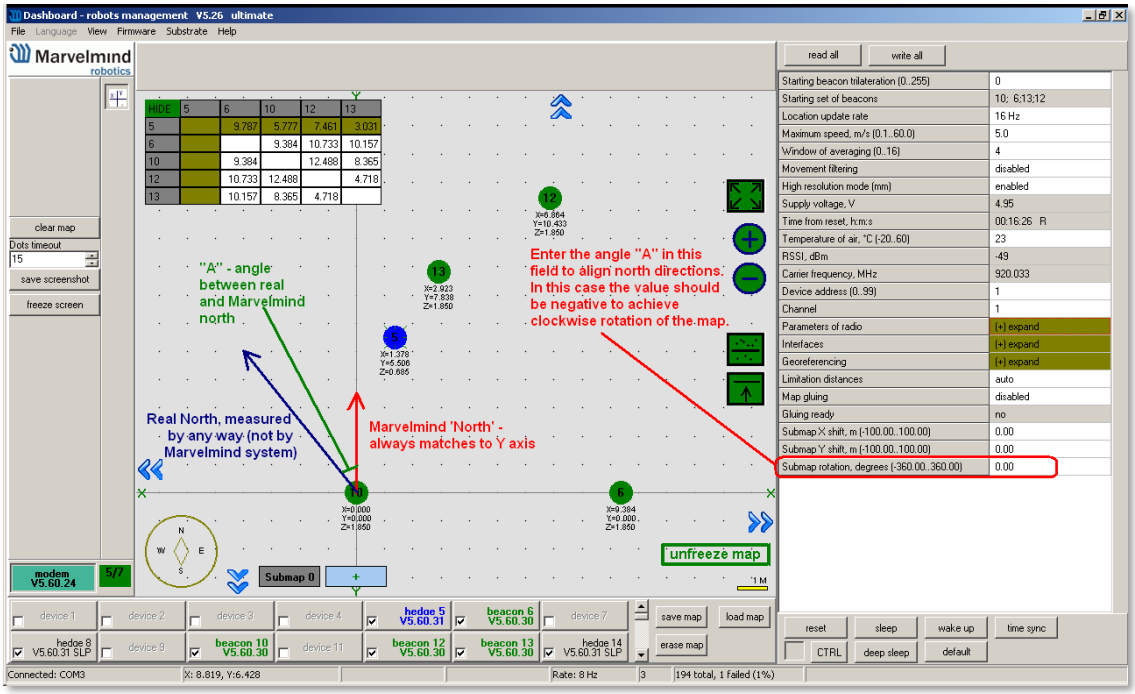
- In each measurement, the accelerometer's readings are corrected by Zero and K. At the end of the measurement of 6 points 7.1 ... 7.6, in the serviceable accelerometer Zero should be close to zero, and K close to 1, see the screenshot. If not - check if you forgot any of the points 7.1 ... 7.6.
- To save the results, click **Calibrate**.

11.11. Settings to Obtain Correct North Direction

In some cases, obtaining a correct north orientation of the map for NMEA output from the Marvelmind system is necessary. For example, when using a Marvelmind mobile beacon as the navigation data source for Pixhawk installed on a copter, the correct north is required for correct yaw control of the copter. The Marvelmind system cannot determine north automatically, so the user should make corrections after building and freezing the map. It can be done in one of two ways:

Option 1

- Rotate the Marvelmind map using the dashboard, as shown in the screenshot below
- You can also view the help video



Option 2

- Enter the angle correction (the angle shown in the screenshot) on the Pixhawk side from the Mission Planner of APM Planner
- Refer to the parameter "BCN_ORIENT_YAW". Here is the link to ardupilot

11.12. Marvelmind API

Marvelmind API library is used by Marvelmind Dashboard software and provides interface to user's software. API is coming as dynamic-link library (DLL) for MS Windows and shared library for Linux (x86 and ARM platforms). The API connects to the modem via USB (virtual serial port) and implements the communication protocol with modem.

In addition to the API library, the software package includes C example software, which was used for testing of the API and includes calls of all API functions.

The example can be used as a basis for developing a user's software and for porting API library interface (file 'marvelmind_api.c') to other programming languages.

For details check the links below:

- Marvelmind interfaces (Chapter 10)
- GitHub

Tested on:

1. MS Windows 10; CPU: Intel Core i5

2. Ubuntu 20.04; CPU: Intel Core i5

3. Raspbian (2018-11-13-raspbian-stretch-full); Platform: Raspberry Pi 3 Model B+

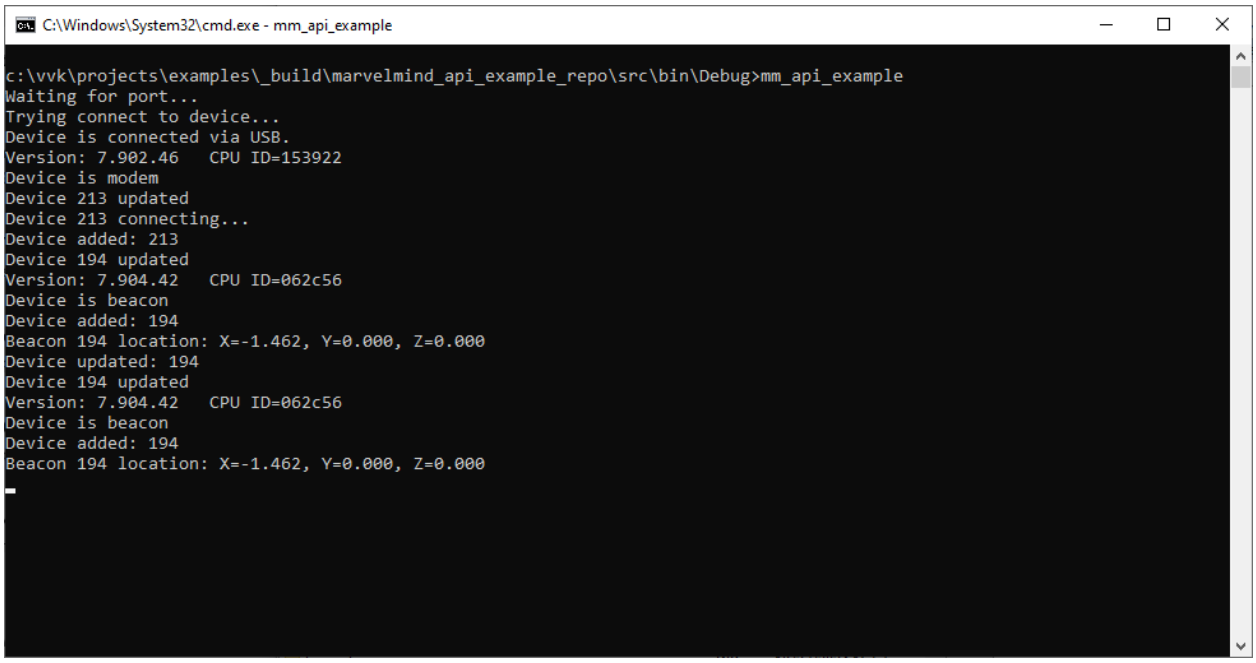


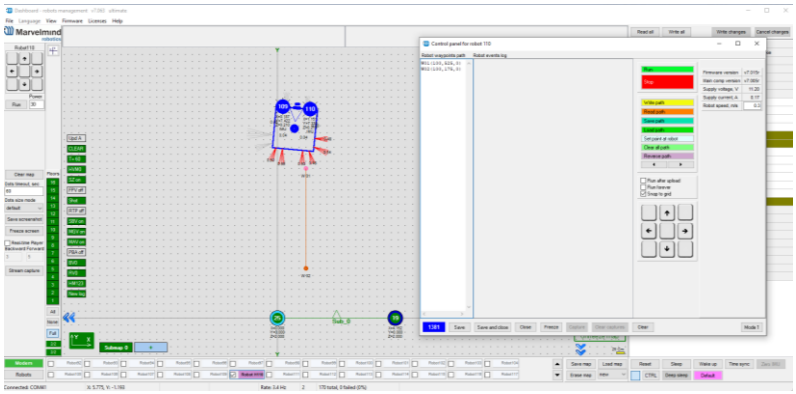
Figure 1. Example of a connection to Marvelmind API via USB

11.13. Communication of Pixhawk with Marvelmind Mobile Beacon

The Marvelmind mobile beacon can be connected to Pixhawk (and to any other hardware or software that inputs GPS according to the NMEA0183 protocol). It can send GPS data via UART and USB (virtual UART) interfaces. For further explanation, please check out the following documents: PixHawk and Marvelmind Integration Manual and Marvelmind and PX4 integration.

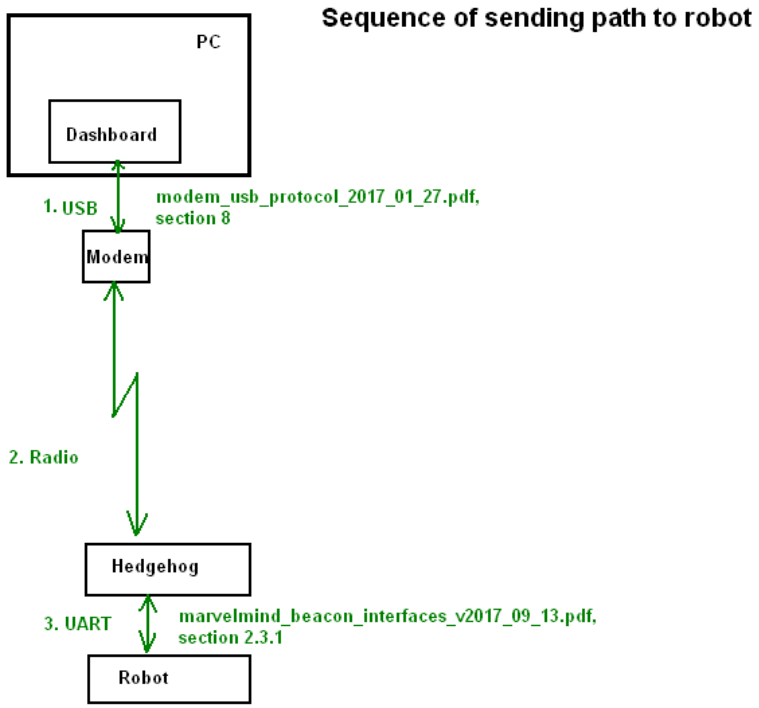
11.14. Sending Path to Robot

You can send the path for your robot via Dashboard



Check our help video.

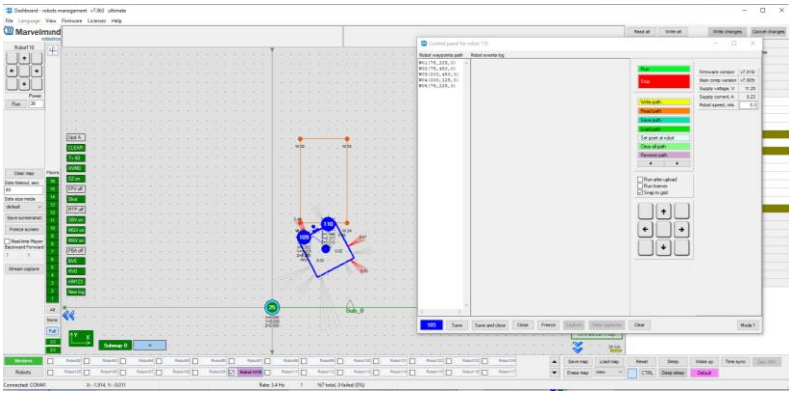
- The dashboard sends a request to the modem via USB.
- The procedure for sending these requests in the dashboard is shown on the second screenshot.
- This format of the request is described in section 8 of the modem protocol:
    - Modem transmits data to the hedgehog via radio, using our proprietary protocol



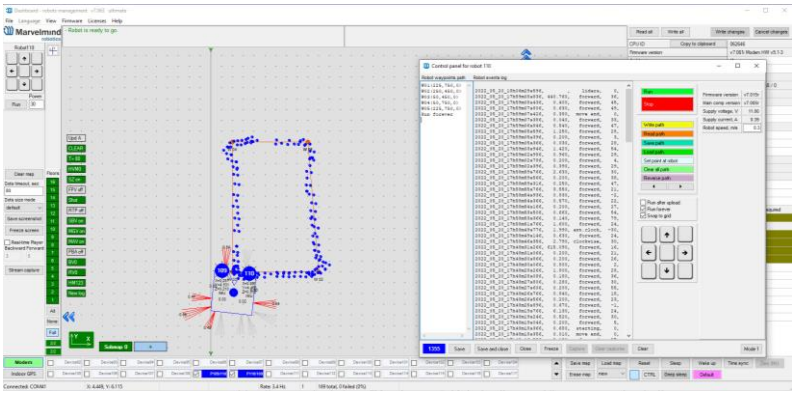
- The hedgehog communicates with the robot via UART. Hedgehog sends data according to section 2.3.1 of this protocol
- The robot should confirm receiving data by response packet shown in section 2.3
- This communication on the robot side is implemented in the Arduino example on our site. As you can see in the protocol, the robot should not request the waypoints; the hedgehog will send the waypoints when they are transmitted from the dashboard. But the robot should confirm receiving each waypoint by this packet:
- [0x03,0x47,0x01,0x02,0x00, <2 bytes of checksum>]

Learn more about Robot Boxie in the [Marvelmind Boxie Operating Manual]

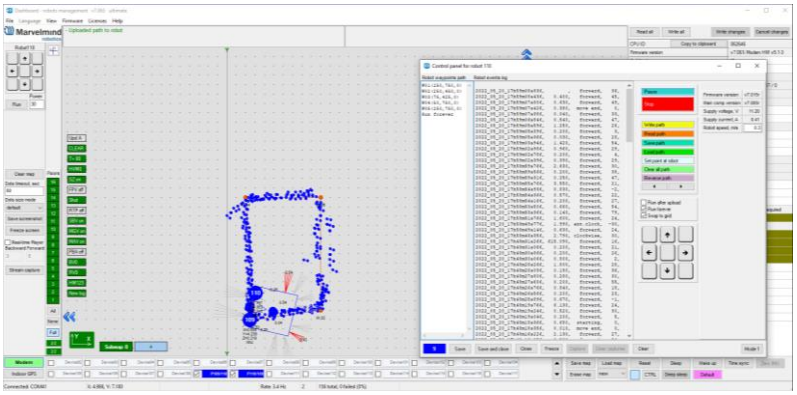
How to send a path:



1) Set up the Marvelmind Indoor “GPS” system.



2) Turn on Boxie and wait for 1 minute



3) Configurate paths and points (Use **Shift+Left mouse button click** to create a point, click on point – to remove):

4) Press “Run”. Robot will follow the path that you draw:

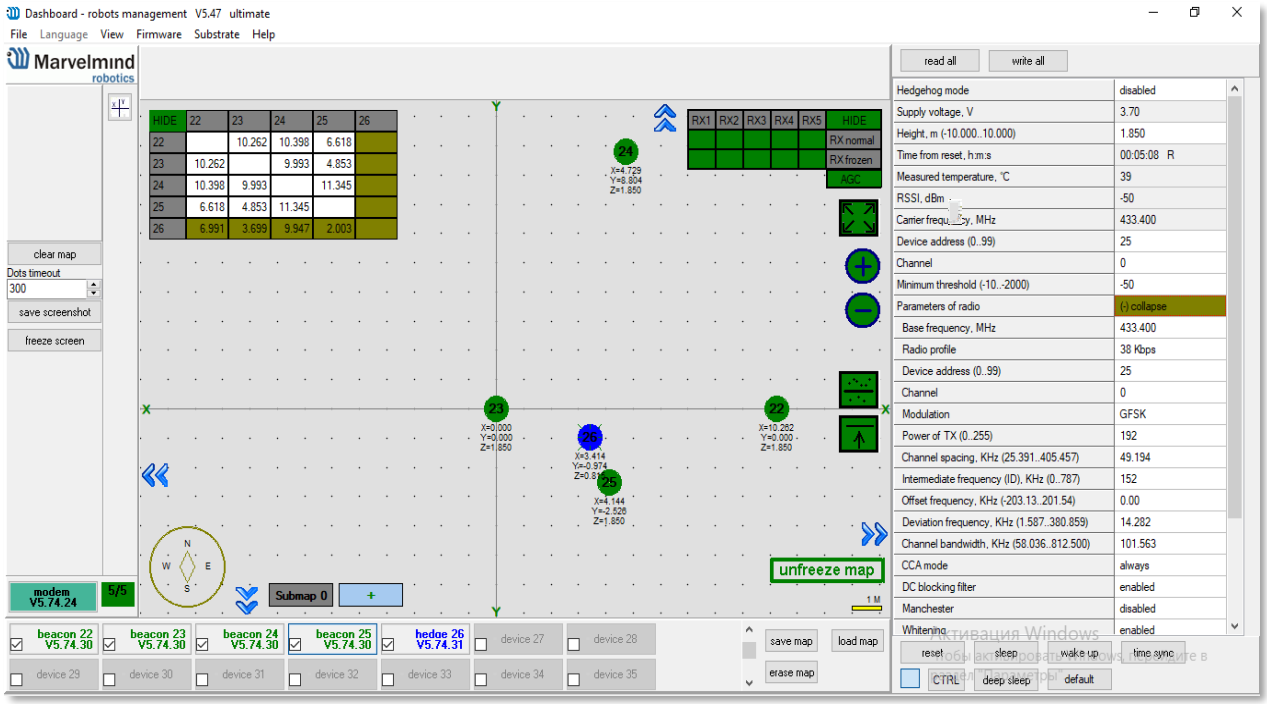
5) If you put a tick on “Run forever”. Robot will move till you press stop button in control panel or before obstacle detected:

11.15. Proper Ultrasonic Coverage

The most critical requirement for the system to work well is to have proper ultrasonic coverage.

Each sensor has an ultrasonic beam of ~90 degrees. Outside of that range, the emitting power and sensitivity drop quite rapidly. The signal is highly attenuated from the left, right, or back of the ultrasonic sensor. Thus, it is crucial to provide proper ultrasonic coverage for the area where the robot will be moving.

- It is also very important to provide proper ultrasonic coverage to the stationary beacons when the map is being formed
- **Mobile beacon (“hedgehog” or “hedge”) is designed to be placed horizontally**
- The mobile beacon has four horizontal and one vertical sensor, each covering its own sector. Together, they cover 360 degrees horizontally and 180 degrees in the upper hemisphere. The lower hemisphere is highly attenuated, so don’t expect ultrasonic coverage in that area
- If the stationary beacons are above the mobile beacon, it is advised that the mobile beacon be placed as high as possible on the robot. This minimizes shadows from other objects, people, etc.

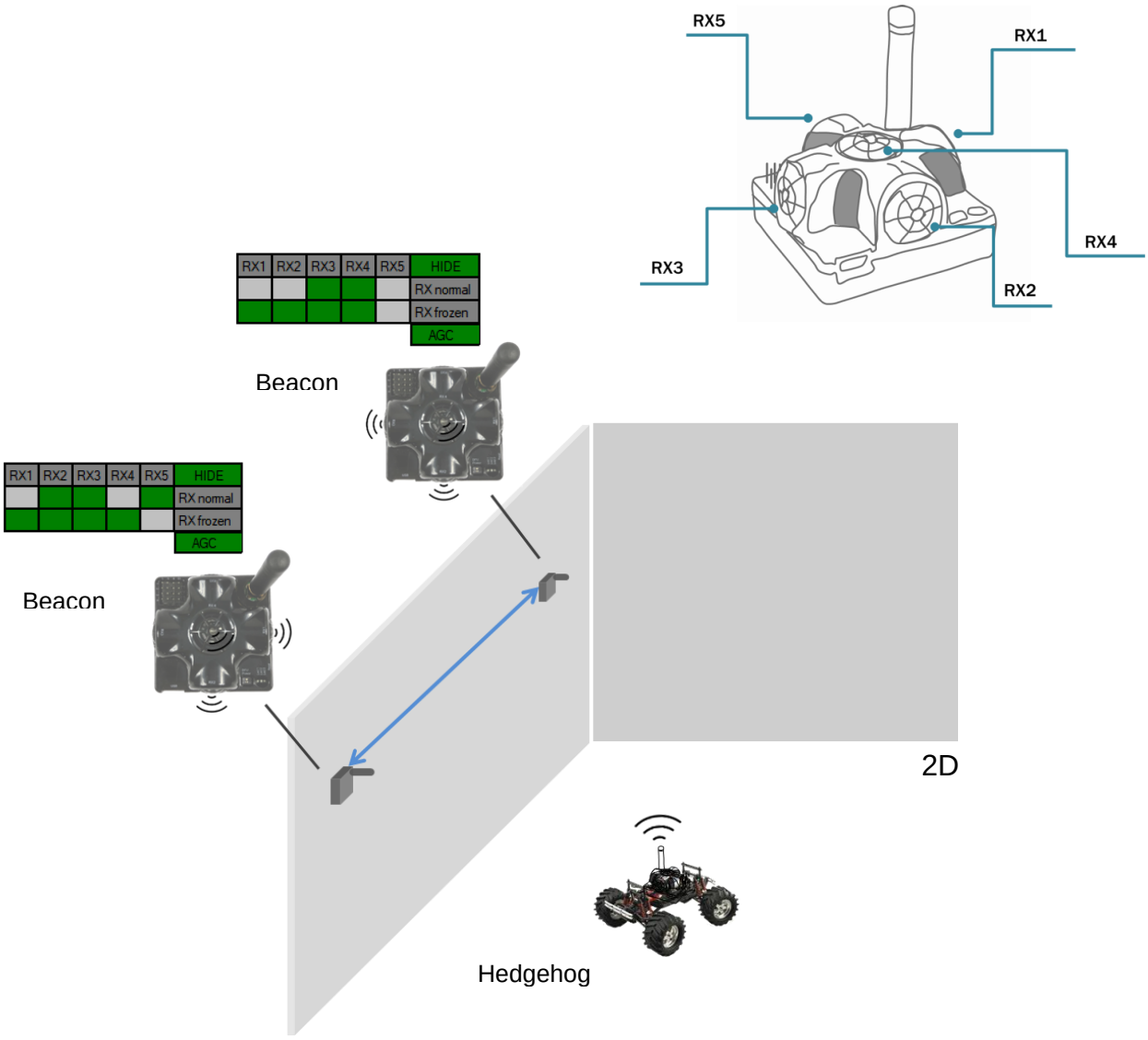


- An example of proper positioning of the mobile beacon can be found here
- The beacon is placed horizontally and above other objects that can cast a shadow on the stationary beacons
- **Keep the radio signal's strength under control**
- The RSSI (Dashboard => right menu) of any beacon/modem must not be higher than -25dBm. Otherwise, the system may malfunction
- It is recommended the distance between the modem and beacons be no less than 0.5–1m. Beacons can be placed as close to each other as needed. If a beacon is exceptionally close to the modem, disconnect the antenna from the beacon. Monitor the Received Signal Strength Indicator (RSSI). It must be in the range of -25 to -70dBm. An RSSI of less than -70dBm will also work, but packet losses may occur. The quality of the radio connection also depends on external interference because the used band is ISM (either 915MHz or 433MHz), and there are numerous co-existing systems.
- Use 30 - 50 periods (pulses) in settings instead of the default 5. Select:
- **Ultrasound settings => Number of periods**

Ultrasound	(-) collapse
Mode of work	TX+RX normal
Analog power in sleep	enabled
Power after transmission	not turn off
Frequency, Hz (100..65000)	31000
Duty, % (1..99)	50
Number of periods (1..100)	5
Amplifier limitation (calibrated)	4000
Amplification	AGC
AGC desired level (-1800..0)	-500
AGC hysteresis (10..2000)	130
AGC step, dB (1..20)	3
Mode of threshold	automatic
Minimum threshold (-10..-2000)	-50

- When you have large errors in position estimation (more than a 1m inaccuracy), use the embedded Oscilloscope on **Dashboard => View** to determine which stationary beacon is jammed
- Reduce the gain of the ultrasonic manually depending on your system

11.16. Sensors Settings: Example for 2D and Mobile Beacon



Beacon 2

RX1 and RX4 emit ultrasound in normal mode for better ultrasonic signal exchange with Beacon 3. In frozen mode RX2 added as working sensor. The rest sensors are turned off

Changing sensors' settings could be found in the panel in the upper right corner of the Dashboard during your beacon is connected to the computer

Beacon 3

RX3 and RX4 emit ultrasound in normal mode for better ultrasonic signal exchange with Beacon 2. In frozen mode RX2 added as working sensor. The rest sensors are turned off

11.17. Powering Beacons

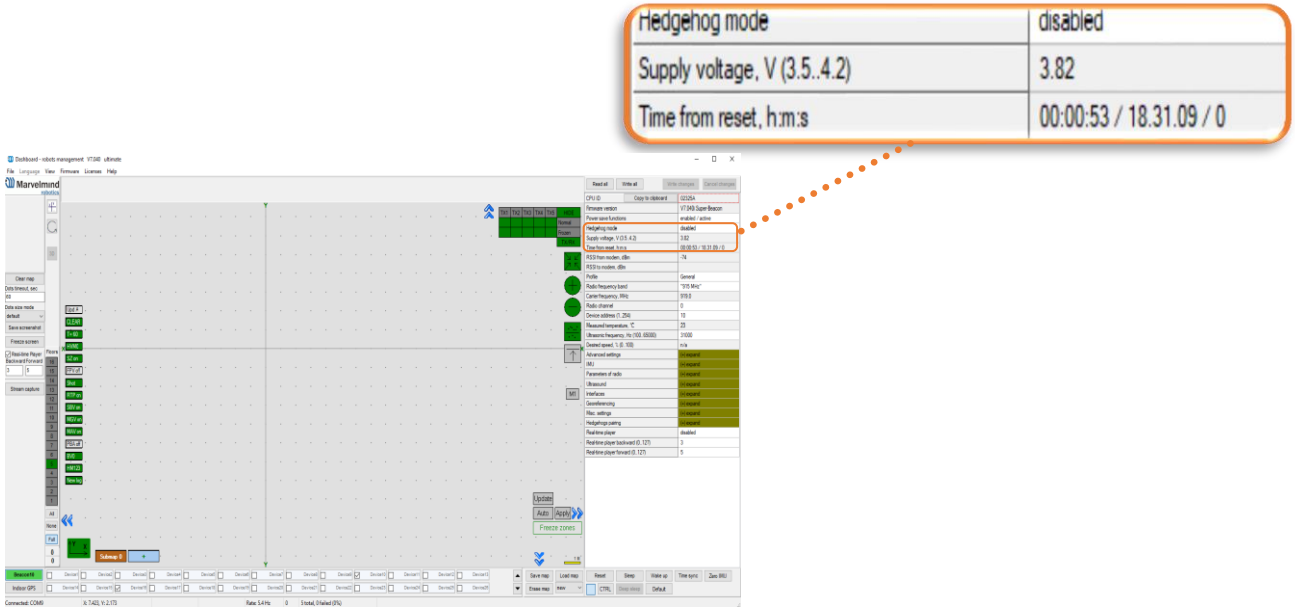
Depending on the type of beacon, it may be an internal battery or an external USB power supply; for more details, check the comparison table

Battery lifetime depends on the mode of operation and can be varied between several days to several months (or more for special applications)

Learn more here: Power supply options for beacons

11.18. Power Supply and Leds

- The modem doesn't have a battery, so the power supply LED is always on when the Modem connects to a computer.
- The power supply led for the battery (for Super-Beacons, Beacons HW v.4.9, and Mini-RX Beacons) is on when the battery is charging and is off when the battery isn't charging. The battery stops charging when fully charged, and the LED goes out when this happens. So, the LED turns off and on periodically, which means that the beacon is fully charged, and the LED turns on again when the battery drops a few millivolts.
- You can always find the battery level by connecting it to the Dashboard via USB or radio.



Status of charge:

- 4.1V - 4.2V – absolutely fully charged
- 3.6V – 4V – good charged
- 3.2V – 3.6V – very low charge
- 3.2V – fully discharged

Learn more here: [Power supply options for beacons]

11.19. Licenses

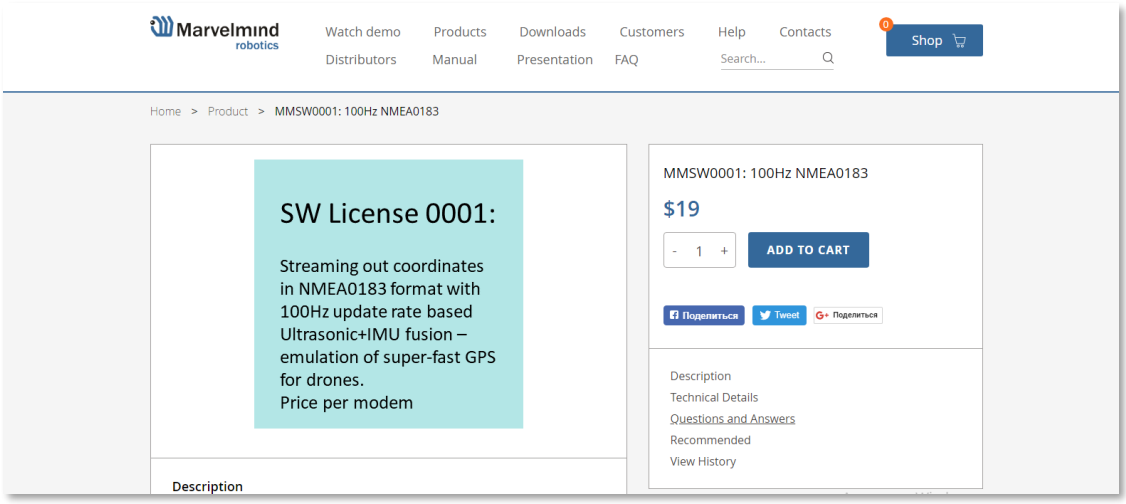
11.19.1. How to Activate Licenses

Please note that we have different types of licenses for modems and beacons. If you need to activate the beacon's license – connect the specific beacon to the Dashboard to choose a license for that beacon. Connect modem for modem's licenses.

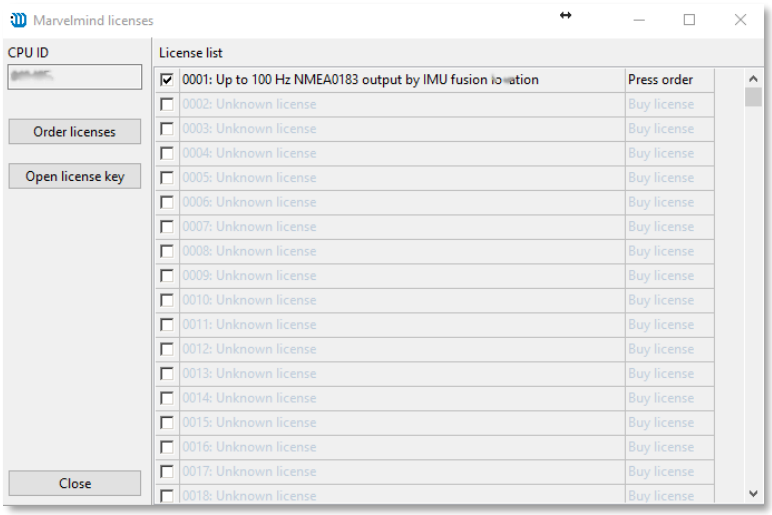
We added the licenses system. Now, you can order some additional features. It is unavailable in the basic Dashboard version, but you can easily purchase it if necessary. You can see the list on Marvelmind.com -> Products

To order:

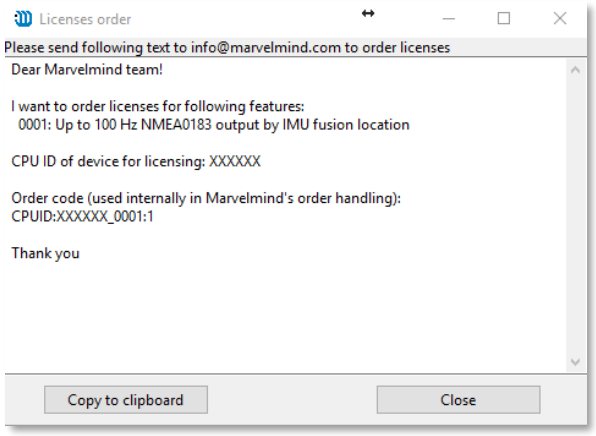
- Go to Marvelmind.com -> Products
- Choose features which you want to get (e.g., MMSW0001: 100Hz NMEA0183)



- Make an order.
- Pay for the feature (via PayPal or other methods).
- Order the feature via the Dashboard by providing the device's CPU ID or send us an email with the device's CPU ID:
    - Open Dashboard SW
    - Connect the device you need to order a license to the Dashboard via USB
    - Go to Licenses → View/activate licenses



- Choose the licenses that you have purchased.
- Press Order licenses.
- Dashboard will generate a text



- Send generated text to info@marvelmind.com
- We will generate the license key and send it to you via email
- Place the license key into the Dashboard/Licenses folder:
- Connect the device to the Dashboard via USB
- Go to **Licenses → View/activate licenses**
- Choose "Open license key"
- Choose the license file (be careful if you have licenses for multiple devices; check CPU ID carefully)
- The features become activated in the Dashboard.

11.19.2. 100Hz NMEA0183 for Drones

SW License 0001:

Streaming out coordinates in NMEA0183 format with 100Hz update rate based Ultrasonic+IMU fusion – emulation of super-fast GPS for drones.
Price per modem

This feature requires MMSW0001 license.
Only works only with Beacons HW v4.9-IMU.

Streaming out coordinates in NMEA0183 format with 100Hz update rate based on Ultrasonic + IMU fusion – emulation of super-fast GPS for drones.

Description:

- Regular location update for the Indoor “GPS” system is based on ultrasonic only and shows a usual update rate in the range of 4-16Hz per system. There is also Ultrasonic + IMU fusion data available, but it is in Marvelmind’s internal format that is not regularly acceptable by devices compatible with NMEA0183 (native GPS format), for example PixHawk and Ardupilot
- The feature is taking Ultrasonic + IMU fusion location data that is streamed out with 100Hz update rate and converts to NMEA0183, thus, emulating super-fast GPS signal
- The feature works only with Beacons HW v4.9-IMU. Future support of Super-Beacons, Industrial Super-Beacons is possible, but an exact roadmap has not been defined yet.

11.19.3. Getting $GPHDT Heading Packet in NMEA0183

SW License 0002:

Heading packet GPHDT for NMEA0183.

Price per streaming beacon.

This feature requires MMSW0002 license.

This feature allows to get $GPHDT packet (heading) in NMEA0183.

Works with Paired Beacons configuration for Location + Direction. Check the Paired Beacons chapter.

Videos:

- Demo: Precise (±2cm) Location + Direction Indoor
- SW feature demo: paired beacons – location + direction

Supported devices:

- Super-Beacon
- Beacon Mini-RX
- Industrial Super-Beacon
- Beacon Industrial-RX

11.19.4. UBX (u-blox) Protocol for PX4

SW License 0003:

Support of UBX (u-blox) protocol for PX4.

Price per streaming beacon.

This feature requires MMSW0003 license.

The feature allows a mobile Super-Beacon to stream out data using UBX (u-blox) protocol. It is used for PixHawk with PX4 stack. This feature also allows substituting u-blox compass that may not work indoor with a signal from the Paired Beacons. PixHawk will believe that is getting direction data from u-blox compass via I2C.

Works only with Super-Beacon.

Check the Paired Beacons chapter.

Videos:

- Demo: Precise (±2cm) Location + Direction Indoor
- SW feature demo: paired beacons – location + direction

Links:

- Communication of PixHawk with Marvelmind Mobile Beacon
- Drones

11.19.5. Advanced SW Pack

SW License 0005:

Advanced SW pack.

Price per beacon.

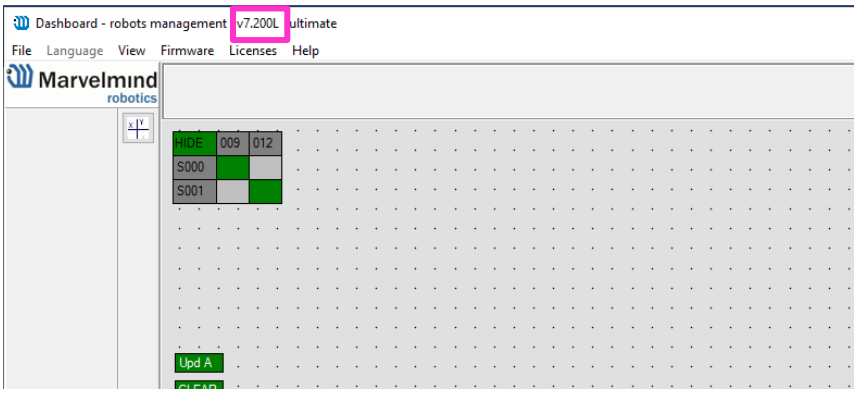
MMSW0005 – one of the most significant licenses for Marvelmind SW.

Learn more: SW Pack 7.0/7.1 Release Notes

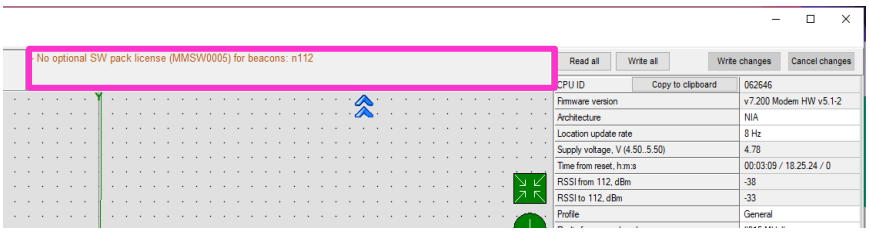
In the previous version of SW (older than 7.200), when the license was activated, the version of SW changed from 7.0xx to 7.1xx.

From version 7.200 activated license shows in the Dashboard as “L”

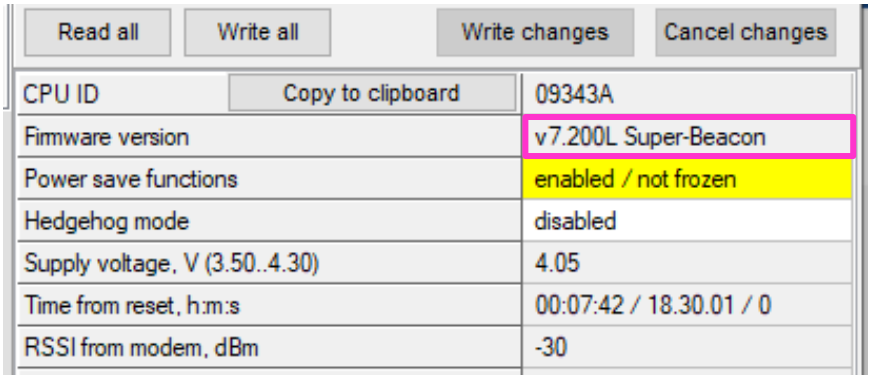
- If license MMSW0005 is activated for all devices, it shows L in the window capture of the Dashboard next to the version of Dashboard:



- If the license is not activated for one or more beacons in a system, it will be reported in the right information window:



- And “L” will be shown next to the version of firmware of each beacon with the activated license:



11.19.6. Geofencing Alarm

SW License 0006:

Dedicated pin for geofencing alarm

Price per beacon or modem.

SW License MMSW006 activates support for a dedicated pin for geofencing zone violation. Instead of reading the stream of location data in the protocol, it is now possible to have just a pin from the 4X4 of Super-Beacon or pins on the modem or internal pins in the Mini-RX to be automatically switched to “0” or “1”, on every time reset, when the geofencing zone rules are violated.

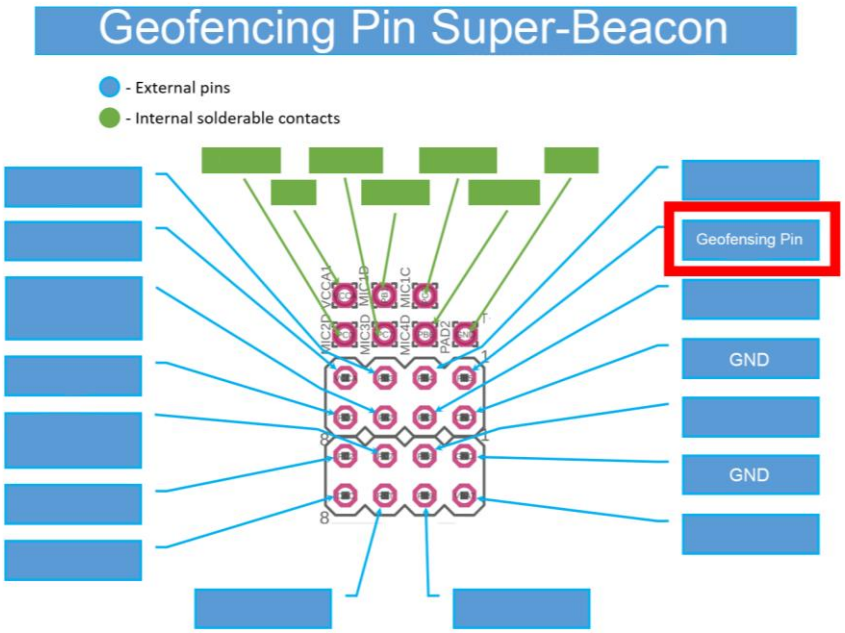
Supported hardware:

- Super-Beacon
- Modem v5.1
- Mini-RX

Follow the instructions below to use this feature:

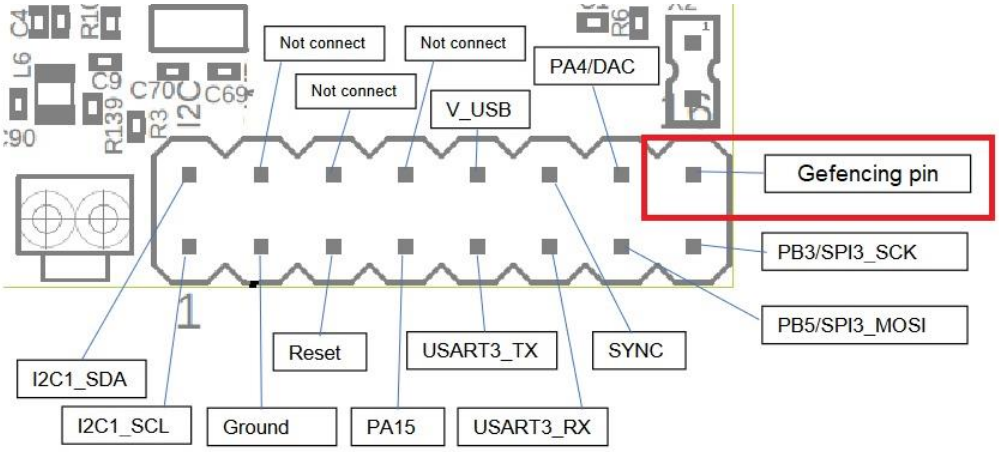
11.19.6.1. Connect the alarm to your device according to the scheme:

11.19.6.2. Geofencing pin scheme for Super-Beacon (when license-activated SPI will not be available):

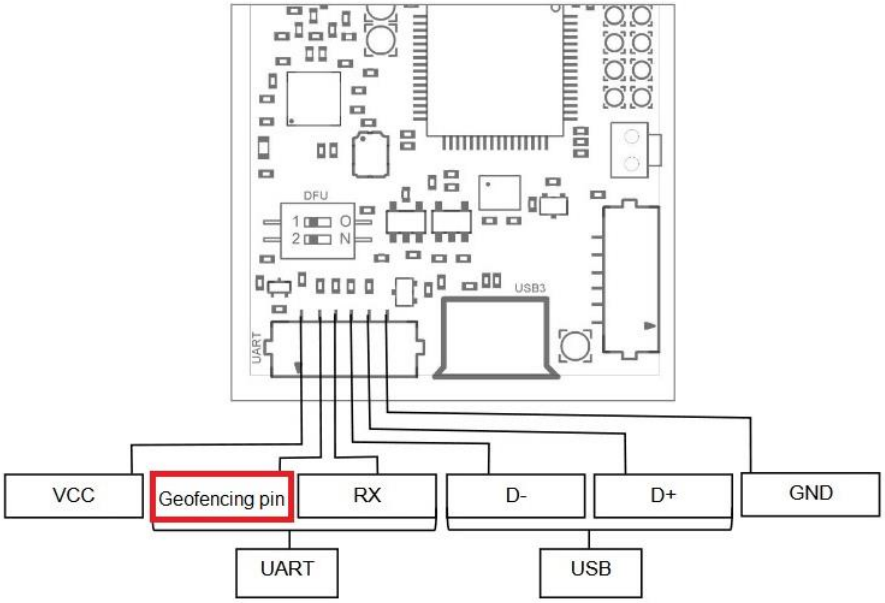


Marvelmind robotics

11.19.6.3. Geofencing pin scheme for Modem HW v5.1:



11.19.6.4. Geofencing pin scheme for Mini-RX:



11.19.6.5. Connect beacon via dashboard or radio and expand Interfaces in a settings bar:

Interfaces	(-) collapse
UART speed, bps	500000
Streaming output	USB+UART
Protocol on UART/USB output	Marvelmind
PB4 pin function	SPI MISO
Quality and extended location data	disabled
Alarm pin function	None
Alarm pin mode	n/a
Streaming mode	License SW v7.1 required
Debugging data	disabled
SPI data output	disabled

11.19.6.6. Switch on the Alarm pin function parameter:

Interfaces	(-) collapse
UART speed, bps	500000
Streaming output	USB+UART
Protocol on UART/USB output	Marvelmind
PB4 pin function	SPI MISO
Quality and extended location data	disabled
Alarm pin function	Geofencing alarm
Alarm pin mode	Low level on alarm
Streaming mode	License SW v7.1 required
Debugging data	disabled
SPI data output	disabled

11.19.6.7. Choose the needed alarm pin mode according to a bellow table:

Alarm pin mode	Pin state with alarm	Pin state without alarm
Low-level alarm	+3.3V	Z state
High-level alarm	0.0V	Z state

Interfaces	(-) collapse
UART speed, bps	500000
Streaming output	USB+UART
Protocol on UART/USB output	Marvelmind
PB4 pin function	SPI MISO
Quality and extended location data	disabled
Alarm pin function	Geofencing alarm
Alarm pin mode	Low level on alarm
Streaming mode	License SW v7.1 required
Debugging data	disabled
SPI data output	disabled

11.19.6.8. Geofencing alarm settings completed.

11.19.8. Islands Feature

SW License 0007:

Submap islands

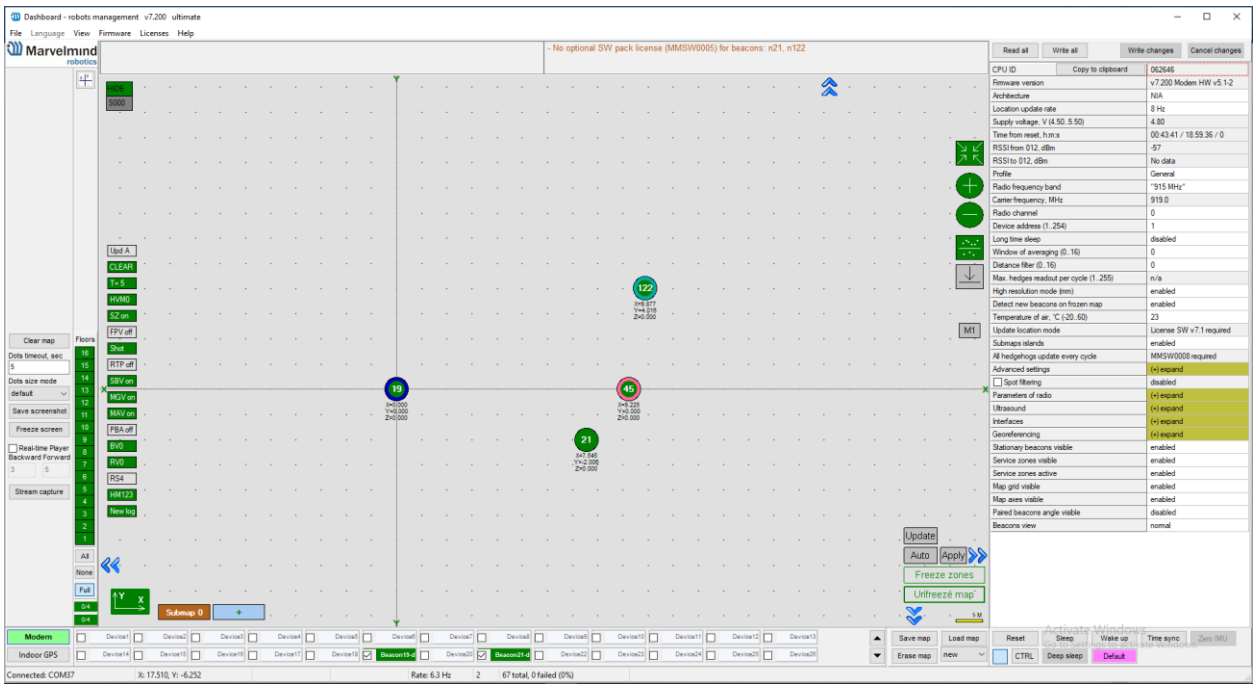
Price per beacon.

To use the Islands Feature, license MMSW0007 is needed, as well as Marvelmind SW from version 7.200 and the latest.

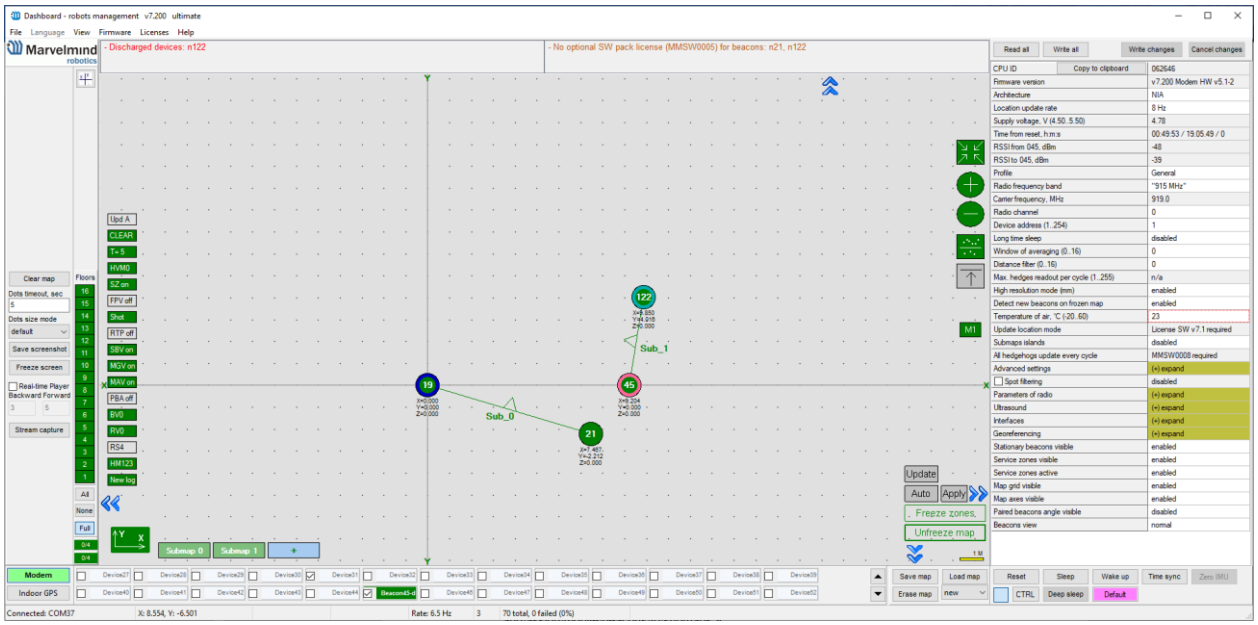
This feature allows you to make different submaps for each hedge.

How to do this (it's an example with 2 submaps. 4 stationary beacons, and 2 mobile beacons):

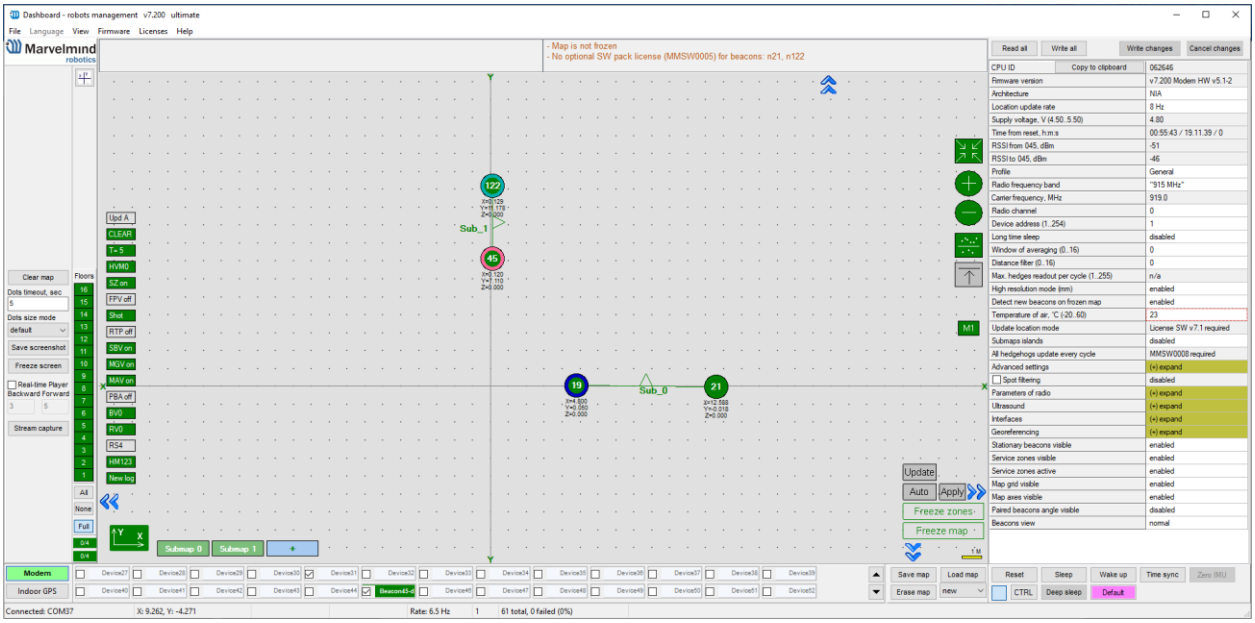
- Awake all 4 stationary beacons (Click on it with the Left mouse button):



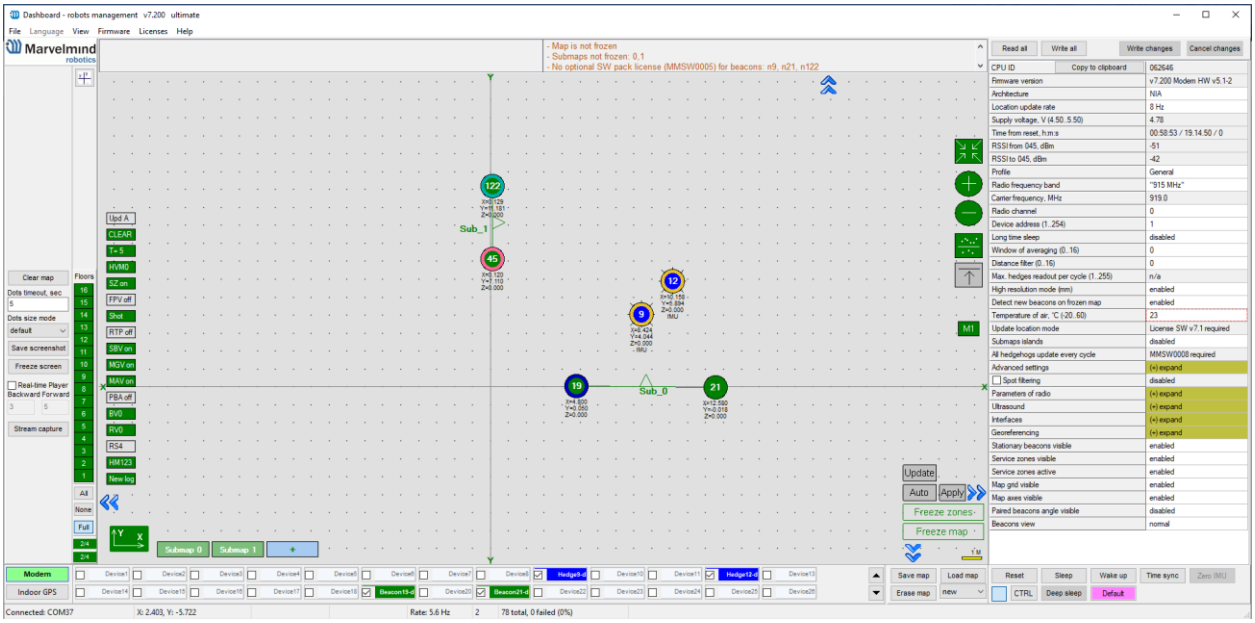
- Leave 2 of them on Submap0 and move another 2 on Submap1. You will get 2 separate submaps.



- Move submaps as you wish. Use CTRL and mouse roll to rotate Submap.



- Awake mobile beacons. It will appear on a map.

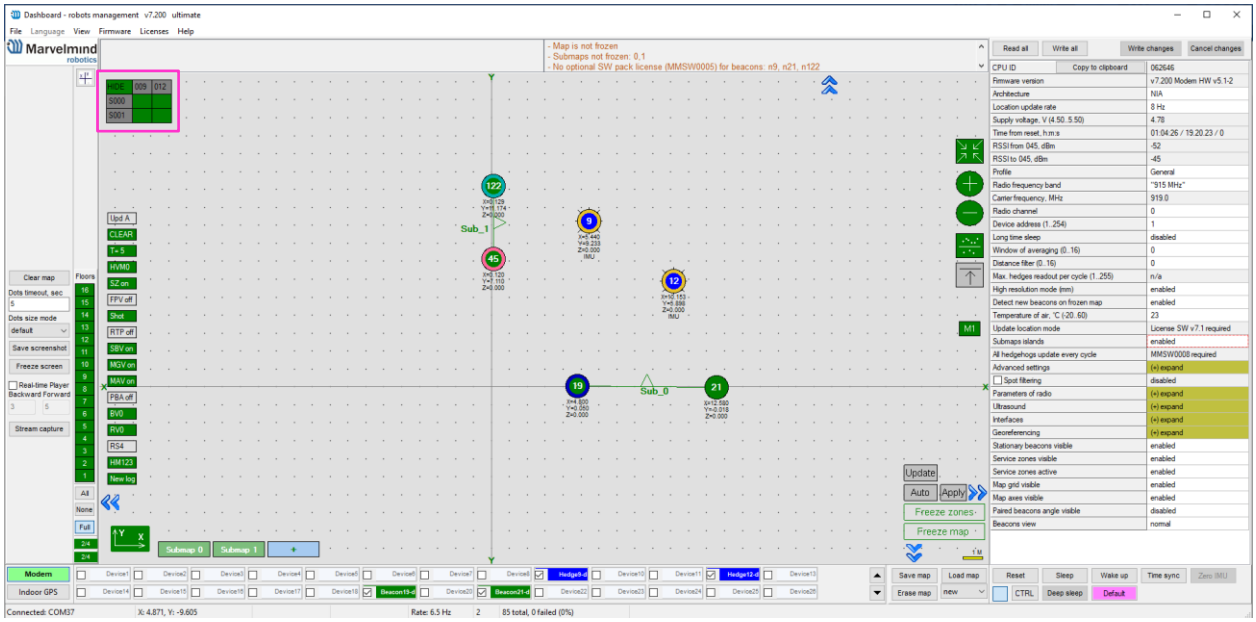


- If the license is activated correctly, you can select the “islands” mode with a selected modem and assign mobile beacons to submaps.

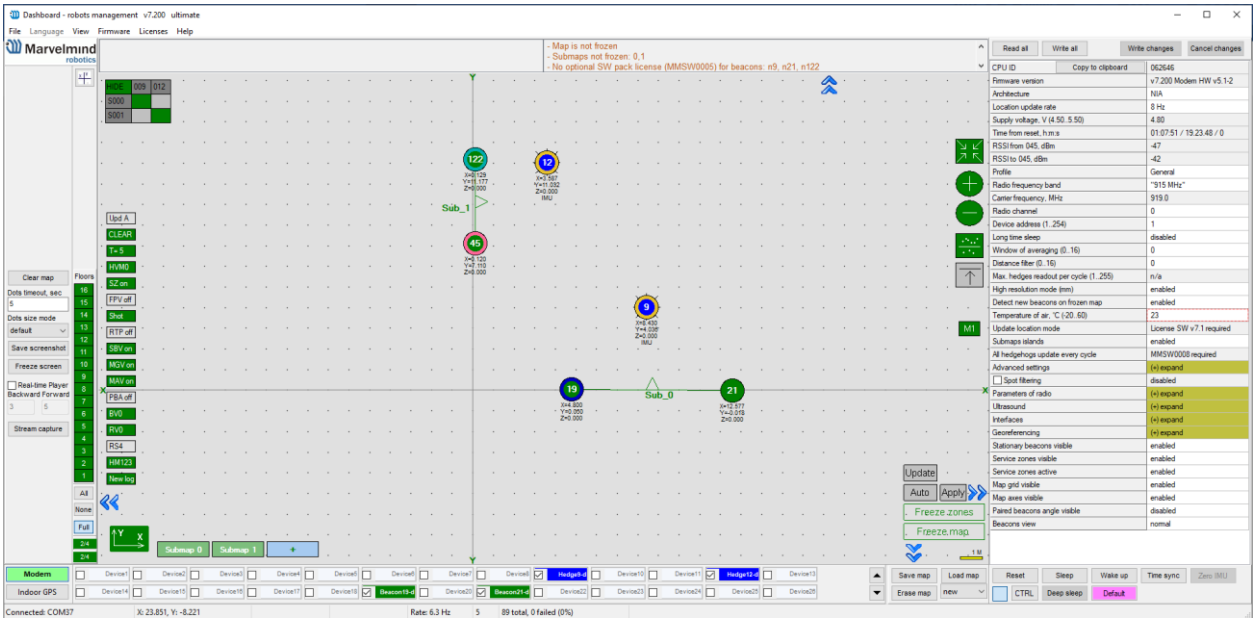
- Enable Submaps islands.

Max. hedges readout per cycle (1..255)	n/a
High resolution mode (mm)	enabled
Detect new beacons on frozen map	enabled
Temperature of air, °C (-20..60)	23
Update location mode	License SW v7.1 required
Submaps islands	disabled
All hedgehogs update every cycle	MMSW0008 required
Advanced settings	(+) expand
☐ Spot filtering	disabled
Parameters of radio	(+) expand
Ultrasound	(+) expand
Interfaces	(+) expand
Georeferencing	(+) expand

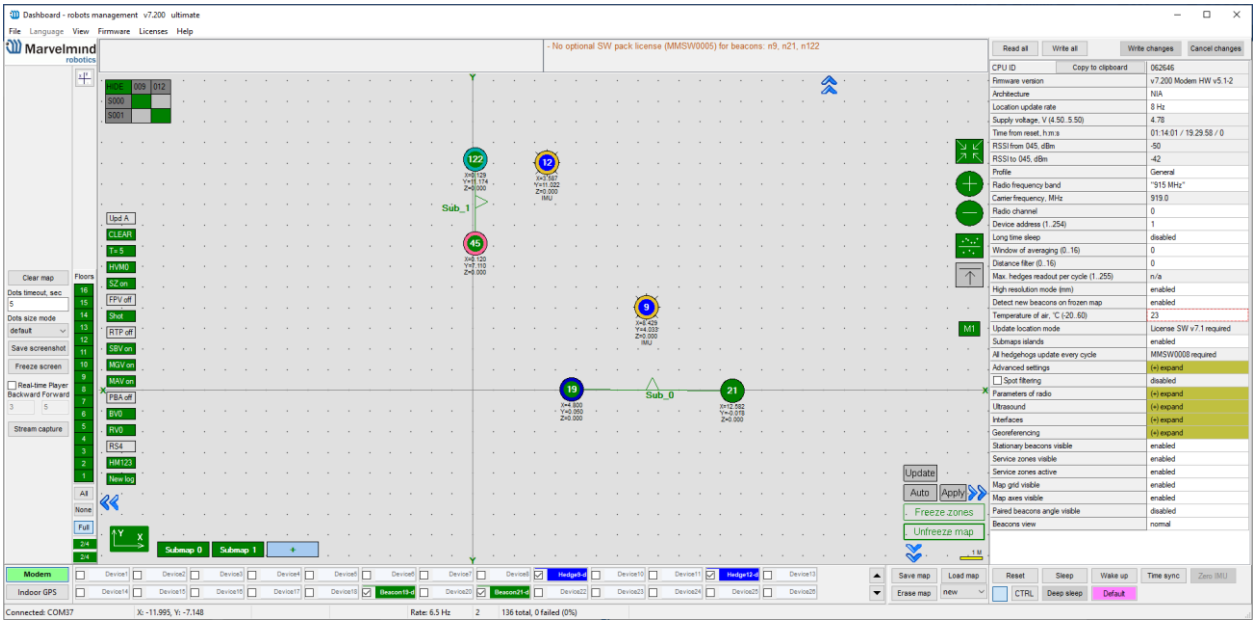
- When Submaps Islands mode is enabled, you can choose a submap for each beacon.



- Now mobile beacon 12 will work with Submap 1 and mobile beacon 9 will work with Submap 0.



- Freeze each submap and Freeze the map.



- Islands feature setup is completed.

11.19.9. All Hedgehogs Update Every Cycle

SW License 0008:

All hedgehogs' location update in every cycle (in MF NIA and NIA)

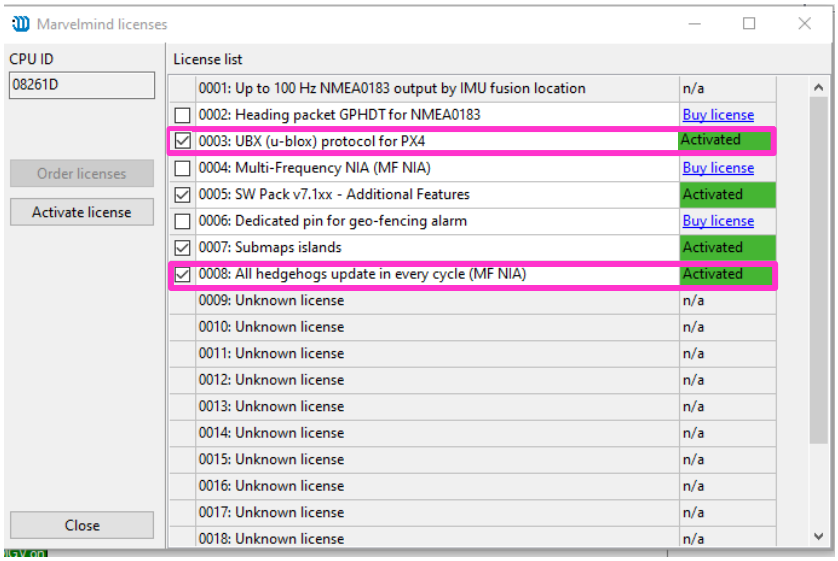
Price per beacon.

To use the “All hedgehogs update every cycle” feature license, MMSW0004 (MF NIA) and MMSW0008 are needed, as well as Marvelmind SW from version 7.200 and the latest.

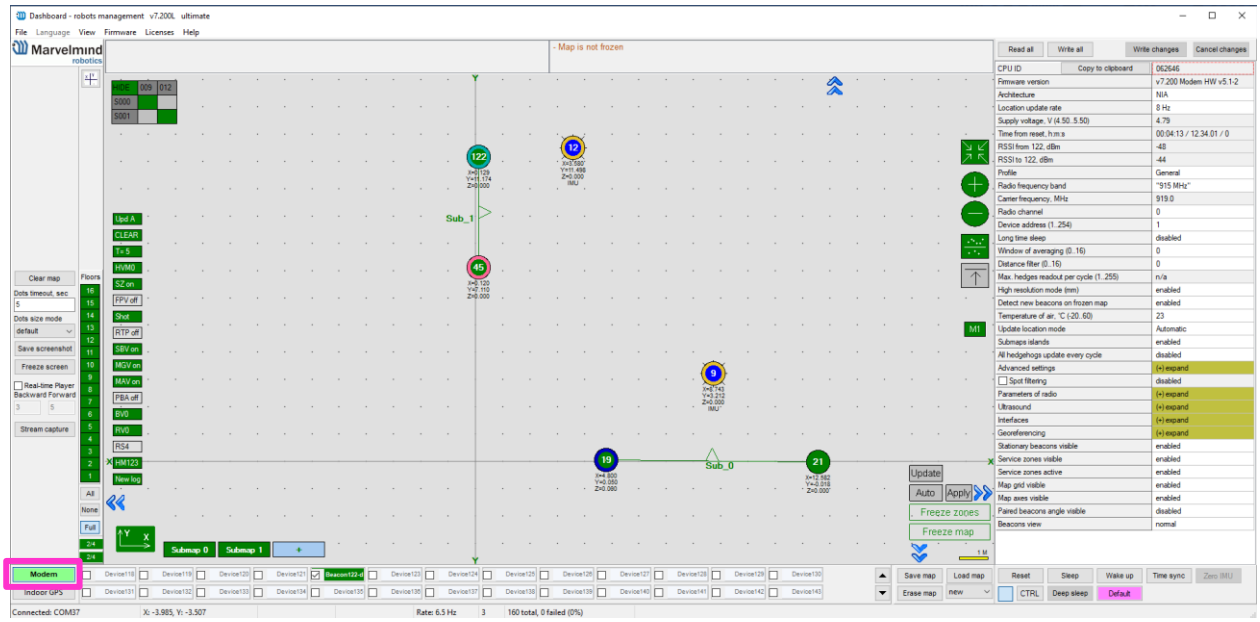
This feature emits all mobile beacons in MF NIA simultaneously (to increase the update rate in cases where it is known that they won’t interfere with each other).

How to use it:

- Make sure that licenses MMSW0004 and MMSW0008 are activated for all beacons in the system:

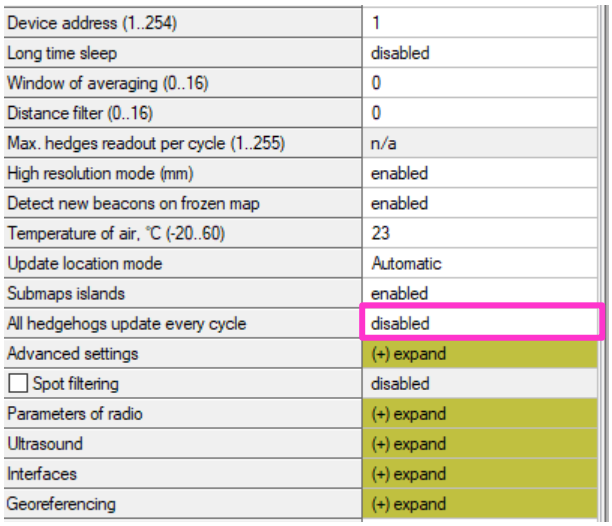


- Choose modem:



Marvelmind robotics

- Enable “All hedgehogs update every cycle” in the settings bar. Left mouse click on disabled (if feature switched off)



Device address (1..254)	1
Long time sleep	disabled
Window of averaging (0..16)	0
Distance filter (0..16)	0
Max. hedges readout per cycle (1..255)	n/a
High resolution mode (mm)	enabled
Detect new beacons on frozen map	enabled
Temperature of air, °C (-20..60)	23
Update location mode	Automatic
Submaps islands	enabled
All hedgehogs update every cycle	disabled
Advanced settings	(+) expand
☐ Spot filtering	disabled
Parameters of radio	(+) expand
Ultrasound	(+) expand
Interfaces	(+) expand
Georeferencing	(+) expand

- Now all mobile beacons update every cycle.

11.19.10. Ultrasound + IMU Sensor Fusion

SW License 0009:

Ultrasound+IMU sensor fusion post-processing.

Price per mobile beacon.

This feature requires MMSW0009 license.

A typical location update rate of indoor positioning systems or GPS is ~8-16Hz, which is enough for most industrial applications, but not for all.

A practical way to increase the location update rate to 100Hz and more is to use IMU and ultrasound sensor fusion that combines the best of both sources of data: a very fast update rate and robustness of IMU and absolute coordinates and no drift of the ultrasound positioning system.

Typical application of the fast indoor positioning system with sensor fusion:

- Fast mobile objects: karting or quick industrial machinery
- Fast sports: half-pipe ski jumpers, indoor bike parks, BMX tracks, skate parks, etc.

More info:

- Fast indoor positioning system based on IMU sensor fusion
- Fast indoor positioning system based on IMU sensor fusion (Video)

Currently tested and supported in IA only. Support in NIA and MF NIA is coming in future. Additionally, tested and supported by Super-Beacon and Modem HW v5.1, other hardware may be supported on request.

11.19.11. RS485 Instead of Radio

SW License 0010:

RS485 instead of radio.

Price per beacon.

This feature requires MMSW0010 license.

This feature allows connectivity between the Super-Modem and Stationary Industrial beacons via RS485 wired interface instead of the radio in an ISM band. It is beneficial when radio connectivity is either not available, subject to interference, or must be hidden.

Supported devices:

- Super-Modem
- Industrial Super-Beacon-Plastic
- Beacon Industrial-RX

11.19.12. API for Manual Distance Measurement

SW License 0011:

API for manual distance measurement.

Price per beacon.

This feature requires MMSW0011 license.

This feature allows you to manually measure distance from beacon to beacon based on the API command.

In regular use of the system, the operations are split between two distinct modes:

1. Building the map of stationary beacons
2. Using the map of stationary beacons for positioning mobile beacons

In mode 1, the system automatically and constantly builds a table of distances between the stationary beacons within a submap until the user freezes the submap or distances in the table of distances confirming that they are correct.

The API for Manual Distance Measurement enables manual measurement between beacon and any other beacon in the system. The feature assumes there are no submaps anymore. The distance can be measured from any beacon to any beacon.

Supported devices:

- Super-Beacon
- Industrial Super-Beacon-Plastic
- Beacon Industrial-RX
- Beacon Mini-RX
- Modem HW v5.1
- Super-Modem

11.19.13. Location Update Rate Boost

SW License 0012:

Location update rate boost.

Price per beacon.

This feature requires MMSW0012 license.

The feature optimizes (minimizes) timing between the location updates. As a result, the location update rate is boosted by 20-100%, depending on the initial configuration: Marvelmind Indoor Positioning System location update rate and user data transfer rate table.

It is done for the expense of elimination of time slots normally occupied by advanced telemetry and data transfer. Thus, advanced telemetry (waking up new beacons while the map is already frozen, for example) or user payload data transfer is unavailable. After freezing the map, no changes to the configuration are possible. But as a result, a higher location update rate is achievable.

It is recommended to use all other recommendations along with the feature to achieve the truly **high location update rate of 40+Hz** for small submaps.

See for more details:

- How to increase the location update rate and reduce latency?
- Marvelmind Indoor Positioning System location update rate and user data transfer rate table

Supported devices:

- Super-Beacon
- Industrial Super-Beacon-Plastic
- Beacon Industrial-RX
- Beacon Mini-RX
- Modem HW v5.1
- Super-Modem

Supported architectures:

- IA
- NIA
- MF NIA

11.19.14. Virtual Pen Drawing

SW License 0013:

Virtual pen drawing.

Price per mobile beacon.

This feature requires MMSW0013 license.

This feature allows using a mobile beacon as a virtual pen and drawing track on a display or projector. It is possible to wipe or move the mobile beacon without a trail by turning the mobile beacon ~±90.

Supported devices:

- Super-Beacon
- Industrial Super-Beacon-Plastic
- Beacon Industrial-RX
- Beacon Mini-RX
- Omni-Microphone-IP67
- External Microphone-IP67
- Modem HW v5.1
- Super-Modem

Supported architecture:

- IA

Recommended configuration:

As infrastructure:

- 2 x Super-Beacon with different frequencies, for example, 31kHz and 45kHz placed on the wall above the screen
- 1 x Modem HW v5.1, as a controller connected to the Dashboard or computer

As a “virtual pen”:

- 1 x Super-Beacon with Omni-Microphone-IP67 (soldering not required) or
- 1 x Super-Beacon with External Microphone-IP67 (soldering required) or
- 1 x Mini-RX with Omni-Microphone-IP67 (soldering required) or
- 1 x Mini-RX with External Microphone-IP67 (soldering required)

An External Microphone-IP67 or Omni-Microphone-IP67 will be a “tip of the pen” for easy drawing.

It is recommended to use along with Location update rate boost for the highest update rate and the lowest – the most comfortable drawing.

See for more details:

- How to increase the location update rate and reduce latency?
- Marvelmind Indoor Positioning System location update rate and user data transfer rate table

11.19.15. Marvelmind API via UDP

SW License 0014:

Super-Modem API via UDP.

Price per Super-Modem.

This feature requires MMSW0014 license.

Super-Modem also supports Marvelmind API via UDP. In future, the whole system will be available via TCP or UDP via Dashboard.

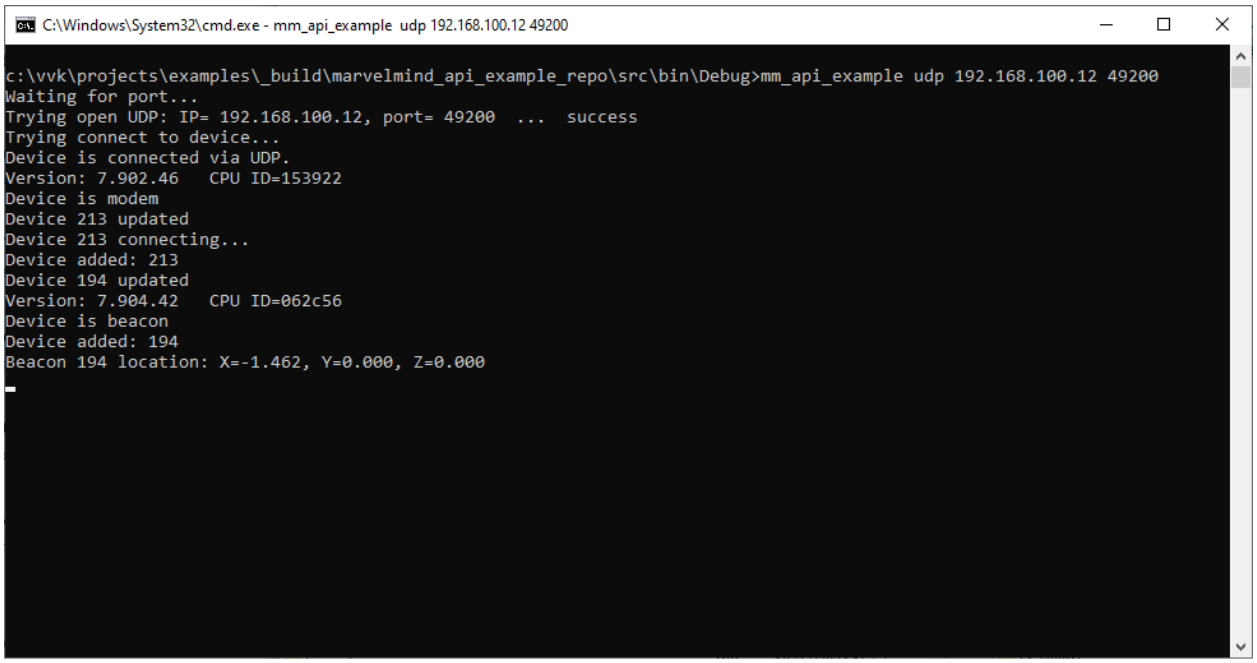
Link for the Marvelmind API chapter.

To enable this feature, enter the IP address and API port in the setting of a Super-Modem:

Wi-Fi/UDP settings	Write Wi-Fi/UDP	(-) WirelessNet-80
Wi-Fi		enabled
Wi-Fi network name		WirelessNet-80
Wi-Fi network password		**********
Show password		disabled
☑ Wi-Fi reconnect timeout, sec (10..65000)		120
Static IP		disabled
Static IP address		n/a
Router IP address		n/a
Wi-Fi RSSI, dBm		-56
Own IP address		192.168.100.12
UDP destination IP address		192.168.100.24
UDP destination port (0..65535)		49100
UDP port for API (0..65535)		49200

See the complete instructions here (Chapter 10)

Below is an example of a connection of Marvelmind API to Super-Modem via UDP:



Marvelmind robotics

11.19.16. Automatic Submap Self-Calibration

SW License 0015:

Automatic submap self-calibration.

Price per self-calibrating submaps.

The license MMSW0015 is required for this feature.

Submap periodically measures the distance between its beacons, compares it with manually entered by user reference distance, and calculates the calibration coefficient, which can be used for tracking in this and other submaps.

After receiving the coefficient from the reference submap, it will be sent to other submaps for more accurate tracking. There can be as many reference submaps as needed, in case if temperature in several reference submaps differs from each other. Non-reference submaps can be referred to as any reference submap.

Additionally, users can adjust self-calibration interval. Increasing its value will decrease the frequency of adjusting the coefficient, vice versa decreasing its value will increase the frequency of adjusting the coefficient but will load the system more.

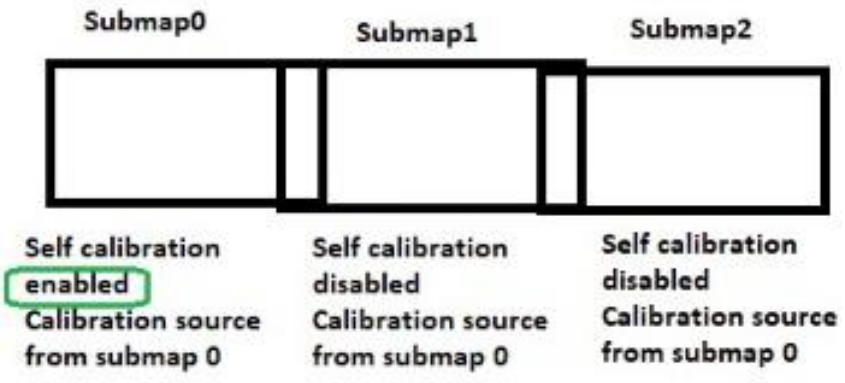


Figure 1. Absolute calibration based on reference submap 0

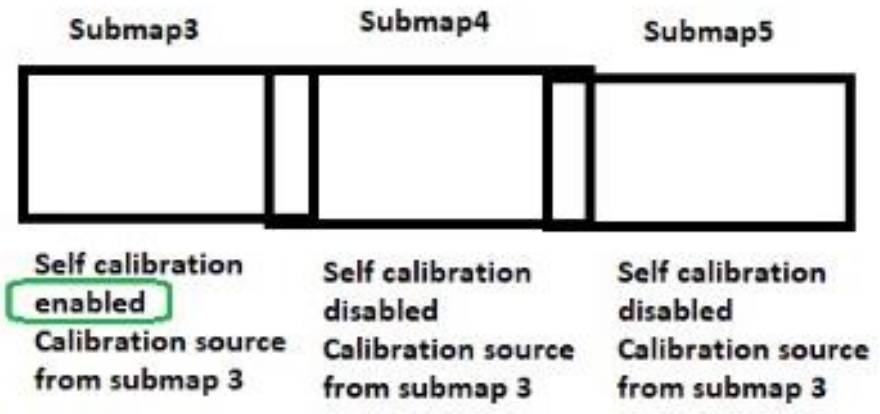


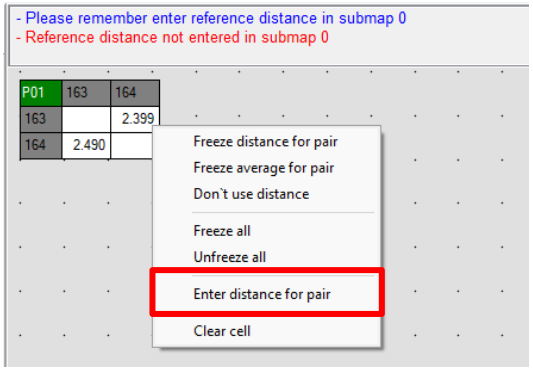
Figure 2. Absolute calibration based on reference submap 3

Below are instructions on how to enable this feature:

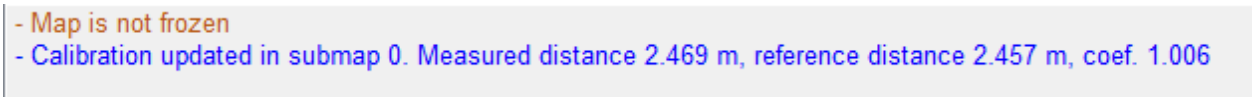
1. Enable the MMSW0015 license on a modem (one per submap)
2. Select a reference submap and enable Self-calibration

Plane rotation Y, degrees (-360.00..360.00)	0.00
Plane rotation Z, degrees (-360.00..360.00)	0.00
Self-calibration	enabled
Self-calibration interval, min (1..255)	5
Calibration source	from submap
Get calibration from submap (0..255)	0
Stationary beacons visible	disabled
Service zone visible	enabled

3. For the reference submap, the “Get calibration from submap” value should be the number of a submap itself (ex. Ref. submap number – 0, “Get calibration from submap” = 0)
4. Change “Self-calibration interval” if necessary
5. Enter the absolute distance (physically measured distance) between the beacon pair in a reference submap



6. The coefficient will be updated and ready for use



7. Select a non-reference submap, change “Calibration source” to “from submap,” and change the number to a number of a reference submap

Self-calibration	MMSW0015 required
Self-calibration interval, min (1..255)	n/a
Beacons for self-calibration	n/a
Calibration source	from submap
Get calibration from submap (0..255)	0
Real-time player	(+) expand

Now, submap 1 will be referred to an absolute distance coefficient in referenced submap 0. Any number of submaps can be referred to a referenced submap.

11.19.17. UDP Streaming

SW License 0016:

UDP streaming support.

Price per modem.

This feature requires MMSW0016 license.

This feature enables data streaming of data via UDP.

Supported devices:

- Super-Modem for native UDP streaming directly from the Super-Modem via UDP over Wi-Fi
- Modem HW v5.1 for streaming from the Dashboard via any IP, for example, Wi-Fi or Ethernet

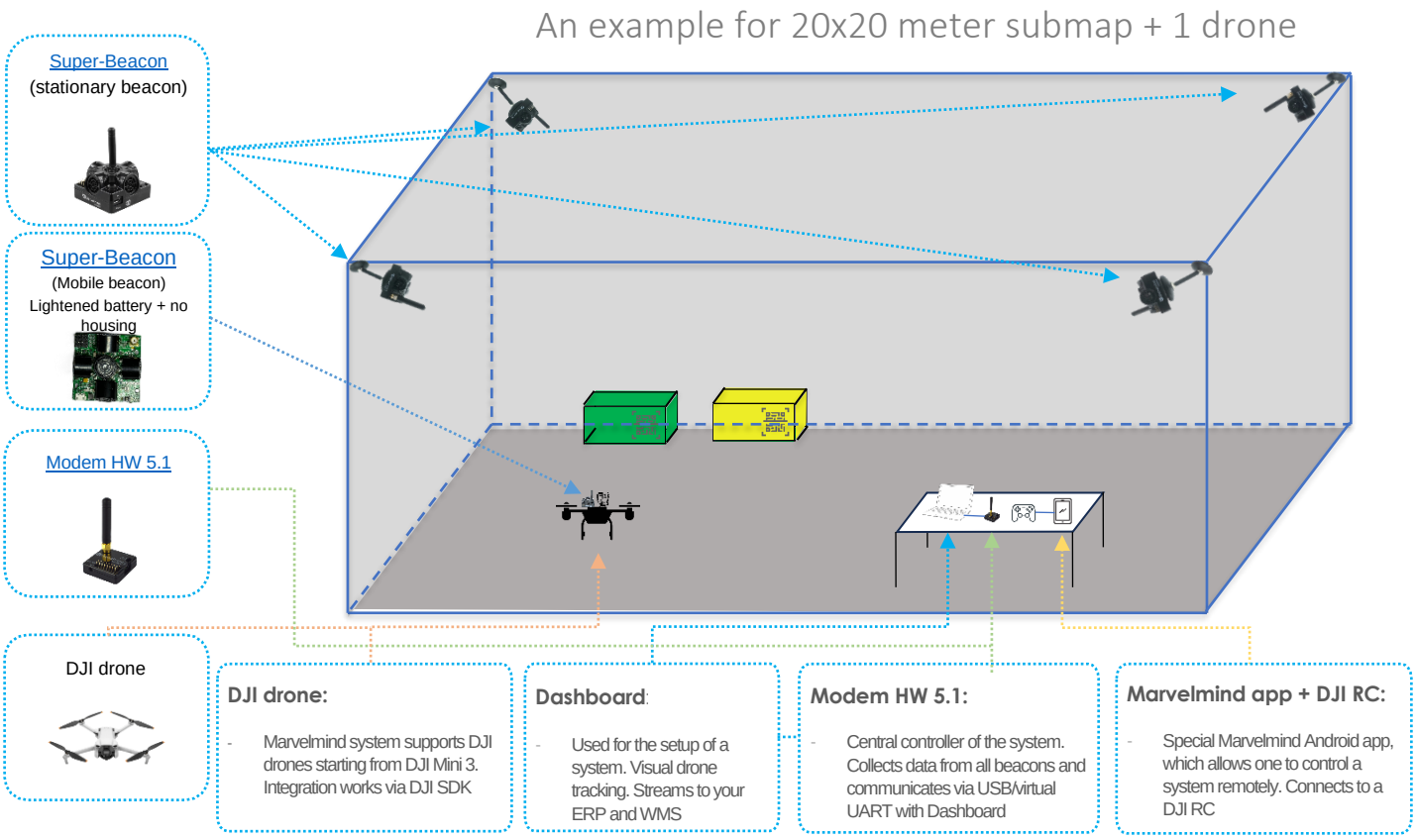
More info:

- Marvelmind Interfaces

12. Solutions

12.1. Autonomous DJI Drones Indoors

Marvelmind provides a solution for integrating Marvelmind Indoor “GPS” system with DJI drones. Using the DJI SDK, we provide tracking and control DJI drones using DJI RC and Android phone with a Marvelmind app.



Task:

- To provide an autonomous indoor flight for DJI drones
- Automatically take pictures, scan QR codes, send location data

Solution:

- Marvelmind Indoor “GPS” system with a Marvelmind app for autonomous flight

Principle of operation:

- The Marvelmind Indoor GPS system in this configuration provides tracking an autonomous flight of a DJI drone using DJI SDK

Result:

- DJI drones autonomously flying according to waypoints in Dashboard, taking pictures or scanning and recognizing QR/bar codes, and sending them along with their precise coordinates to WMS or ERP
- Autonomous return to the base

Configuration:

1. 4 x Super-Beacon – stationary beacons
2. 1 x Super-Beacon (lightened) – a mobile beacon
3. 1 x Modem HW 5.1 – a central controller of a system
4. 1 x DJI drone – a trackable object (see the list of supported DJI drones below)
5. 1 x DJI RC + Android phone with a Marvelmind DJI app – a controller of an autonomously fly pattern of a drone
6. 1 x Windows/Linux laptop – used to install Dashboard and set up a system

List of supported drones:

DRONE	RC	EARLIEST COMPATIBLE VERSION OF MSDK
MATRICE 350 RTK*	DJI RC Plus	5.4.0
MATRICE 300 RTK*	DJI RC Plus	5.4.0
MATRICE 300 RTK*	DJI RC Enterprise with Screen	5.0.0
DJI MINI 3	DJI RC N1	5.3.0
DJI MINI 3 PRO	DJI RC N1 DJI RC Pro	5.3.0
DJI MAVIC 3 M*	DJI RC Pro Enterprise	5.2.0
DJI MAVIC 3 ENTERPRISE SERIES*	DJI RC Pro Enterprise	5.1.0
MATRICE 30 SERIES*	DJI RC Plus	5.0.0

**Expected to work well because it supports MSDK 5.0 but wasn't tested. We can perform your tests by request. Request us by email info@marvelmind.com*

13. Frequently Asked Questions

Here we will answer the most common questions

1 What is the proper way to place the beacons?

- The actual distance between beacons must be ≤ 30m. Provide the line of sight from one beacon to a minimum of two others

2 How far can beacons be located from the modem?

- In the open space, the distance from the modem to the beacon can reach several hundred meters

3 What if the hedgehog is shown as an orange circle or transparent inside the Dashboard?

- **Blue** - normal mode and confident tracking
- **Orange** - system provides the best location data possible, but confidence is lower than blue
- **transparent** - lost radio packets or no ultrasound coverage

4 What is the obstacle for ultrasound?

- The natural obstacles for ultrasound are walls (concrete), glass, and metal. If you need to cover a multiple-floor territory, you can use our Submap feature, in which case the tracking will not be interrupted

5 How the system works in very low and very high temperatures?

- System is designed for normal office-like conditions and temperatures 0 ºC - 40 ºC
- You can see some other types of beacons (outdoor, explosion safe, etc.) in the comparison table
- We can also produce some special versions which will suit your case. Please write to info@marvelmind.com

6 Are beacons resistant to explosions, dust, dirt, water, and noise?

- - Low-frequency noise (motor noise, industrial equipment) does not interfere with the normal operation of the system
- You can see some other types of beacons (outdoor, explosion safe, etc.) in the comparison table

7 What is the time of delay between positioning the object and responding?

- The delay is directly proportional to the update rate. For example, if the update rate is 16 Hz, the delay is 1.2:1.5x60ms
- The limit is 1.5 times the maximum distance between the stationary beacons. Please follow the instructions in the attached screenshot to expand the service area. Notice that positioning the mobile beacon far from stationary beacons and close to their plane may result in increased positioning error because of lousy geometry of measurement

8 How do I define IMU or not IMU beacon?

- Check the white sticker on the box and the beacon's bottom /IMU - with IMU
- Connect beacon via USB: Dashboard => View => Accelerometer data

9 Can we use a non-IMU beacon as a mobile beacon or not?

- Yes, you can (https://www.youtube.com/watch?v=A4aRsjH2-_E)

10 What is the reason to choose 915Mhz vs 433Mhz?

- The 915MHz version is designed for the US, Canada, and the Americas in general. The ISM band (license-free band for industrial, science, and medical applications) in those countries is 915MHz
- In Europe, it is 433MHz

11 Devices do not connect via USB?

- Use a USB cable with a long metal part. If you have any problems with the USB connection, change the cable first. One cable can work for one device and do not work for other

12 Does the orientation of the beacon matter?

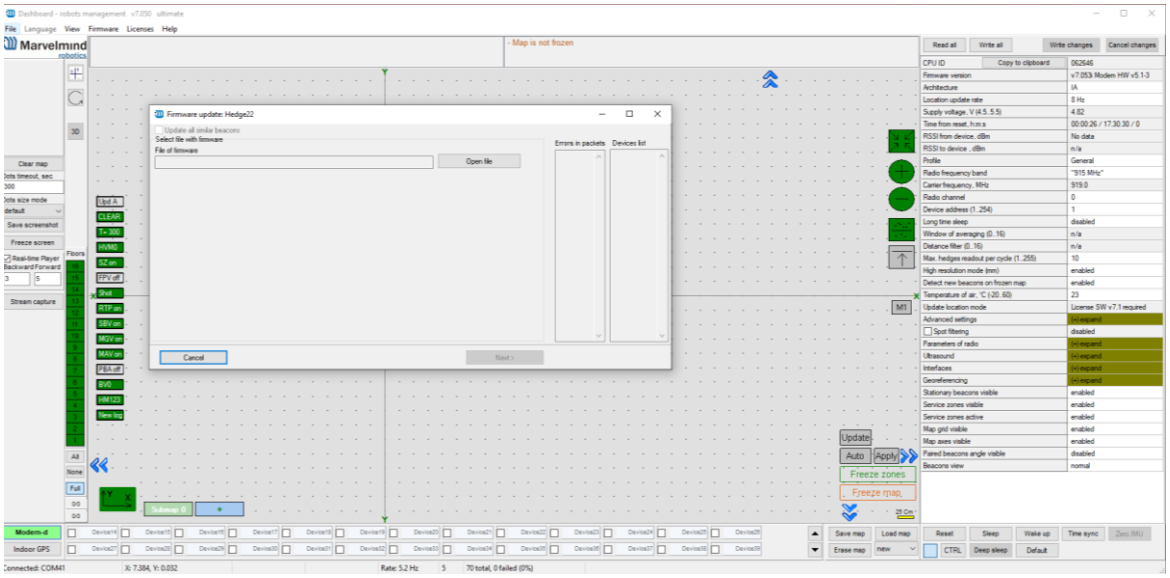
- Yes, it is. Place and orientate it in positions where sensors can “hear” each other. v4.9 beacon has ≈90° per sensor coverage(illustration), Mini-RX and Industrial-RX have ≈180° coverage(illustration)

13 Why Dashboard does not see more than 4 beacons

- System has a limitation of 4 beacons per submap. If you have more than 4 beacons, create another submap, and beacons will appear

14. Troubleshooting Checklist

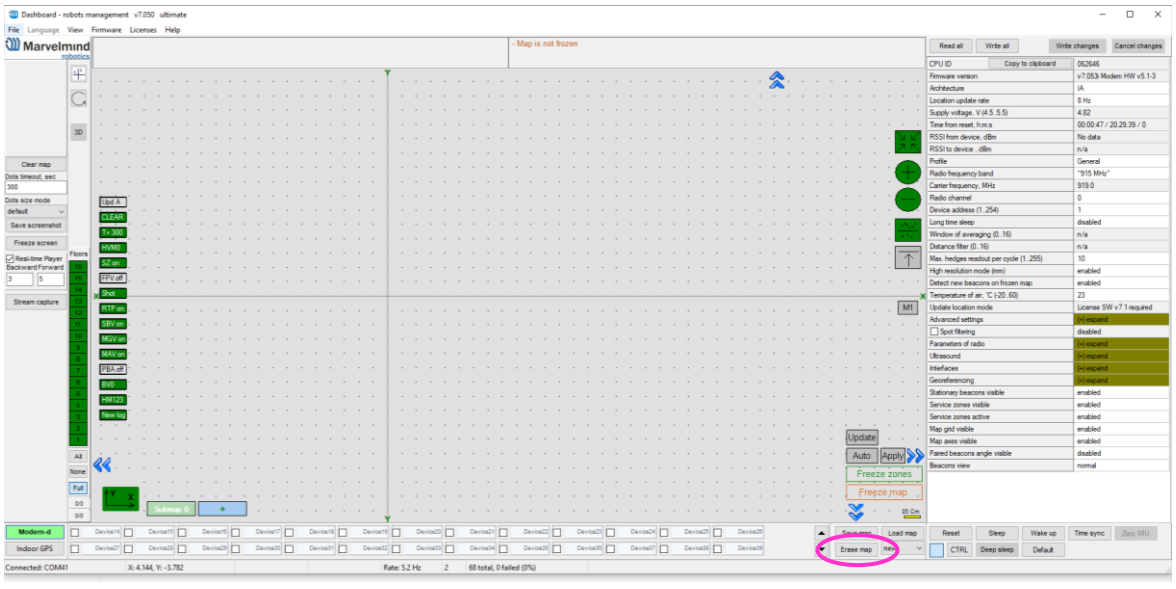
If you have any problems with the system, follow these simple steps:



- **Update SW** on modem and beacons

- Now, connect all beacons and modem one by one and press the **Default** button in the Dashboard (When updating the SW, please press the **Default** button to make sure that beacons have default settings. Otherwise, the modem may be calling on the wrong channel or something)

- Press **Erase map** when the modem is connected to the PC



Check our help video:

[Typical mistakes with Precise Indoor “GPS”]

14.1. Checklist Before Starting the System:

IA and NIA SW differs
For IA, you should use stationary beacons with different frequencies
Make sure that you use the correct SW. Inverse Architecture(IA) SW for Inverse system, Non-Inverse Architecture(NIA) SW for Non-Inverse system (Architectures comparison)
Make sure that your beacons are 3.5V and higher before using them. If not, charge it for 2-3 hours.

- Keep modem 1-2m away from beacons. if closer, the beacon radio may be overloaded
- Antenna's recommendations:
  - The antenna must be kept as straight as possible. Otherwise, it will reduce the effective range
  - The antennas must be kept away from conductive materials, such as metal and carbon, by at least a half-inch
  - Keep the antennas away from the motors and other noise sources as much as possible
- Use a USB cable with a long metal part. If you have problems with the USB connection, change the cable first. One cable can work for one beacon and not work for other
- Be sure that you use SW from the same pack
- When updating the SW, please press the Default button to make sure that beacons really have default settings. Otherwise, the modem may be calling on the wrong channel or something
- Start with a simple configuration (10x10m square, 2 stationary beacons)
- Do not obstruct the line of sight between beacons
- Build the map first, freeze it, then wake up the "hedge"
- Number of periods. By default – 5 for HW v4.9. 20 for Super-Beacon, 50 for Mini-TX. For longer distances, you can put 10-50

Mini-RX beacon may be over-discharged. In that case, do the following:

- Turn off the beacon with DIP switches
- Charge it for 1 hour
- Turn the beacon on, flash the latest SW via DFU Programming, and charge it for 1 hour again

15. Contacts

For more information about the company, check About us

For additional support, please send your questions to info@marvelmind.com