# Marvelmind Indoor Navigation System
# Operating manual

v2020_07_15

www.marvelmind.com

# Table of contents

# Version changes

**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 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
- Architectures 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
- Architectures comparison improved
- Receiving and transmitting angles illustrations added (v4.9 chapter and Mini-RX chapter)
- 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 setup handover zones between submaps to guarantee handover quality for complex maps with multi-floor and similar
- New feature: default wireless connection is setting is now 153kbps (used to be 38kbps). Radio profile 153kbps provides radio coverage range nearly as much as 38kbps and update rate nearly as high 500kbps, i.e. it is a middle of 38kbps and 500kbps, combining the best of both
- Correction: USB streaming in power save mode improved
- Correction: Zero IMU button in the Dashboard is improved, while button Reset IMU is removed completely
- Correction: ultrasound TX is not reset to 31kHz when Default button is pressed. Now, several types of ultrasonic frequencies supported, so 31kHz is not anymore default ultrasonic frequency for all beacons
- Improved: both energy saving and tracking quality with Power Saving mode enabled
- Improved: only beacons with selected tick in the Dashboard lower menu will be accepted to the network – not any addresses. This improves predictability of the network, when there many beacons that 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 accelerometer described

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

**V2017_12_29**

- SW features paragraph updates
- General updates
- Sending path to robot
- Radio frequency band switch in latest Dashboard version
- Sending path to robot
- Paired beacons feature described
- Submap feature help video
- Different hedgehog colors in the Dashboard
- FAQ updates

**V2017_11_01**

- Added Sensors settings
- Added Dashboard features
- FAQ
- Fresh Dashboard screenshots
- General updates

**V2017_09_08**

- Added estimation of accuracy of distances measurement
- Added Raw inertial sensors data
- Added Communication of Pixhawk with Marvelmind mobile beacon
- Added Optimal settings for stationary beacons in small and big rooms
- Added Optimal settings for noisy environment

# 1. Executive summary

Marvelmind Indoor Navigation System is an off-the-shelf indoor navigation system, designed to provide precise (±2cm) location data to autonomous robots, vehicles (AGV), and copters. It can also be used to track moving objects via mobile beacons attached to them. Other applications include, for example, forklifts, virtual reality (VR) systems, helmets for construction workers or miners, etc.

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

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

The system can build the map of stationary beacons automatically (For Non-Inverse Architecture). 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 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 (Non-Inverse Architecture) 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

## Key capabilities:

| Parameter | Technical Specifications |
|---|---|
| Distance between beacons | - Reaches up to 50 meters in lab conditions (Mini-RX or Super-Beacon to HW v4.9 with RX4 only)<br>- 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<br>- Coverage for larger territories is provided using submap – like cells in cellular networks |
| Location precision | - Absolute: 1–3% of the distance to the beacons<br>- Differential precision: **±2cm** |
| Location update rate | - 1/20Hz to 25Hz (Ultrasonic based only)<br>- 100Hz with ultrasonic + IMU fusion enabled<br>- Can be set manually via Dashboard software<br>- Depends on the distance between mobile and stationary beacons (shorter distance—higher update rate)<br>- Depends on the number of mobile beacons (Non-Inverse Architecture; for Inverse Architecture no such dependency)<br>- Depends on the radio profile (500kbps vs. 38kbps)<br>- Slightly depends on the number of stationary beacons—dependence is not the same as for mobile beacons |
| Power supply | Internal: 1000mAh LiPo battery (HW v4.9)<br>- Battery lifetime: from 2 days to several months depending on the mode of operations<br>*For other types of beacons look to the comparison table |
| | External: micro USB – recommended for permanent use |
| Weight | Mobile beacon (HW v4.9) from the starter set:<br>- 59 grams (including 1000mAh battery, HW v4.9 housing and 50mm antenna)<br>- 27 grams (HW v4.9, bare board w/o battery)<br>*For other types of beacons look to the comparison table |
| Beacon size | Size: 55x55x33mm (with 50mm antenna: 55x55x65mm) (HW v4.9)<br>*For other types of beacons look to the comparison table |

## 1.1 Legend

Legend chapter contains small icons and signs to highlight some key points of the text.

 - Important

 - For experienced users

 - Demo or Help video

 - Useful link

# 2. Basics of the system

## 2.1 What's in the box

2.1.1 Starter Set Super-NIA-3D:

- 5 x Super-beacons
- 1 x Modem/Router


2.1.2 Mini-RX Starter Set:

- 4 x Mini-RX beacons
- 1 x Mobile beacon (HW v4.9) + IMU (aka "hedgehog")
- 1 x Modem/Router


*This is just an example of two starter sets.
More options you can see on our site: Products

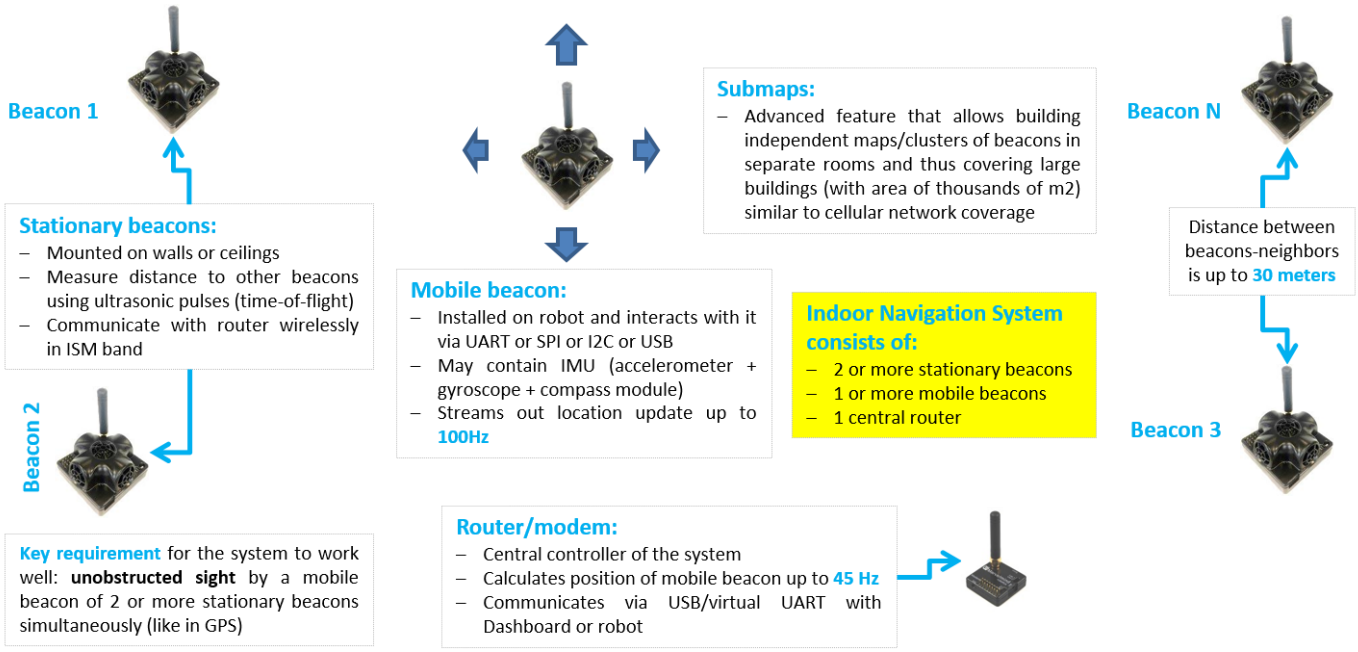
## 2.2 Indoor Navigation System architectures

Marvelmind Indoor Navigation System provides high-precision (±2cm) indoor coordinates for autonomous robots and systems ("indoor GPS"). A brief description of the key elements of the system is given on the scheme below.

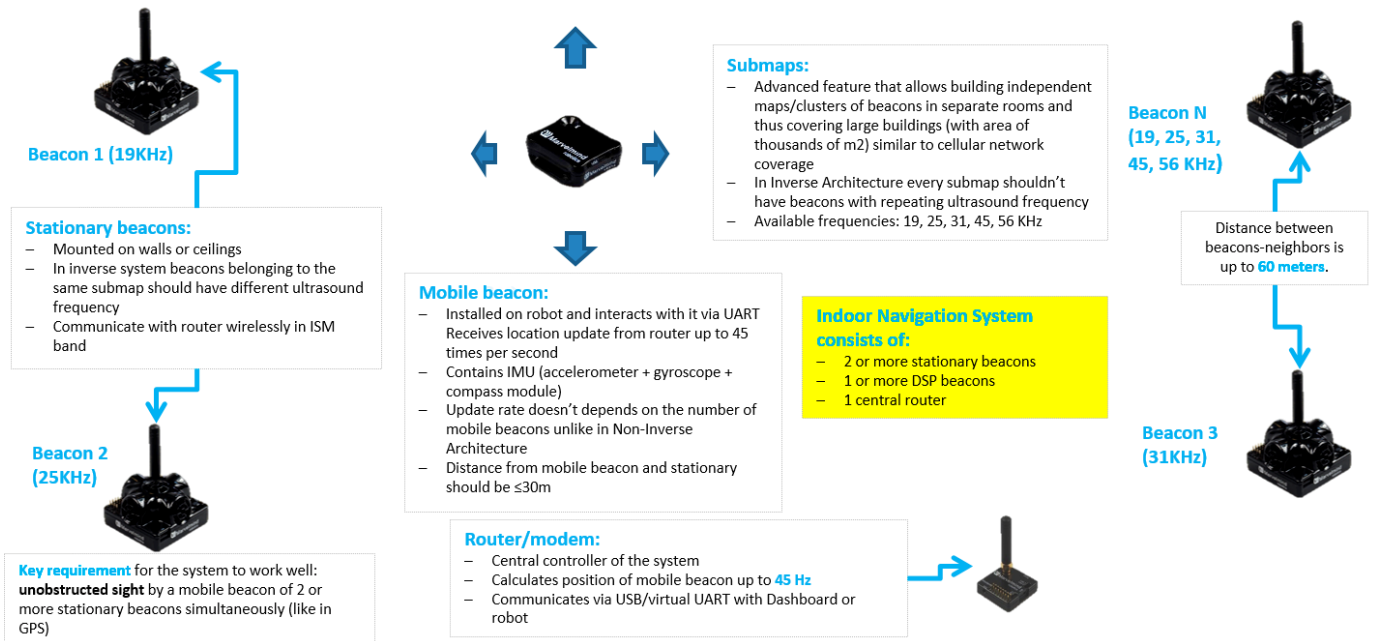
IA and NIA **SW differs**
For IA you should use stationary beacons with **different frequencies**

Below you can see 2 types of architectures: Non-Inverse (NIA) and Inverse (IA):

# Non-Inverse Architecture




# Inverse Architecture



# Architecture comparison

| | Non-Inverse Architecture (NIA) | Inverse Architecture (IA) |
|---|---|---|
| **Typical use cases** | 1-4 autonomous robots/drones. Supported up to 250 beacons<br>When mobile beacon shall be installed on a noisy vehicle, but stationary beacons are in quieter places | Many mobile users (people, robots, VR). Supported up to 250 beacons<br>When mobile beacons are in quieter places |
| **Not recommended** | In applications, where emitting ultrasound of mobile beacon is undesirable | For drones, because mobile beacon is receiving ultrasound. The range may be limited to just 2-5m. Special HW solutions and future SW releases will allow to overcome the limitation |
| **Precision** | ±2cm or better:<br>https://www.youtube.com/watch?v=YAU-WXz26YY | ±2cm or better: https://www.youtube.com/watch?v=OXetXiDyAZI |
| **Location update rate** | Directly depends on the number of mobile beacons (n) as 1/n –TDMA approach<br>Slightly depends on the radio protocol, if low speed profile (38kbps, etc.)<br>Depends on the sizes of submaps. Larger submap – lower update rate<br>IMU fusion is HW and SW supported | Does not directly depend on the number of mobile beacons<br>Slightly depends on the radio protocol (the same as NIA)<br>Depends on the sizes of submaps (the same as NIA)<br>IMU fusion is HW-supported. SW support is coming |
| **Ultrasonic range** | Up to 30m in real life and up to 50m in lab conditions within a submap, i.e. stationary beacons shall be placed every 30m or closer<br>Can cover as large territory as you wish using submaps | |
| **Map building** | Can build a submap automatically, if HW v4.9 beacons are used. Mini-beacons cannot build the map, because they are TX-only | Manual entry of stationary beacons' location or distances between them is required for Beacons HW v4.9, because they work on different ultrasonic frequencies<br>Super-beacons v6.0 allow automatic building of submaps (like in in NIA) |

## 2.3 Indoor “GPS” System close-up and internal view

Here, you can see how system elements look like

- Super-beacon


- HW v4.9 modem (without housing)

- Mini-RX beacon


- Mini-TX

- HW v4.9 beacon with Mini-TX size comparison


- Beacon Industrial-RX


- Beacon Industrial-Super

# 3. System elements

## 3.1 Stationary beacon

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

- The position and orientation of the beacons should be chosen in a way that provides maximum ultrasonic signal coverage. System efficacy strongly depends on the quality of ultrasonic signal received by stationary beacons


*Fig.1: Super-beacon as an example*

- Stationary beacons emit and receive ultrasound during the map configuration period. Once the map is formed and frozen, they only work as the receivers

- Stationary beacons have no exterior differences with regard to mobile beacons

- Inertial measurement unit (IMU) is not installed on the stationary beacons

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

- There are 433MHz and 868/915MHz versions available. A proprietary radio protocol is used for communication and synchronization. Other ISM bands are available upon request as well

- Stationary beacon can be equipped with full-size 165mm antenna (for 433 MHz), which provides more robust radio connection between modem and beacons (for HW v4.9)

## 3.2 Mobile beacon a.k.a. “hedgehog”

- The mobile and stationary beacons can be easily interchanged by selecting in the Dashboard
- The mobile beacons designed to be placed on a robotic vehicle, copter/drone, AGV, or helmet to trace its location. Formally speaking, 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 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*

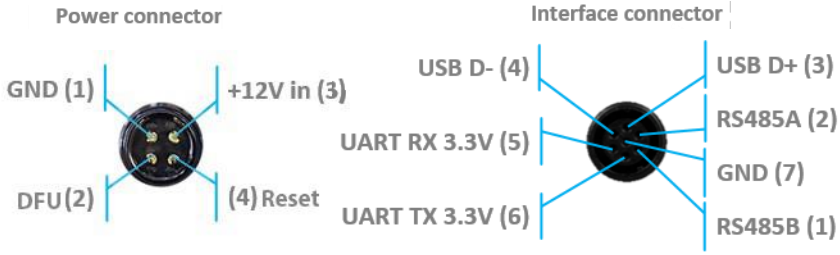
- Its sensors must not be covered with anything that can reduce the strength of ultrasonic signal. For example, the system won’t normally work, if one puts the mobile beacon in a plastic box
- The beacon’s coordinates are updated according to the rate set on the Dashboard
- The system may contain one or several mobile beacons. Current implementation relies on a time-division multiple access approach. 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 Architectures comparison
- Location data is obtained either from the “hedgehog” via USB (virtual UART), UART, SPI, or from the modem/router via USB (virtual UART). More information on interfaces can be found here (Mini-RX and Mini-TX beacons do not have pinouts, only over micro-USB)
- Data from the beacon sent in a streaming format identical to that of GPS (NMEA 0183)
- There are 433MHz and 868/915MHz (868/915MHz only for Mini-RX and Super-Beacon) 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.

## 3.3 Super-Modem


*Fig.1: Super-Modem*

Super-Modem is a superior version of the Modem HW v4.9 with advanced capabilities:

- Super-modem supports all the basic features of HW v4.9 Modem and can be connected over USB to the Dashboard for system tuning and control (Do not forget to power Super-Modem via 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, supports license-free 915MHz ISM band (for example, US, Japan, Korea) and license-free SRD band 868MHz (EU, Russia). Future 433MHz HW variants may come in some months, but no firm schedule yet. You can place orders for 433MHz. When sufficient amount is 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 (similar to Industrial beacons):




- Exactly the same mounting holes as for Industrial beacons
- No battery inside – external power supply (+6..17V) required (for example, https://marvelmind.com/product/converter-220v-12v-ip67/). External battery is not practical for long-term due to relatively high and constant power consumption of 1.5-2W
- 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 both IA and 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


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

-

**Super-Modem's SW update**

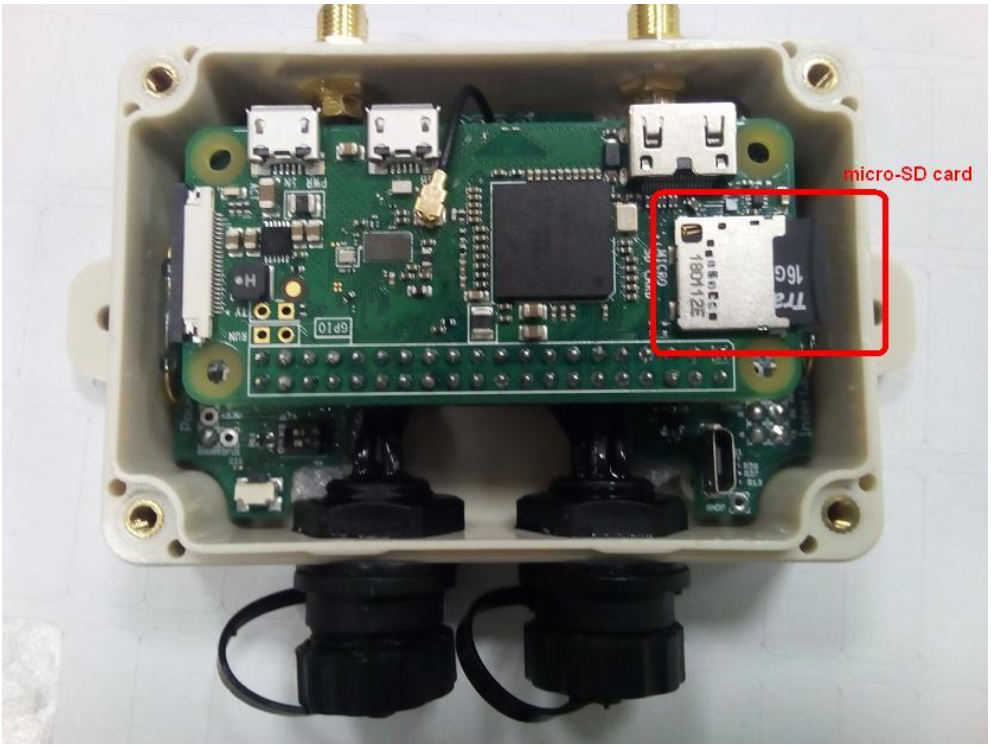
Marvelmind Super-Modem software consists of two parts:

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

Low level firmware is placed in general software package with all Marvelmind software in 'Super-Modem' folder. This firmware can be updated via dashboard (hex file) or via DFU (dfu file) like other firmware in the package. Please refer to Operating Manual for details of updating software via dashboard or dfu.

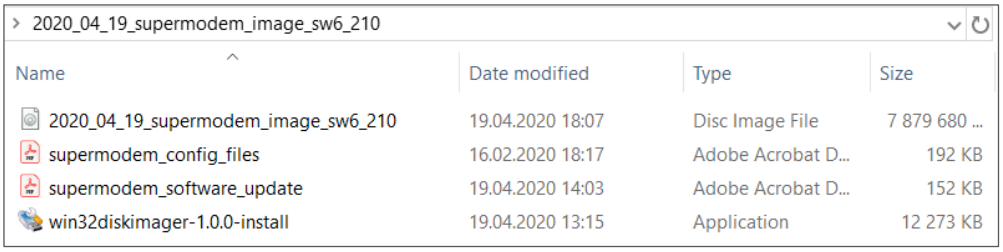
High level software is located on micro-SD card inserted in the Raspberry Pi single-board computer inside Super-Modem. To update this software, you should write on this micro-SD card the image of micro-SD card with updated software. You can download the image on downloads page (https://marvelmind.com/download/). The image is placed in archive separately from general software package because its size is pretty large (archive is about 1.5…2 GB).

Micro-SD card location

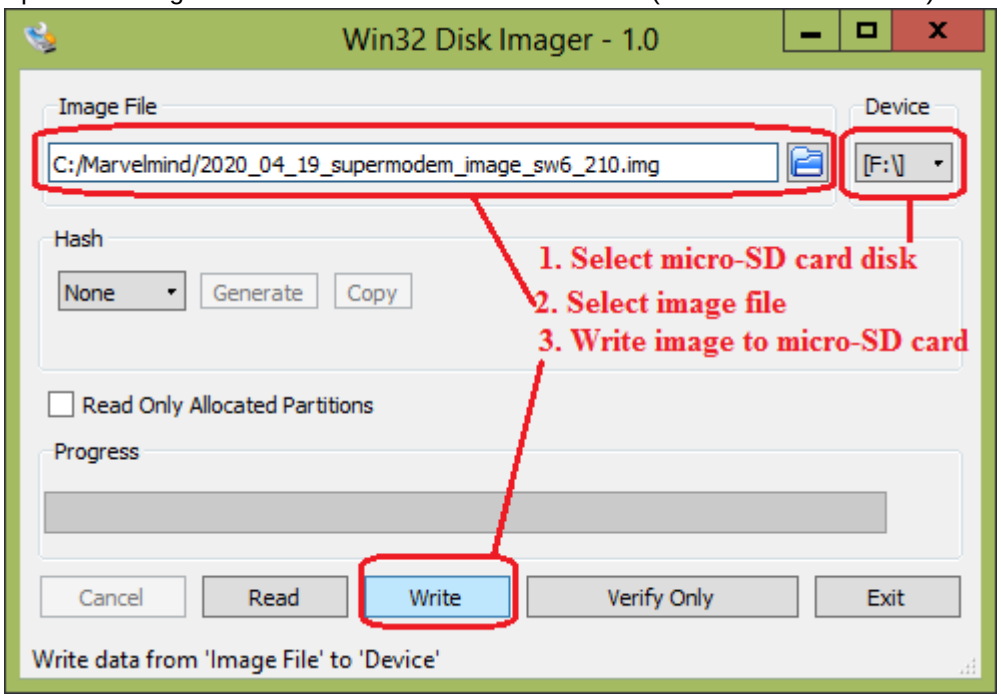


**How to update SW:**

- Open Super-Modem enclosure
- Eject the micro-SD card (Super-Modem should not be powered at this time)
- Insert micro-SD card into any MS Windows computer via card reader
- Download and unpack the archive with image of updated software




- Install and run Win32 disk imager program (supplied in the archive with image)
- Open the image file and write to the micro-SD card (see screenshot below)




- Eject micro-SD card from computer and insert back into Super-Modem
- Close Super-Modem enclosure

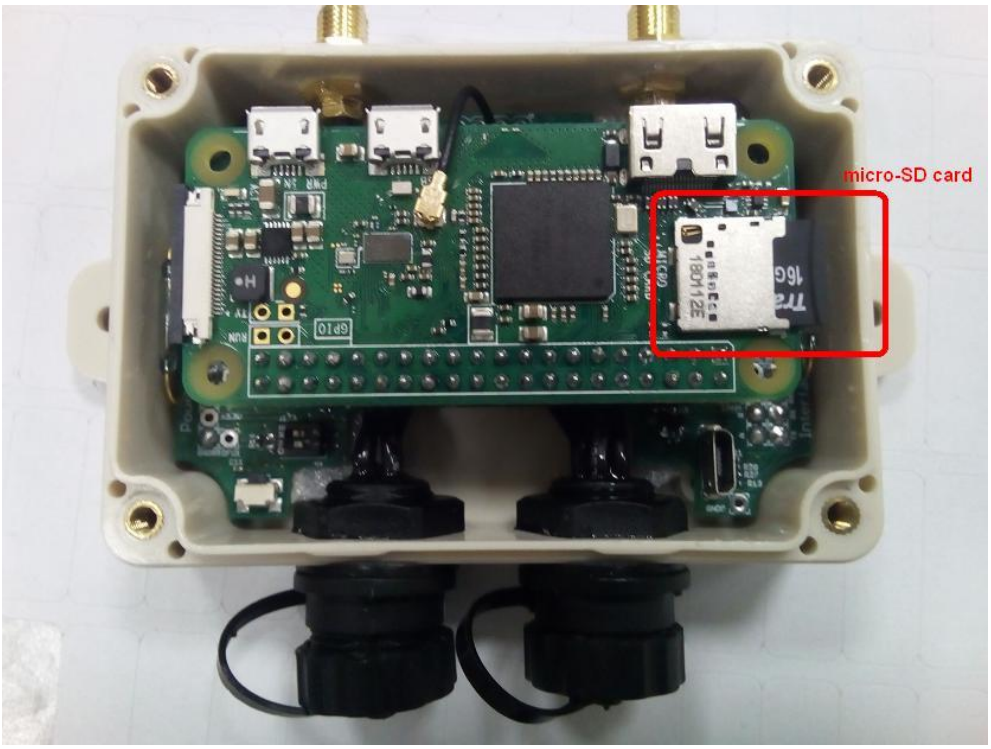
**Super-Modem's configuration**

Marvelmind Super-Modem contains Raspberry Pi single-board computer with corresponding software. Some settings can be modified via configuration files on the micro-SD card inserted in the Super-Modem.

To modify these files, you need to:

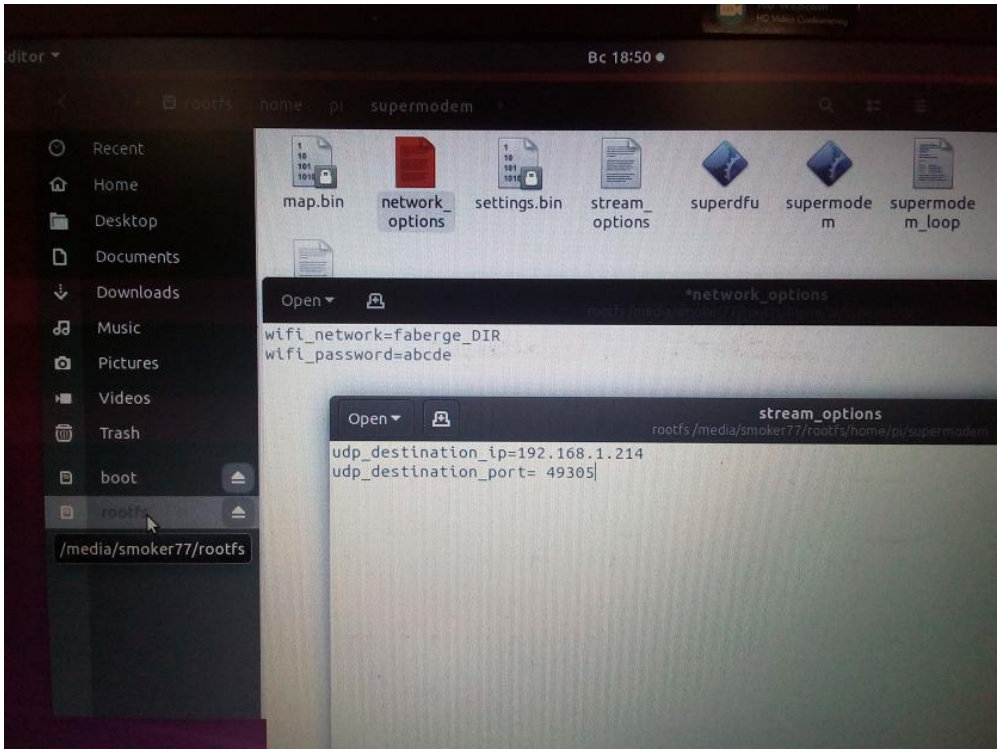
- Open Super-Modem enclosure
- Eject the micro-SD card (Super-Modem should not be powered at this time),
- Insert micro-SD card into any computer with Linux
- Open and modify certain configuration files on the micro-SD card (see below)
- Eject micro-SD card from computer and insert back into Super-Modem
- Close Super-Modem enclosure

Micro-SD card location




When you insert it into computer with Linux, required files are usually located by following path:

***/media/<user name>/rootfs/home/pi/supermodem:***




**Following settings are available:**

In file “network_options”:

- **wifi_network** – name (SSID) of WiFi network to connect
- **wifi_password** – password (PSK) for this network

In file “stream_options”:

- **udp_destination_ip** – IP address in local network where Super-Modem will stream data
- **udp_destination_port** – UDP port where Super-Modem will stream data

## 3.4 Modem

- Modem is the central controller of the system. It must always be powered when the Navigation System is working. It is recommended to use an active USB hub for that purpose or even a regular cellular phone USB power supply. 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 the radius of up to 100 meters with antennas from the Starter Set
- Radio coverage 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

*Fig.1: HW v4.9 Modem*

- There are 433MHz and 915MHz versions available
- A proprietary radio protocol used for communication and synchronization between modem and beacons

## 3.5 Different types of beacons

### 3.4.1 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 both the Non-Inverse Architecture (NIA) and the Inverse Architecture (IA): Architecture comparison.

Supports license-free 915MHz ISM band (US) and license-free SRD band 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 setup, because you don't have to care about turning on and off ultrasonic sensors in order to optimize coverage vs. sensitivity
- The Super-Beacon can receive any ultrasonic frequency from the bands: 19kHz, 25kHz, 31kHz, 37kHz, 45kHz. The filter can be simply 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 as a part of navigation systems. In all cases, beacons shall use the same radio band

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

Demo video: https://www.youtube.com/watch?v=cIA2Gc5KaQI


*Figure 1 Outdoor version (IP54)*

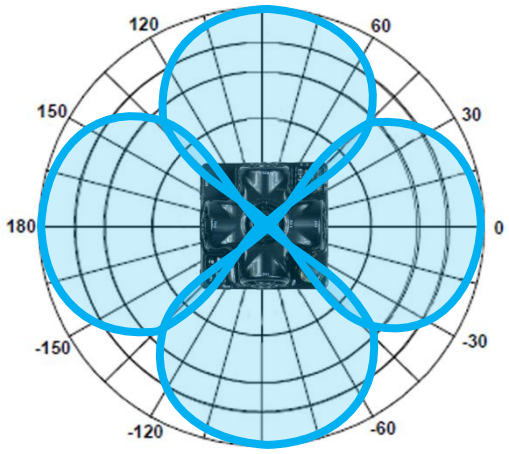



*Figure 2 Transmitting diagram (with sensors)*

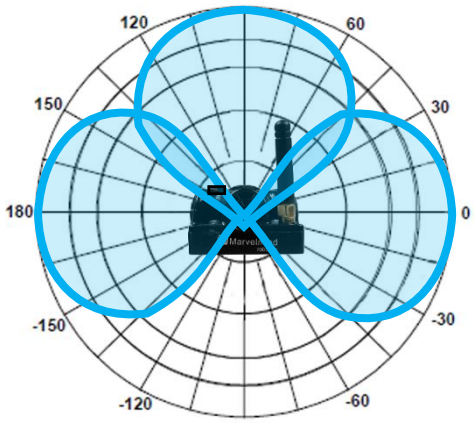



*Figure 3 Transmitting diagram (with sensors)*

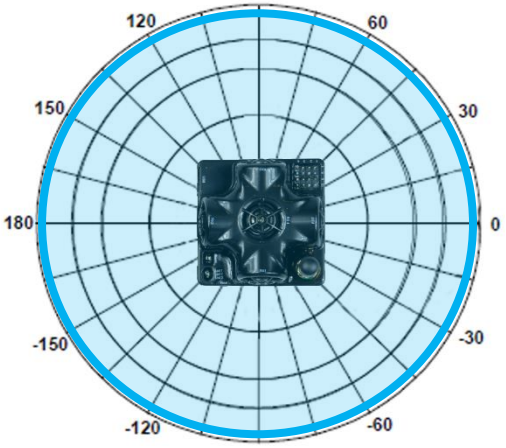



*Figure 4 Receiving diagram (with digital microphone)*

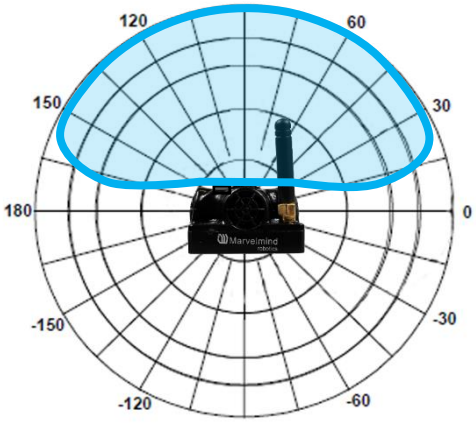



*Figure 5 Receiving diagram (with digital microphone)*

### 3.4.1.1. External microphone extension

This modification of the Super-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.

Length is 25cm (default), may be expanded up to 1m (optional)

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


*Figure 2 Super-Beacon with one external microphone connected*


*Figure 3 Super-Beacon with two external microphones connected*

**External microphones schemes:**

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

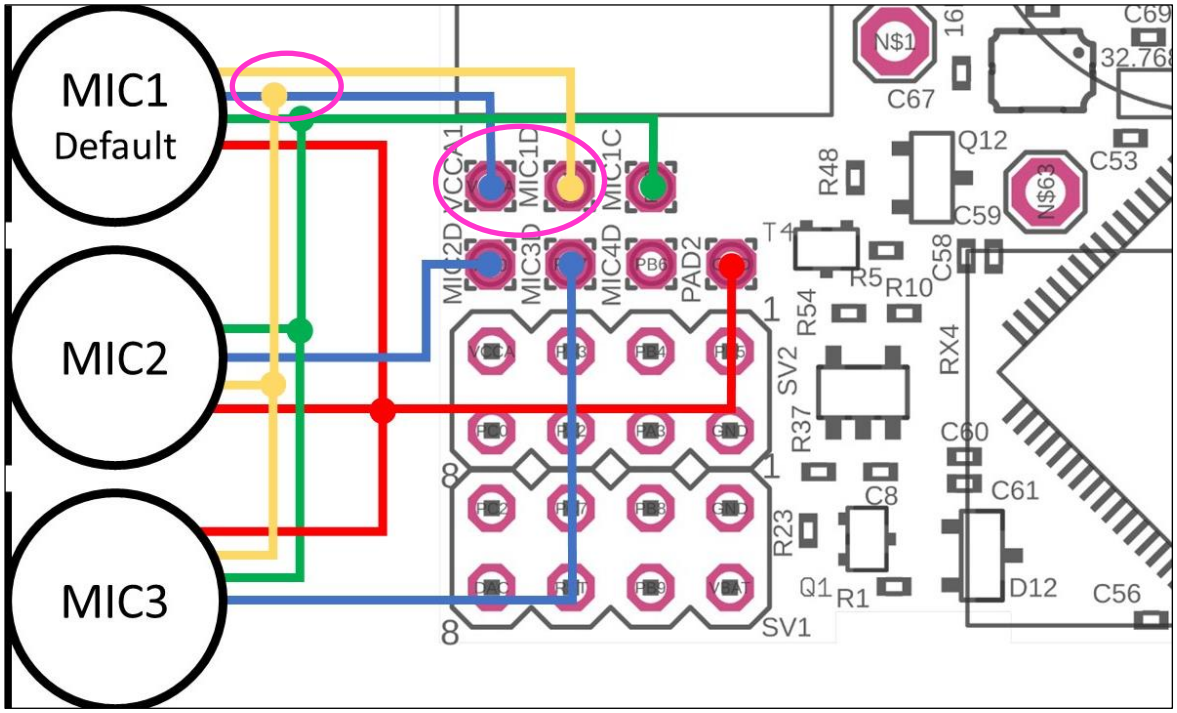



*Figure 4 Connection for beacon with switched blue and yellow wires*

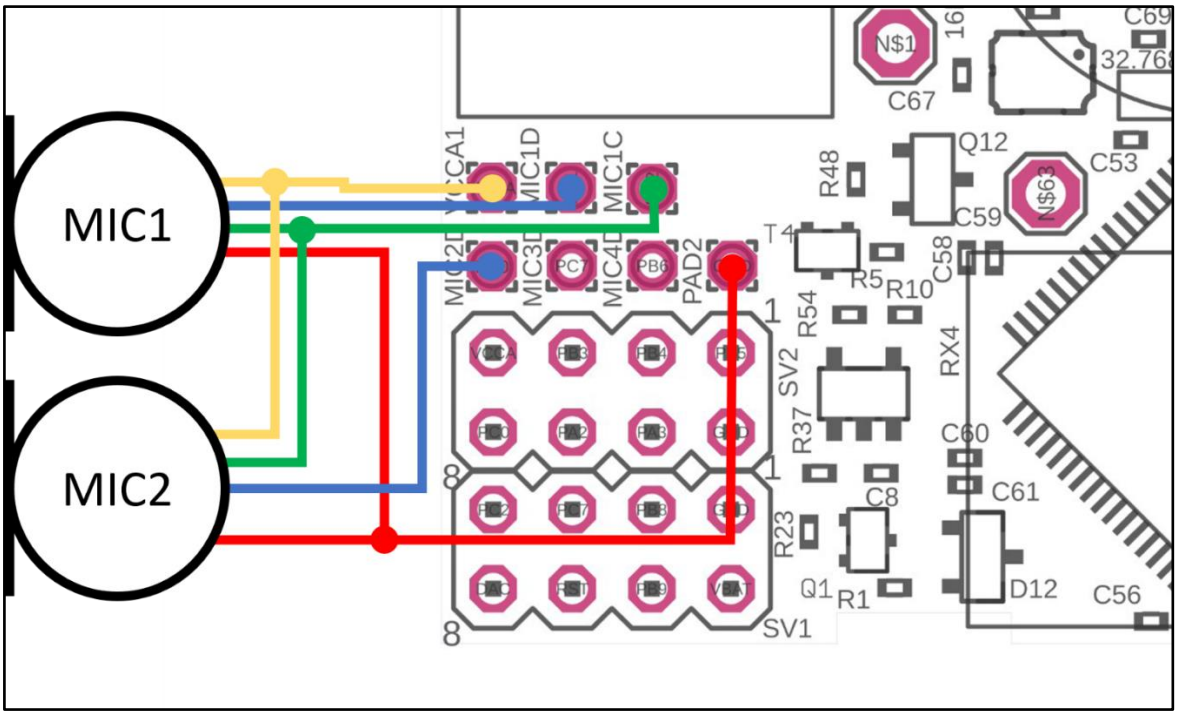



*Figure 5 One external microphone connection*

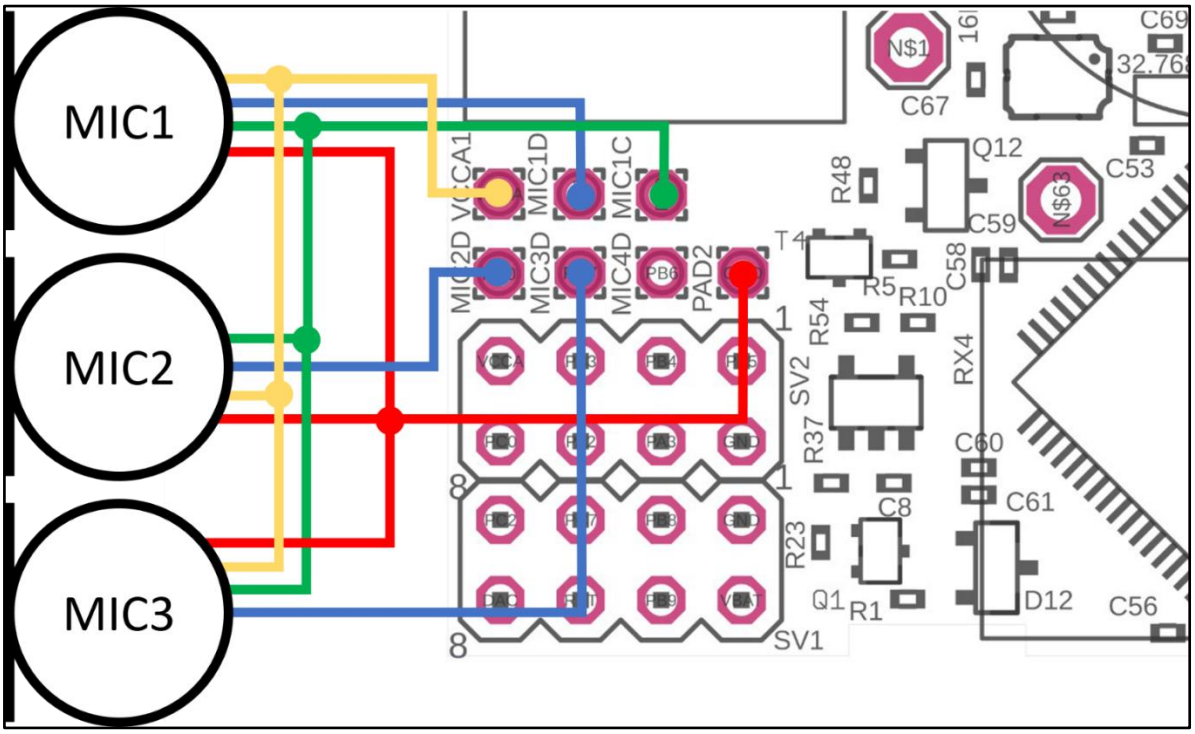



*Figure 6 Two external microphone connection*

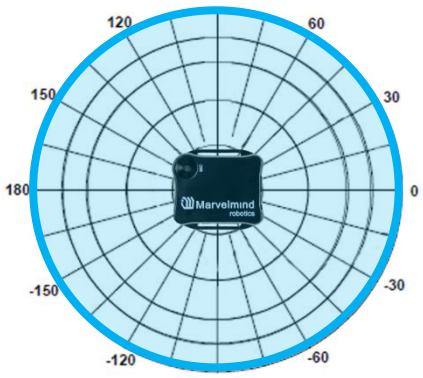
### 3.4.2 Mini-RX beacon

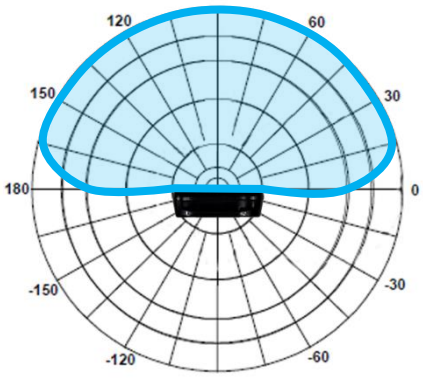
The Mini-RX Beacon can be used in both the Non-Inverse Architecture (NIA) and in the Inverse Architecture (IA): NIA and IA comparison

The Mini-RX beacon HW differs from the regular Beacon HW v4.9 in several ways:

- It is an RX-only beacon, i.e. it can receive, but it cannot transmit ultrasonic signal
- The fact that it is RX-only makes it far more sensitive, i.e. you will get a longer range between Beacon HW v4.9 and Mini-RX v5.xx than between Beacon HW v4.9 and Beacon HW v4.9
- Mini-RX beacon can receive any ultrasonic frequency from the bands: 19kHz, 25kHz, 31kHz, 37kHz, 45kHz. The filter can be simply selected in the Dashboard. At the same time, the working ultrasonic frequency of Beacon HW v4.9 is HW-defined by ultrasonic sensors and can't be changed
- Mini-RX beacon can receive several ultrasonic frequencies at once. That is used in Inverse Architecture. See the comparison: NIA and IA comparison
- The Mini-RX Beacon is significantly smaller than Beacon HW v4.9
- Can play a role of stationary beacon when imputing coordinates manually
- Can play a role of mobile beacon (in IA system)
- Has digital microphone, which is more sensitive than regular sensors
- Supports 868/915MHz radio only
- Light weighted
- Can be water-protected
- The component of the Marvelmind Helmet and Marvelmind Watch
- It has 360° reception angle (horizontally) and 180° reception angle (vertically)

Reception diagram. Digital microphone has about 360° (horizontally) and 180° (vertically) reception angle




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

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

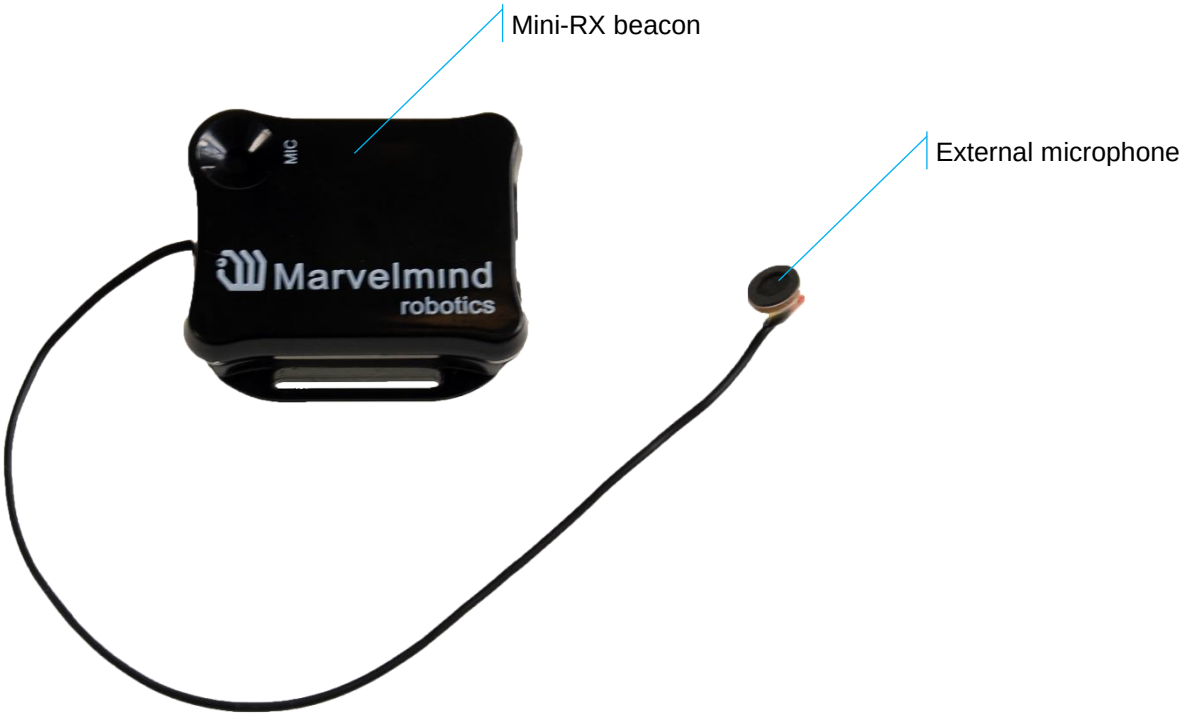
### 3.4.2.1. External microphone extension

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.

Length is 25cm (default), may be expanded up to 1m (optional)

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




Dual microphones modification:

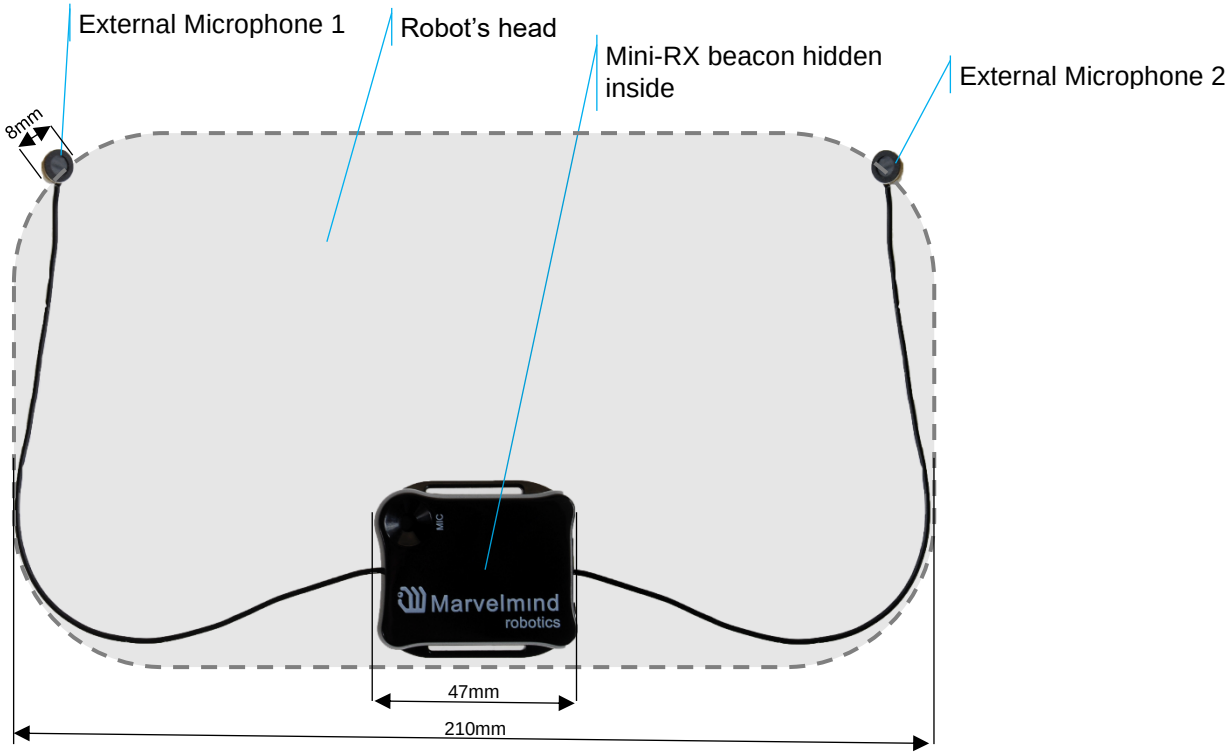


*Figure 7 One external microphone with housing*

*Figure 8 Two external microphones with housing*

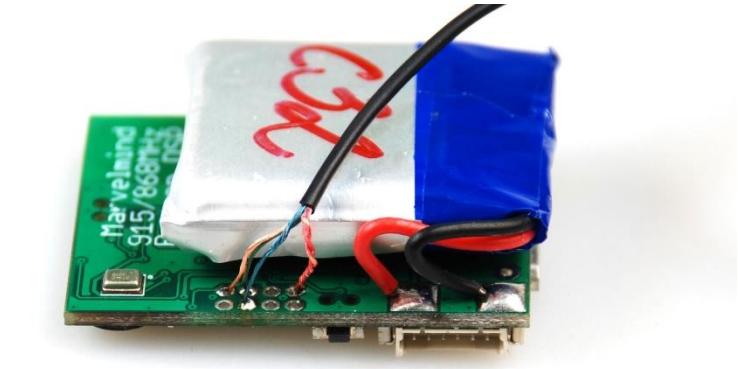


*Figure 9 One external microphone soldering*

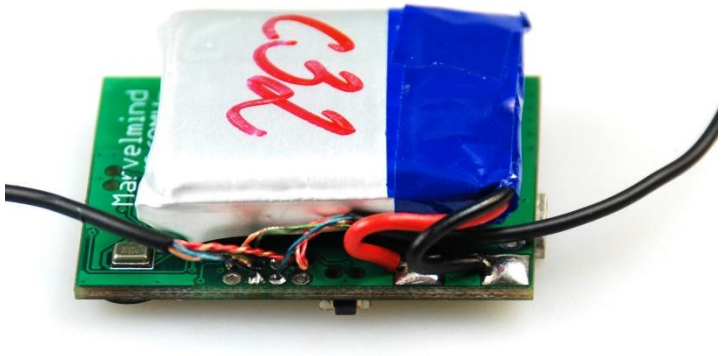


*Figure 10 Two external microphones soldering*

External microphones schemes:

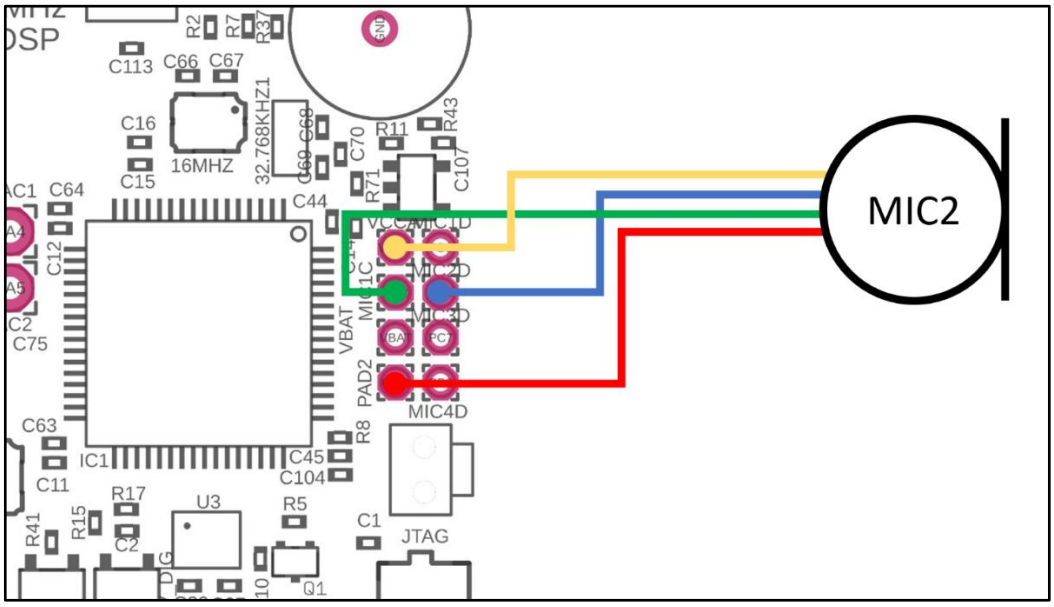



*Figure 11 One external microphone connection*

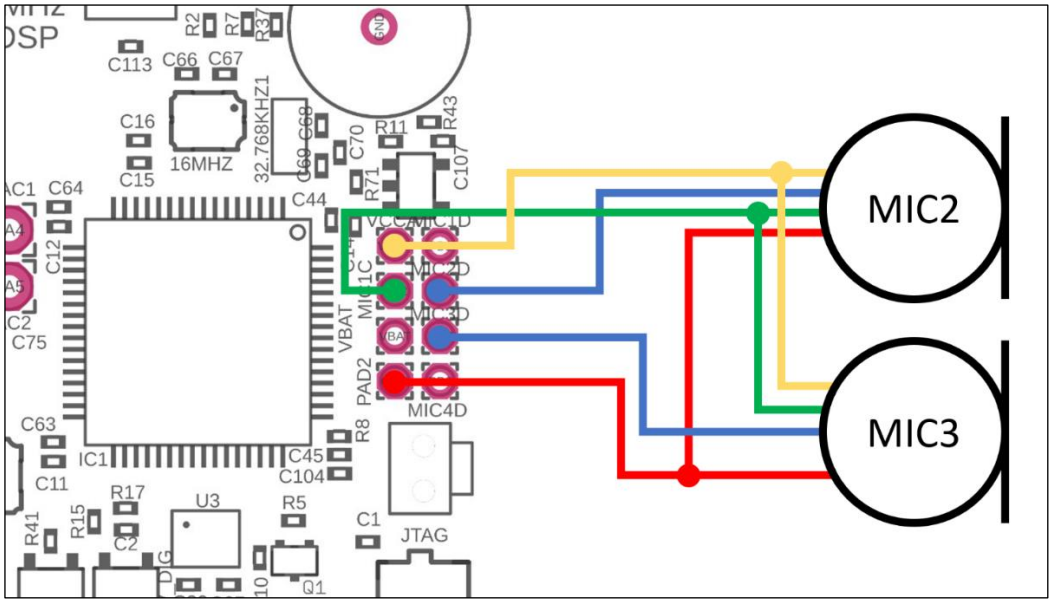



*Figure 12 Two external microphones connection*


*Figure 13 Two external microphones final view*


*Figure 14 Two external microphones final view*

### 3.4.3 Mini-TX beacon

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

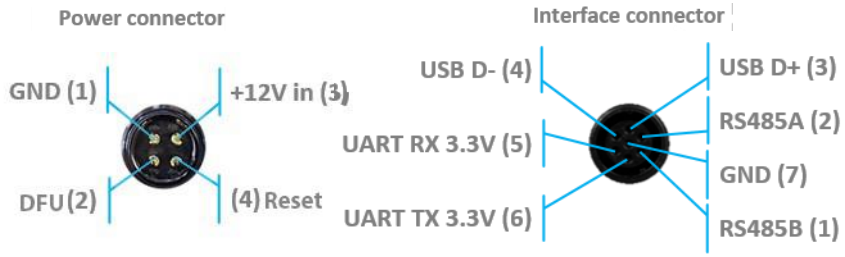

Comparison to Beacon HW v4.9:

- 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. Beacon HW v4.9 is dual use: can receive and transmit ultrasonic
- 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 lower update rate – nearly proportionally longer. Very efficient ultrasonic TX module
- Mini-TX has only USB (virtual UART) output – no additional pins
- Mini-TXs always have embedded IMU – newer and better, but it has 3D accelerometer and 3D gyroscope, but no magnetometer (which we do not recommend using indoors anyway, due to magnetic field distortion indoor)
- Embedded antenna – smaller size, but smaller radio coverage ~50m with regular Modem HW v4.9 as compared with ~100m of Beacon HW v4.9 with Modem HW v4.9
- Range in ultrasonic is virtually on par with regular Beacon HW v4.9 – up to 30m with Beacon HW v4.9 as RX beacon. At the same time, for example, a combination of Mini-RX RX beacon + Mini-TX TX provide a better coverage and a stronger signal, than Beacon HW v4.9 + Beacon HW v4.9
- This HW is for the 868/915MHz band only, i.e. 433MHz is not supported and not planned

### 3.4.4 Beacon Industrial-TX-Metal


- 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:

RS485 modification pinouts (After Sep.2019)



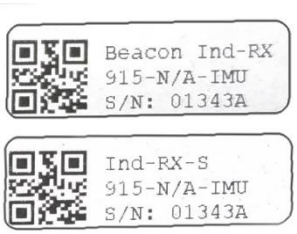

RS485 modification pinouts (Before Sep.2019)


CAN modification pinouts


- Can work with any Mini-RX beacon or Beacon HW v4.9 with 25kHz ultrasonic sensors (radio bands must match)
- 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

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

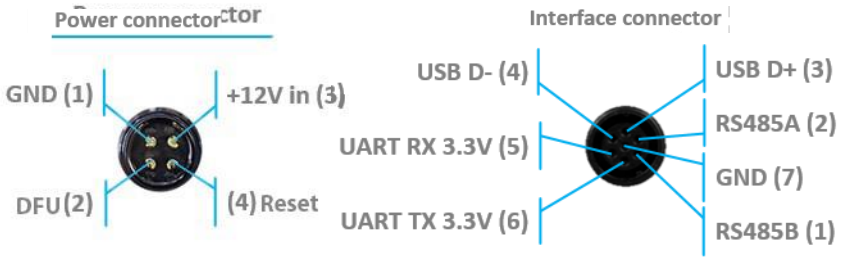
**Determine carefully the version of your Industrial beacons: it may be built before September 2019 and after September 2019. If it is beacon from the late batch, you must use Industrial Super-beacon SW. if you have beacons from the early batch, use Industrial-RX or Industrial-TX SW. Stickers' differences: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



### 3.4.5 Beacon Industrial-RX

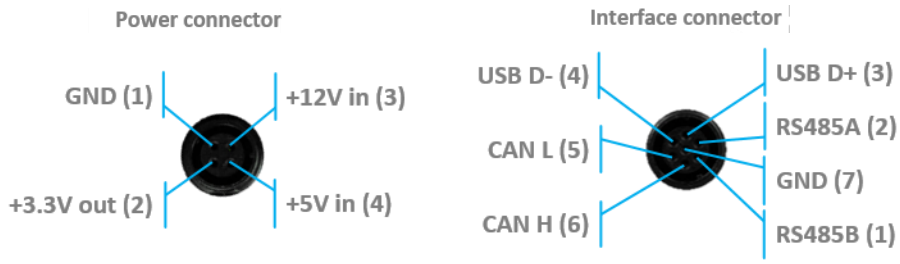

- RX-only beacon – can receive ultrasonic, but can't transmit it
- Electronics is IP67 protected
- Special IP67-membrane for ultrasonic sensor
- External antenna with SMA connector for extended radio range
- Corresponding IP67 connectors (male part) included
- No battery inside by default – external power bank or external power supply (+12V 0r +5V). But, optional variant with internal battery is possible
- Two IP67 external connectors:

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 wide range of ultrasonic frequencies: 19/25/31/37/45kHz
- 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

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

**Determine carefully the version of your Industrial beacons: it may be built before September 2019 and after September 2019. If it is 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.**

### 3.4.6 Industrial Super-Beacon Metal-25kHz


- Supports dual-use – RX and TX beacon. It can transmit on its native ultrasonic frequency (25kHz) and it can receive on any ultrasonic frequency via an embedded RX sensor – like Industrial-RX or Mini-RX does. Effectively, the Industrial Super-Beacons beacons combines 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:

  RS485 modification pinouts


- Can work together with modems with corresponding radio (radio bands must match)
- Can work with any Mini-RX beacon or Beacon HW v4.9 with 25kHz ultrasonic sensors (radio bands must match)
- 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

**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**

### 3.4.7 HW v4.9 beacon

HW v4.9 beacon 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:

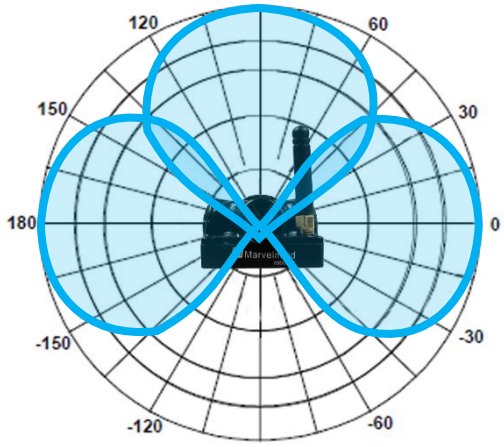



*Figure 1 Transmitting diagram (with sensors)*

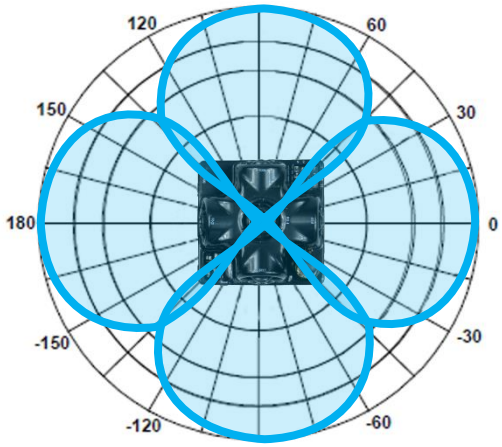



*Figure 15 Transmitting diagram (with sensors)*

## 3.6 Beacon comparison



Here you can see more details about the different types of beacons:
https://marvelmind.com/pics/marvelmind_beacons_comparison.pdf

# 4. Setting up the system (NIA)

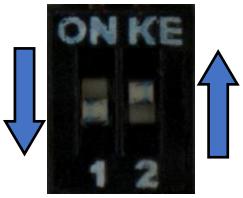
## 4.1 Starter Set Super-NIA-3D

The steps below describe the very first time you set up of the system. Super-beacons and modem required.


4.1.5 Unpack the system. Look at a similar unpacking video of HW v4.9. The videos have certain differences but the basic are the same: https://youtu.be/sOce7B2_6Sk

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

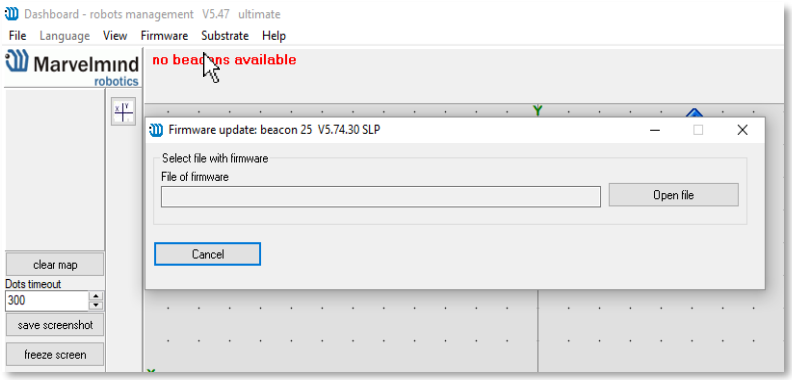
4.1.7 Turn the beacons on: Place DIP switches as shown on the picture below




4.1.8 Download SW Pack

4.1.9 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 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 link at top window in the Dashboard and run the installation file, then click on the link under and install the driver

  Ensure that:

  (a) You are programming the modem’s SW to the modem and the beacon’s SW to the beacon

  (b) You are using SW for Super-beacon, if you have Super-beacon; 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 SUCESSUFLY, MOVE DIRECTLY TO 4.1.10. If you have some problems with HEX programming, use DFU programming:

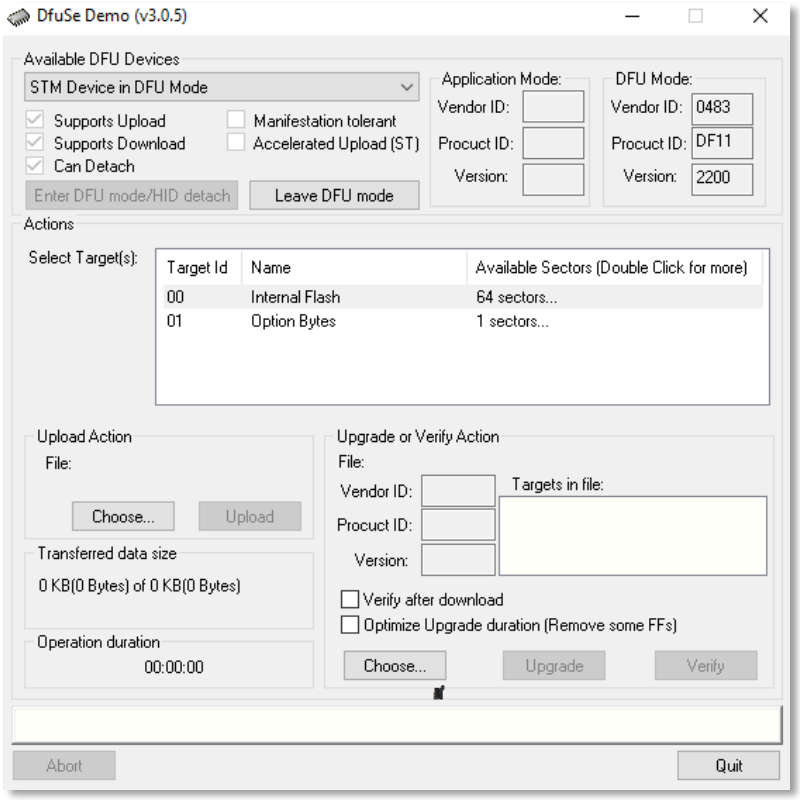
DFU programming or SW uploading is used when HEX SW uploading in the Dashboard cannot be used. For example, when you are updating from a very old SW version or when the SW includes major changes to the system and the only possible way to update the SW is via DFU programming

- After the DFU SW upgrade, future SW upgrades can be done in a regular manner via the Dashboard
- To start programming, move the beacon’s DIP switch to the DFU programming mode, as described in the paragraph on DIP switch modes
- Download the latest SW package, unzip it, and select the proper version of the SW for your HW and for your 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. v3.0.4 or v3.0.5, whichever works the best for your Windows: DfuSe v3.0.4 or DfuSe v.3.0.5

DFU Programming:

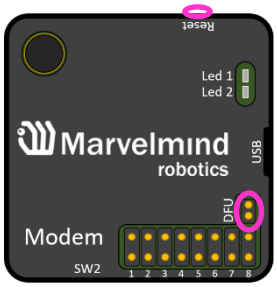
- Put DIP switch into ***Power* = ON**, ***DFU* = ON**
- Connect the beacon via USB to your PC
- Run DfuSe
- Press the **RESET** button on your beacon
- In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode

- Choose the DFU driver (file) for the beacon




- Click the **UPGRADE** button
- 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
- Move the DIP switch into ***Power* = ON**, ***DFU* = OFF**
- Start the Dashboard and press the **RESET** button on the beacon
- Check SW on the beacon afterwards
- Everything should be OK with SW now. DFU programming is complete

- Follow the same scenario for the modem:
  - Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming
  - After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v4.9) and press **Reset** button

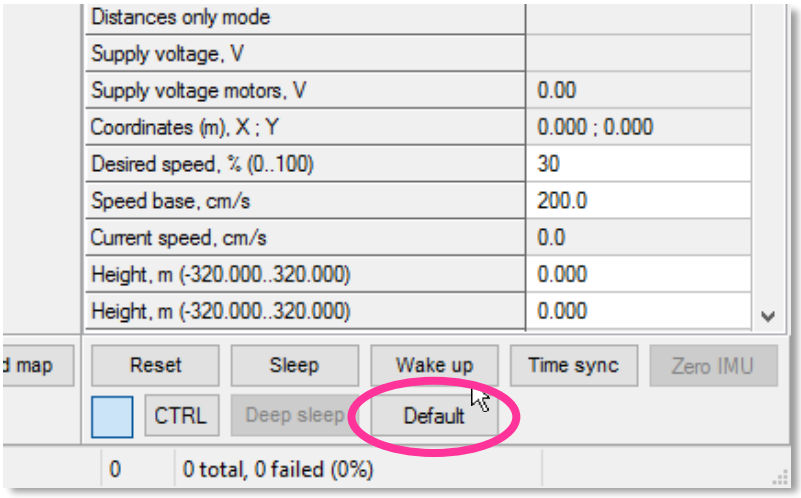


- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program
- After a couple of seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen immediately. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different one
- Disconnect the short circuit
- Start the Dashboard and press **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:

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



4.1.11 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 |

4.1.12 Press the RESET button on your beacons and modem after programming

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

4.1.14 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 change in the settings. The help video on installation can be found here - https://youtu.be/WY0HkLzmjys

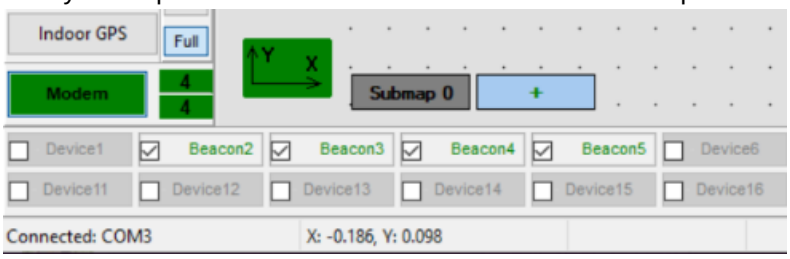
4.1.15 Connect the modem/router via USB to a Windows PC with the Dashboard installed

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

4.1.17 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 new submap for them or it won't be displayed on the map and in the table of distances.**

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




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

4.1.20 The system may run the frequency search, if it is the very first time you are waking 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

4.1.21 Check that the radio settings on the modem and the radio settings on the beacon are the same

4.1.22 Now you can check RSSI, voltage, ultrasonic filter settings, etc. on the panel on 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 |

4.1.5 Enter the height of stationary beacons. Choose beacon in the list and enter 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 |

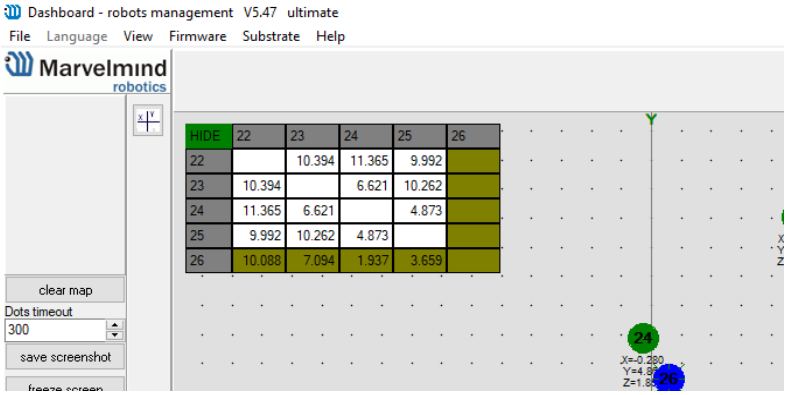
4.1.6 Enter the height for mobile beacon if you use 2D mode

4.1.7 In the current version one modem 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

4.1.8 Double click on the device both to put it into sleep mode and to wake it up

4.1.9 The map will form and zoom in automatically

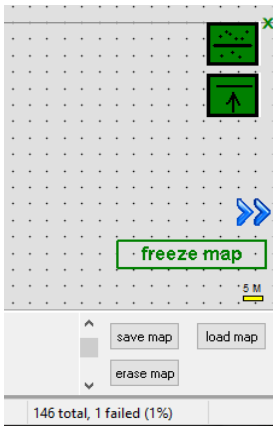
4.1.10 If the map does not form well, check the table of distances in the left corner of the Dashboard. The cells must be colored in white; it means the distances between stationary beacons are measured correctly




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

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

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




4.1.14 Turn on and wake up the mobile beacon following the same steps as with the stationary beacon. More details in our video: https://youtu.be/A4aRsjH2-_E

4.1.15 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 or some ultrasonic or radio settings may be different. You can change the settings for sensors manually by clicking on the panel on the upper right corner of the Dashboard to change the cells from gray to green to turn on 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.

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

4.1.17 The system is now fully operational.

4.1.18 In the dashboard, you can upload a picture / map of your room. You can use a different picture for every floor. Go to Loading the floorplan (Help video: https://www.youtube.com/watch?v=NHUnCtJIYXc)

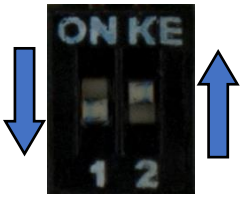
## 4.2 Starter Set HW v4.9

The steps below describe the very first time you set up of the system. Beacons HW v4.9 and modem required.


4.2.1 Unpack the system. Watch the help video: https://youtu.be/sOce7B2_6Sk

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

4.2.3 Turn the beacons on: Place DIP switches as shown on the picture below




4.2.4 Download SW Pack

4.2.5 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 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 link at top window in the Dashboard and run the installation file, then click on the link under and install the driver

Ensure that:

(c) You are programming the modem’s SW to the modem and the beacon’s SW to the beacon

(d) You are using SW for HW v4.9, if you have HW v4.9; 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 SUCESSUFLY, MOVE DIRECTLY TO 4.2.6. If you have some problems with HEX programming, use DFU programming:

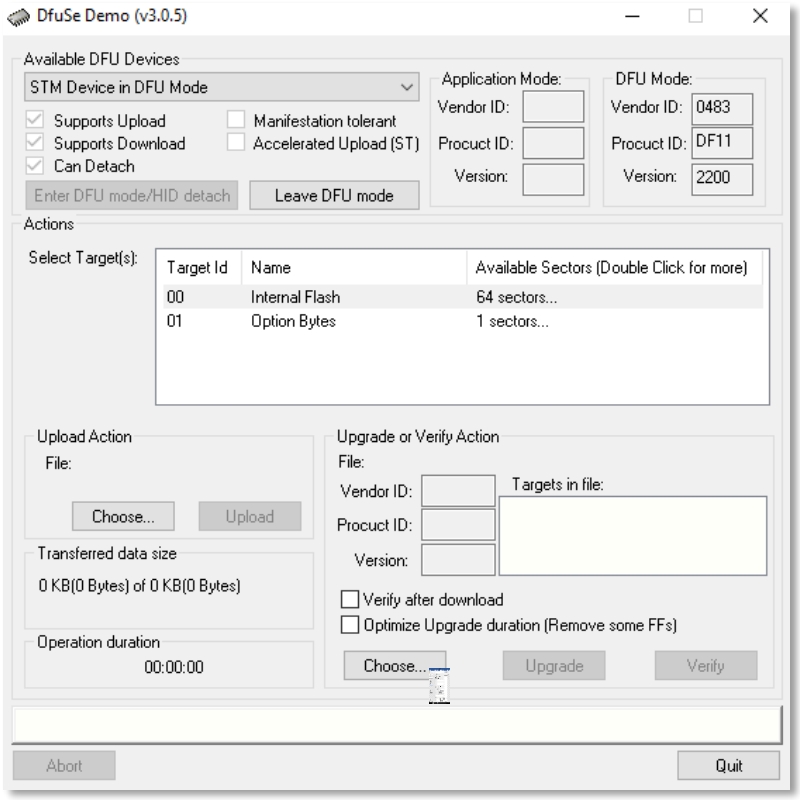
DFU programming or SW uploading is used when HEX SW uploading in the Dashboard cannot be used. For example, when you are updating from a very old SW version or when the SW includes major changes to the system and the only possible way to update the SW is via DFU programming

- After the DFU SW upgrade, future SW upgrades can be done in a regular manner via the Dashboard
- To start programming, move the beacon's DIP switch to the DFU programming mode, as described in the paragraph on DIP switch modes
- Download the latest SW package, unzip it, and select the proper version of the SW for your HW and for your 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. v3.0.4 or v3.0.5, whichever works the best for your Windows: DfuSe v3.0.4 or DfuSe v.3.0.5

DFU Programming:

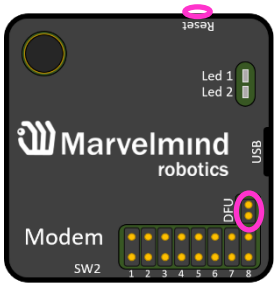
- Put DIP switch into ***Power* = ON**, ***DFU* = ON**
- Connect the beacon via USB to your PC
- Run DfuSe
- Press the **RESET** button on your beacon
- In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode

- Choose the DFU driver (file) for the beacon




- Click the **UPGRADE** button
- 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
- Move the DIP switch into ***Power* = ON**, ***DFU* = OFF**
- Start the Dashboard and press the **RESET** button on the beacon
- Check SW on the beacon afterwards
- Everything should be OK with SW now. DFU programming is complete

- Follow the same scenario for the modem:
  - Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming
  - After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v4.9) and press **Reset** button

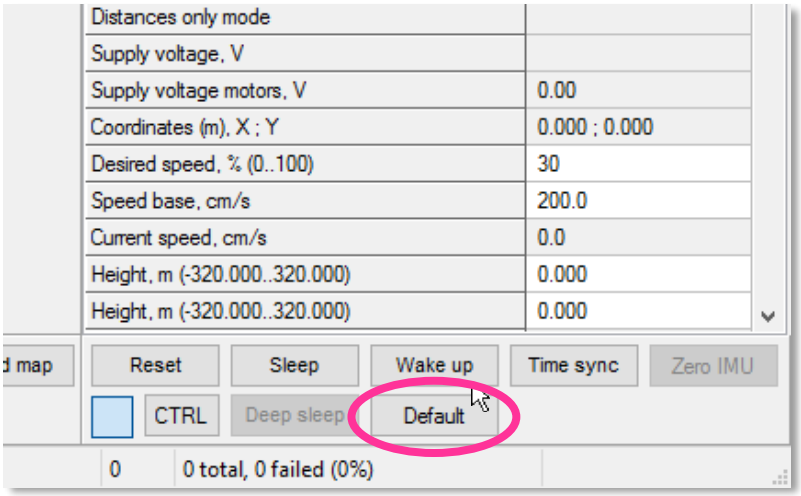


- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program
- After a couple of seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen immediately. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different one
- Disconnect the short circuit
- Start the Dashboard and press **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:

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



4.2.7 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 | [illegible] |
| 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 |

4.2.8 Press the RESET button on your beacons and modem after programming

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

4.2.10 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 change in the settings. The help video on installation can be found here - https://youtu.be/WY0HkLzmjys

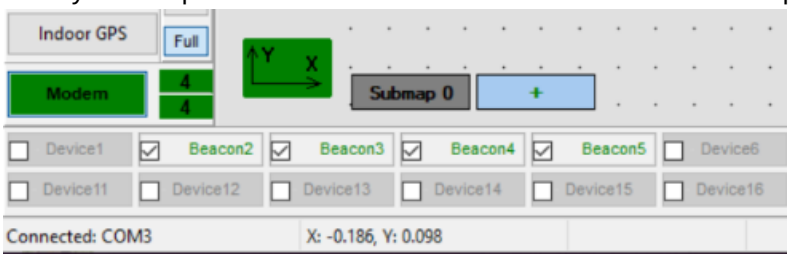
4.2.11 Connect the modem/router via USB to a Windows PC with the Dashboard installed

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

4.2.13 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 new submap for them or it won't be displayed on the map and in the table of distances.**

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




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

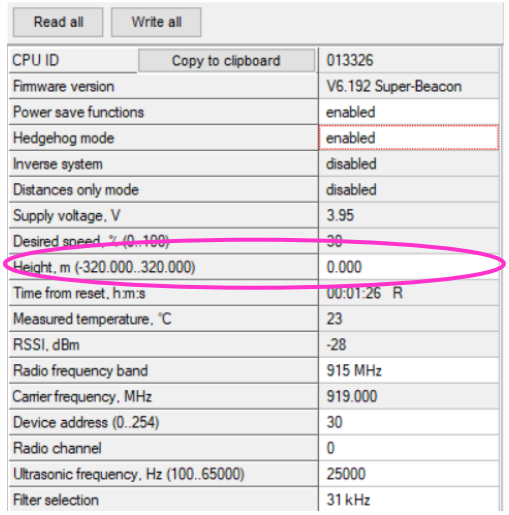
4.2.16 The system may run the frequency search, if it is the very first time you are waking up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are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

4.2.17 Check that the radio settings on the modem and the radio settings on the beacon are the same

4.2.18 Now you can check RSSI, voltage, ultrasonic filter settings, etc. on the panel on 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 |

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



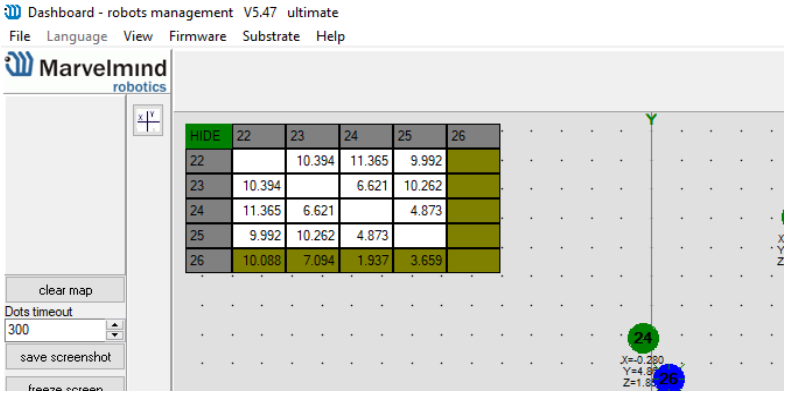

4.2.20 Enter the height for mobile beacon if you use 2D mode

4.2.21 In the current version one modem 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

4.2.22 Double click on the device both to put it into sleep mode and to wake it up

4.2.23 The map will form and zoom in automatically

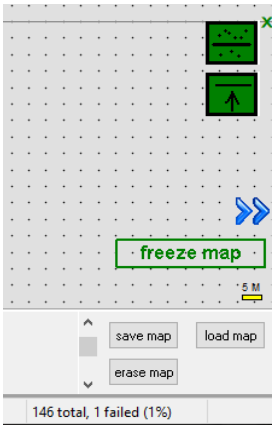
4.2.24 If the map does not form well, check the table of distances in the left corner of the Dashboard. The cells must be colored in white; it means the distances between stationary beacons are measured correctly




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

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

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



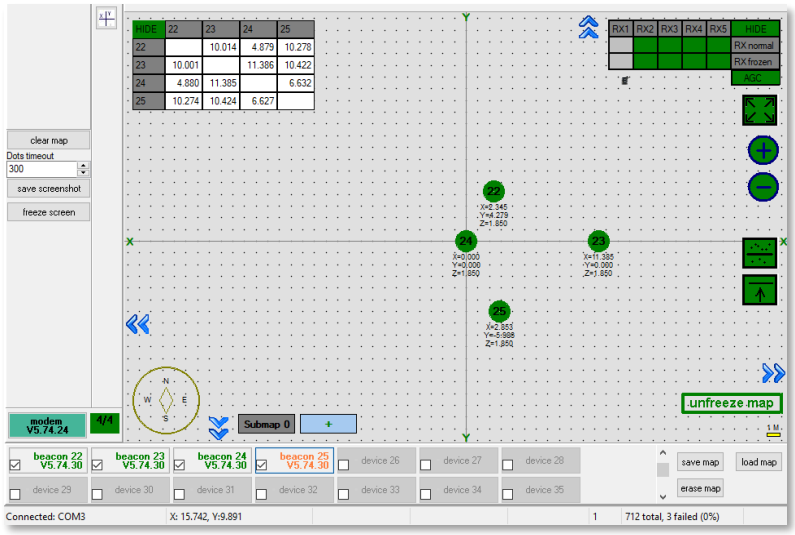

4.2.28 Turn on and wake up the mobile beacon following the same steps as with the stationary beacon. More details in our video: https://youtu.be/A4aRsjH2-_E

4.2.29 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 or some ultrasonic or radio settings may be different. You can change the settings for sensors manually by clicking on the panel on the upper right corner of the Dashboard to change the cells from gray to green to turn on 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.

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

4.2.31 The system is now fully operational.

4.2.32 In the Dashboard, you can upload a picture/map of your room. You can use a different picture for every floor. Go to Loading the floorplan
(Help video: https://www.youtube.com/watch?v=NHUnCtJIYXc)



## 4.3 Starter Set NIA-01-3D

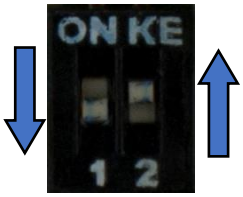
The steps below describe the very first time you set up the system. Mini-RX, HW v4.9 beacons and modem required.

**Mini-RX has different HW and SW from HW v4.9. Use Mini-RX SW for Mini-RX beacons, HW v4.9's SW for HW v4.9**


4.3.1 Unpack the system. Look at a similar unpacking video of HW v4.9. The videos have certain differences but the basic are the same: https://youtu.be/sOce7B2_6Sk

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

4.3.3 Turn the beacons on (To turn Mini-RXs on, carefully disassemble its housing and find DIP switches inside. It is necessary only for the first start. You can also turn it off with switches for long-term storage): Place DIP switches as shown on the picture below




4.3.4 Download SW Pack

4.3.5 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 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:

  a. You are programming the modem's SW to the modem and the beacon's SW to the beacon

b. You are using SW for 4.9, if you have HW v4.9; 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 SUCESSUFLY, MOVE DIRECTLY TO 4.3.6. If you have some problems with HEX programming, use DFU programming:

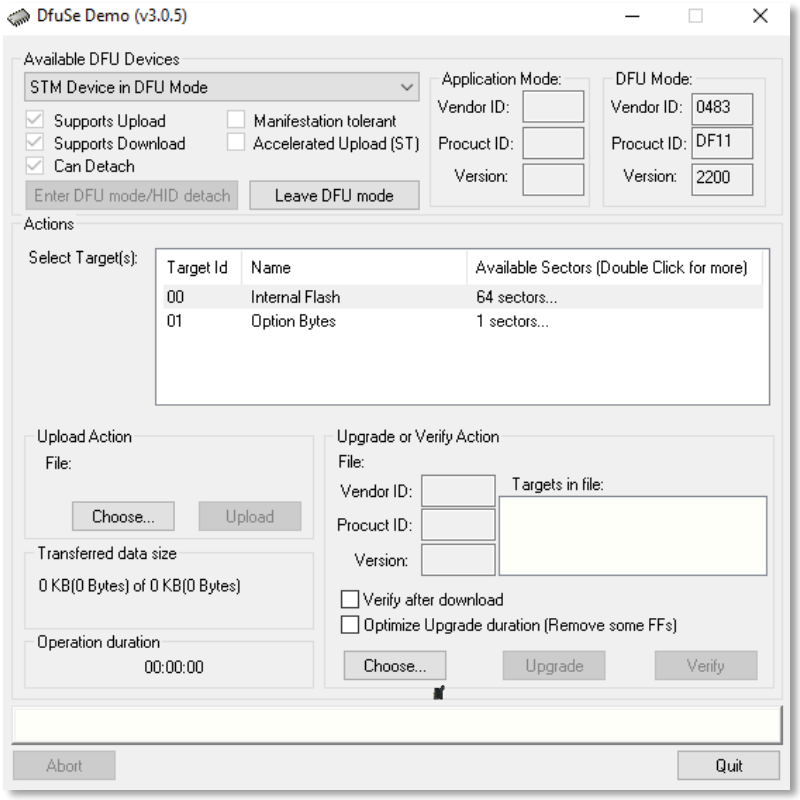
DFU programming or SW uploading is used when HEX SW uploading in the Dashboard cannot be used. For example, when you are updating from a very old SW version or when the SW includes major changes to the system and the only possible way to update the SW is via DFU programming

- After the DFU SW upgrade, futures SW upgrades can be done in a regular manner via the Dashboard
- 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)
- Download the latest SW package, unzip it, and select the proper version of the SW for your HW and for your 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. v3.0.4 or v3.0.5, whichever works the best for your Windows: DfuSe v3.0.4 or DfuSe v.3.0.5

DFU Programming:

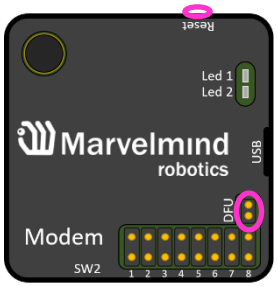
- Put DIP switch into ***Power* = ON**, ***DFU* = ON** (DIP switch in Mini-RX and Mini-TX situated inside the body. To switch it, carefully disassemble the body)
- Connect the beacon via USB to your PC
- Run DfuSe
- Press the **RESET** button on your beacon
- In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode

- Choose the DFU driver (file) for the beacon




- Click the **UPGRADE** button
- 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
- Move the DIP switch into ***Power* = ON**, ***DFU* = OFF**
- Start the Dashboard and press the **RESET** button on the beacon
- Check SW on the beacon afterwards
- Everything should be OK with SW now. DFU programming is complete

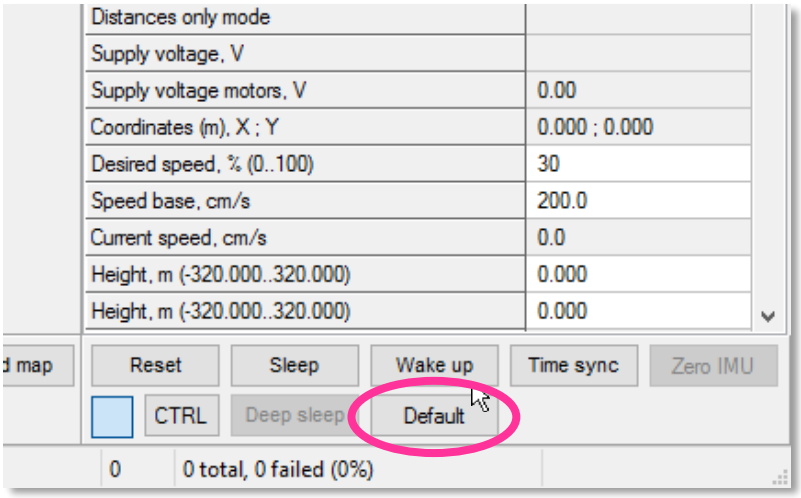
- Follow the same scenario for the modem:
  - Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming
  - After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v4.9) and press **Reset** button



- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program
- After a couple of 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
- Disconnect the short circuit
- Start the Dashboard and press **RESET** button

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

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




4.3.7 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 | 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 |

4.3.8 Press the RESET button on your beacons and modem after programming

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

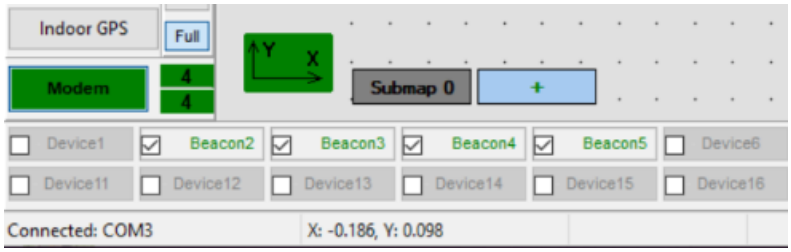
4.3.10 Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon's height for future change in the settings. The help video on installation can be found here - https://youtu.be/WY0HkLzmjys

4.3.11 Connect the modem/router via USB to a Windows PC with the Dashboard installed

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

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

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




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

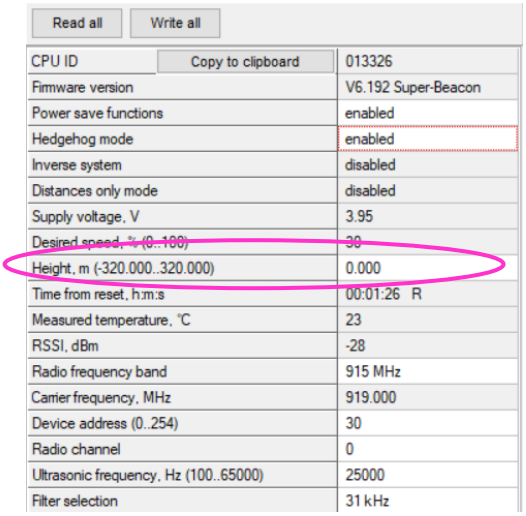
4.3.16 The system may run the frequency search, if it is the very first time you are waking up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are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

4.3.17 Check that the radio settings on the modem and the radio settings on the beacon are the same

4.3.18 Now you can check RSSI, voltage, ultrasonic filter settings, etc. on the panel on 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 |

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




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

4.3.21 In the current version one modem 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

4.3.22 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 it will not be displayed on the map and in the table of distances.**

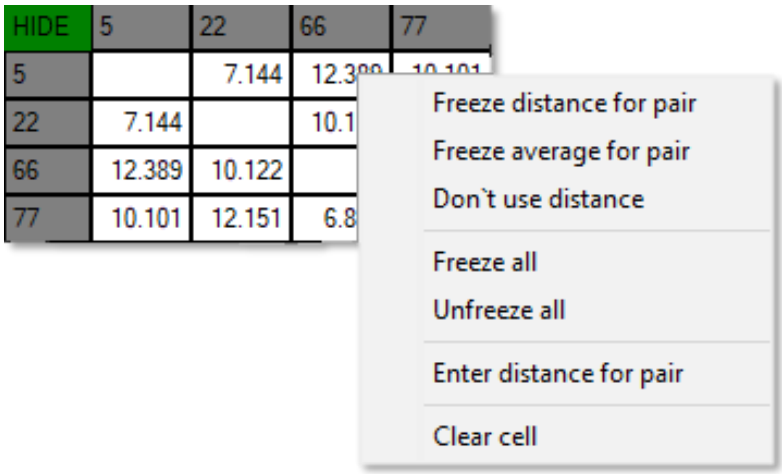
4.3.23 Build the map:

Mini-RX beacons cannot build the map automatically, manual inputting of the coordinates is required

Step 1. Open the Dashboard. You will see the table of distances

Step 2. Use right mouse click on cell you want to enter the distance. Additional menu will open. There you can

control the table of distances. Choose **Enter distance for pair** to enter the value



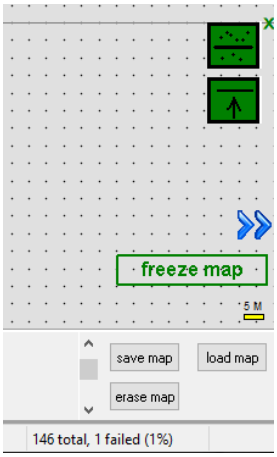

Step 3. Now, enter measured (measure it with laser distance meter or so) value. That values would not change until you unfreeze or clear it. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can cause a significant impact on your tracking

Step 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 | |

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

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



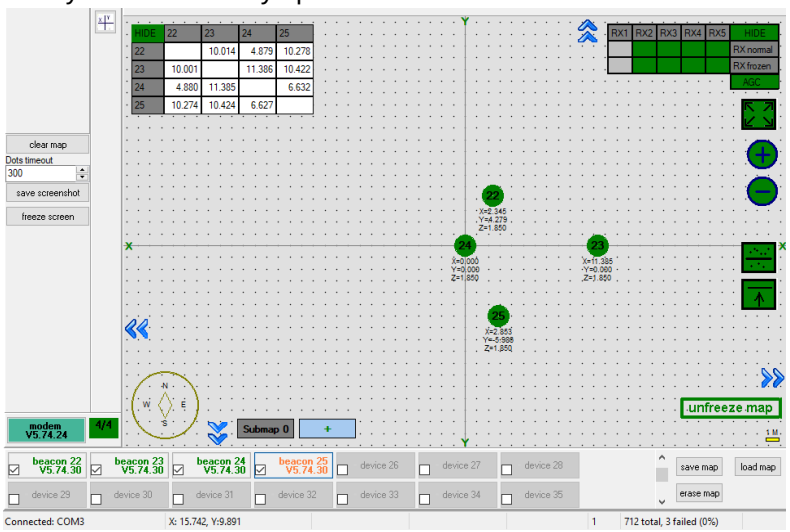

4.3.26 Turn on and wake up the mobile beacon following the same steps as with the stationary beacon: https://youtu.be/A4aRsjH2-_E

4.3.27 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

or some ultrasonic or radio settings may be different. You can change the settings for sensors manually by clicking on the panel on the upper right corner of the Dashboard to change the cells from gray to green to turn on 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.

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

4.3.29 The system is now fully operational.



## 4.4 Starter Set NIA-SmallDrone

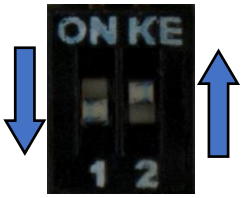
The steps below describe the very first time you set up the system. Mini-RX, Mini-TX beacons and modem required.

**Mini-RX and Mini-TX have different HW and SW from HW v4.9. Use Mini-RX SW for Mini-RX beacons, Mini-TX SW for Mini-TX beacons, HW v4.9's SW for HW v4.9**

4.4.1 Unpack the system. Take a look at a similar unpacking video of HW v4.9. The videos have certain differences but the basic are the same: https://youtu.be/sOce7B2_6Sk

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

4.4.3 Turn the beacons on (To turn Mini-RXs on, carefully disassemble its housing and find DIP switches inside. It is necessary only for the first start. You can also turn it off with switches for long-term storage): Place DIP switches as shown on the picture below

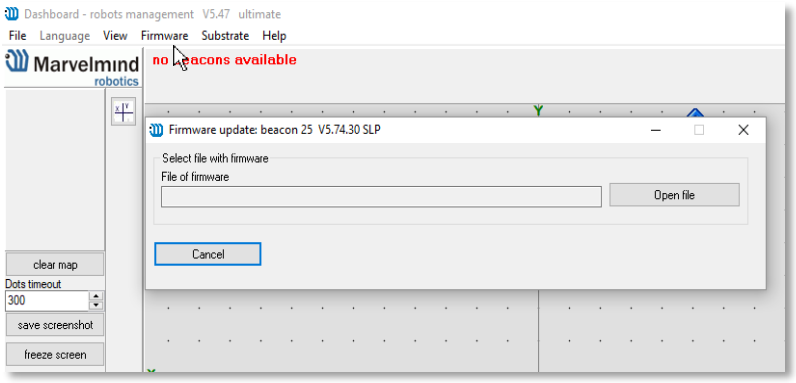



4.4.4 Download SW Pack

4.4.5 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 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:

c. You are programming the modem’s SW to the modem and the beacon’s SW to the beacon

d. You are using SW for Mini-TX, if you have Mini-TX; 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

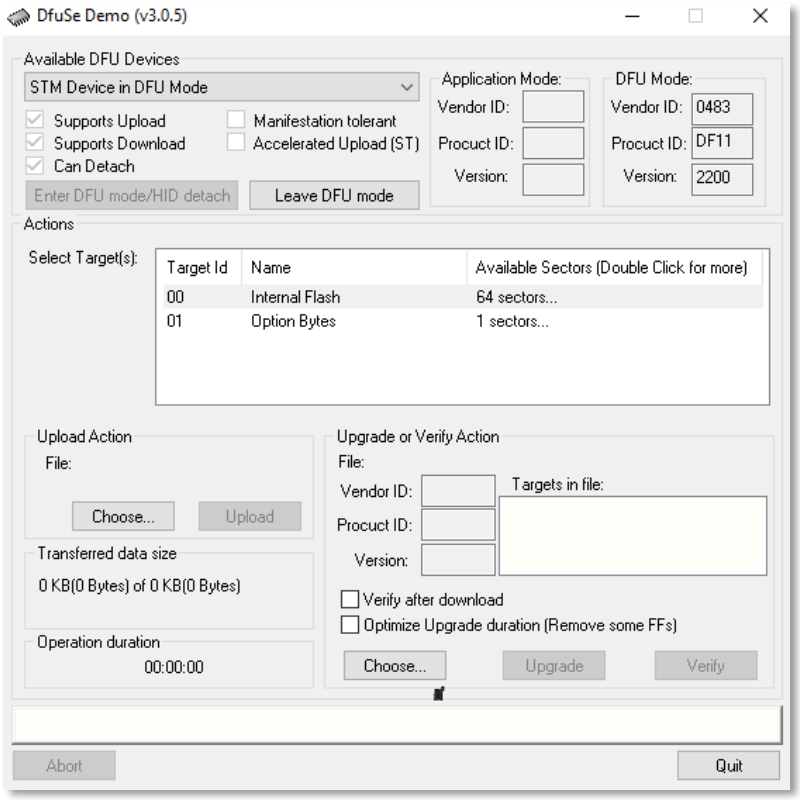
If SW flashed SUCESSUFLY, MOVE DIRECTLY TO 4.4.6. If you have some problems with HEX programming, use DFU programming:

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 major changes to the system and the only possible way to update the SW is via DFU programming

- After the DFU SW upgrade, futures SW upgrades can be done in a regular manner via the Dashboard
- 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)
- Download the latest SW package, unzip it, and select the proper version of the SW for your HW and for your 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. v3.0.4 or v3.0.5, whichever works the best for your Windows: DfuSe v3.0.4 or DfuSe v.3.0.5

DFU Programming:

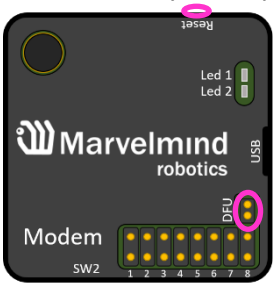
- Put DIP switch into ***Power* = ON**, ***DFU* = ON** (DIP switch in Mini-RX and Mini-TX situated inside the body. To switch it, carefully disassemble the body)
- Connect the beacon via USB to your PC
- Run DfuSe
- Press the **RESET** button on your beacon
- In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode
- Choose the DFU driver (file) for the beacon




- Click the **UPGRADE** button
- 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
- Move the DIP switch into ***Power* = ON**, ***DFU* = OFF**
- Start the Dashboard and press the **RESET** button on the beacon
- Check SW on the beacon afterwards
- Everything should be OK with SW now. DFU programming is complete

- Follow the same scenario for the modem:
  - Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming

- After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v4.9) and press **Reset** button




- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program

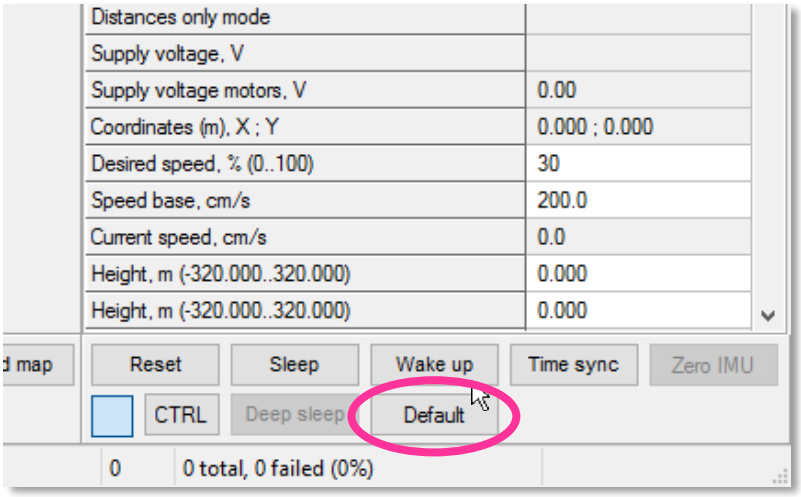
- After a couple of seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different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

- Disconnect the short circuit

- Start the Dashboard and press **RESET** button

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

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



4.4.7 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 | [illegible] |
| 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 |

4.4.8 Press the RESET button on your beacons and modem after programming

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

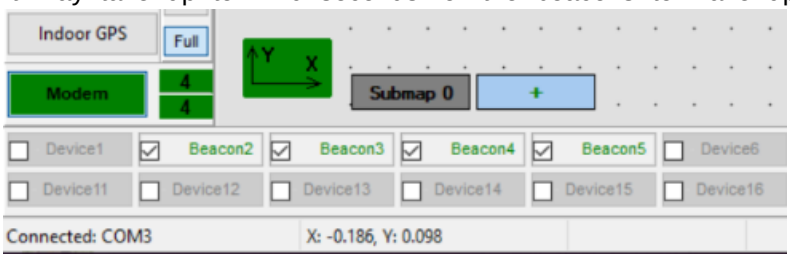
4.4.10 Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon's height for future change in the settings. The help video on installation can be found here - https://youtu.be/WY0HkLzmjys

4.4.11 Connect the modem/router via USB to a Windows PC with the Dashboard installed

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

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

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



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

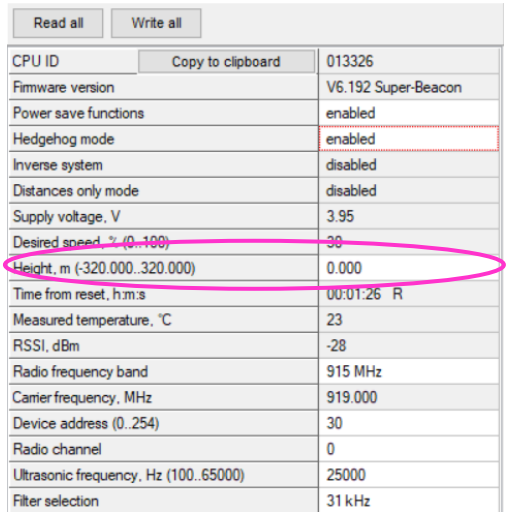
4.4.16 The system may run the frequency search, if it is the very first time you are waking up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are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

4.4.17 Check that the radio settings on the modem and the radio settings on the beacon are the same

4.4.18 Now you can check RSSI, voltage, ultrasonic filter settings, etc. on the panel on 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 |

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




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

4.4.21 In the current version one modem 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

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

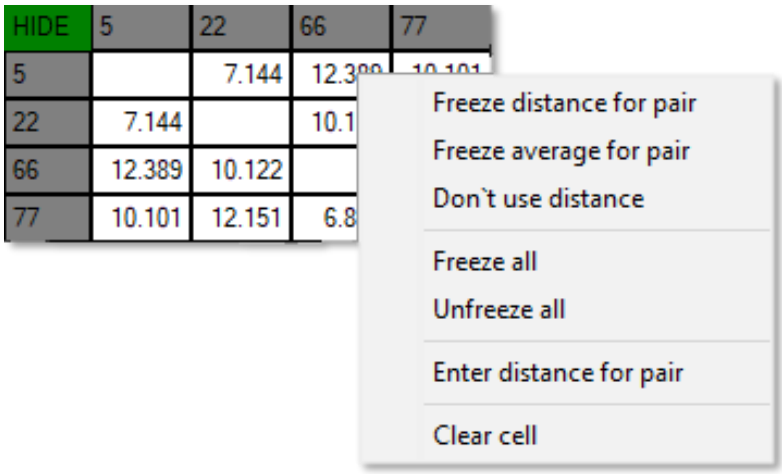
**Only 4 stationary beacons may be in 1 submap. If you wake up more beacons, create a new submap for them, otherwise it will not be displayed on the map and in the table of distances.**

4.4.23 Build the map:

Mini-RX beacons cannot build the map automatically, manual inputting of the coordinates is required

Step 5. Open the Dashboard. You will see the table of distances

Step 6. Use right mouse click on cell you want to enter the distance. Additional menu will open. There you can control the table of distances. Choose **Enter distance for pair** to enter the value

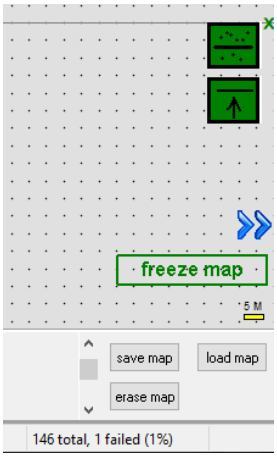



Step 7. Now, enter measured (measure it with laser distance meter or so) value. That values would not change until you unfreeze or clear it. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can cause a significant impact on your tracking

Step 8. 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 | |

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



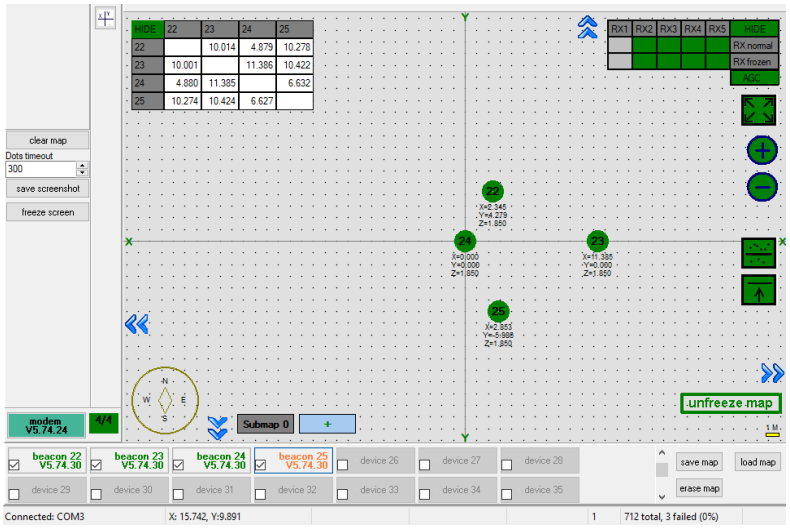

4.4.25 Turn on and wake up the mobile beacon following the same steps as with the stationary beacon: https://youtu.be/A4aRsjH2-_E

4.4.26 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 or some ultrasonic or radio settings may be different. You can change the settings for sensors manually by clicking on the panel on the upper right corner of the Dashboard to change the cells from gray to green to turn on 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.

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

4.4.28 The system is now fully operational.



## 4.5 Starter Set NIA-02-2D

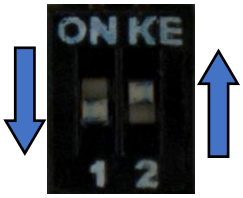
The steps below describe the very first time you set up the system. Mini-RX, Mini-TX beacons and modem required.

**Mini-RX and Mini-TX have different HW and SW from HW v4.9. Use Mini-RX SW for Mini-RX beacons, Mini-TX SW for Mini-TX beacons, HW v4.9's SW for HW v4.9**


4.5.1 Unpack the system. Take a look at a similar unpacking video of HW v4.9. The videos have certain differences but the basic are the same: https://youtu.be/sOce7B2_6Sk

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

4.5.3 Turn the beacons on (To turn Mini-RXs on, carefully disassemble its housing and find DIP switches inside. It is necessary only for the first start. You can also turn it off with switches for long-term storage): Place DIP switches as shown on the picture below

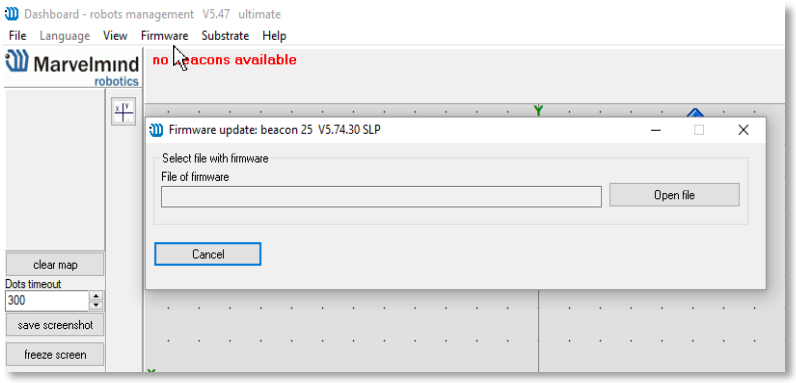



4.5.4 Download SW Pack

4.5.5 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 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:

e. You are programming the modem’s SW to the modem and the beacon’s SW to the beacon

f. You are using SW for Mini-TX, if you have Mini-TX; 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

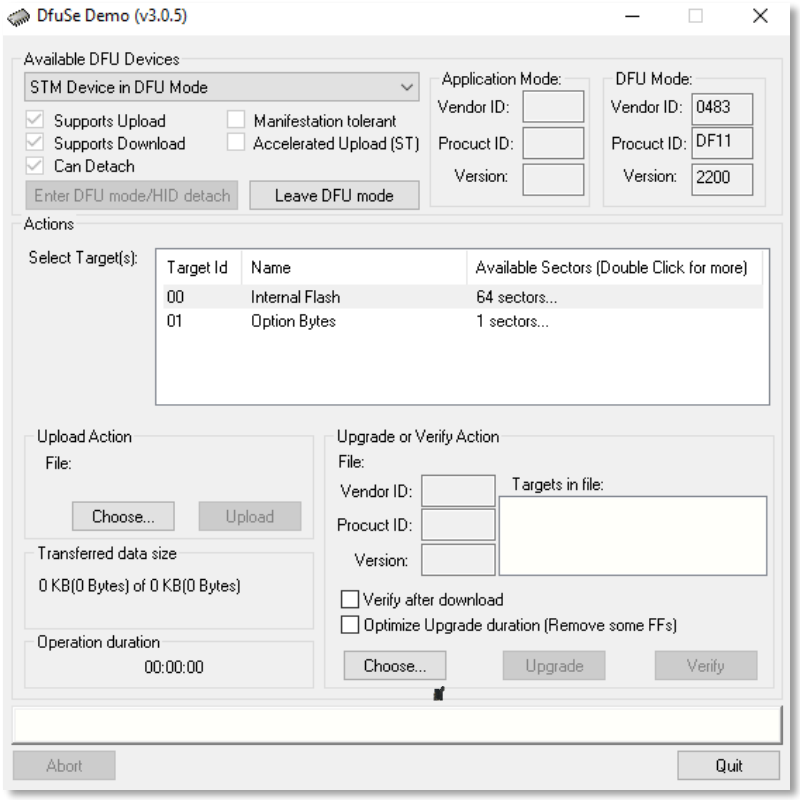
If SW flashed SUCESSUFLY, MOVE DIRECTLY TO 4.5.6. If you have some problems with HEX programming, use DFU programming:

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 major changes to the system and the only possible way to update the SW is via DFU programming

- After the DFU SW upgrade, futures SW upgrades can be done in a regular manner via the Dashboard
- 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)
- Download the latest SW package, unzip it, and select the proper version of the SW for your HW and for your 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. v3.0.4 or v3.0.5, whichever works the best for your Windows: DfuSe v3.0.4 or DfuSe v.3.0.5

DFU Programming:

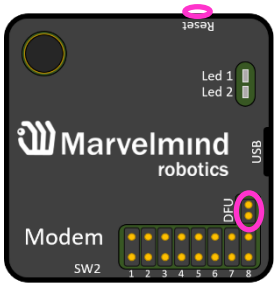
- Put DIP switch into ***Power* = ON**, ***DFU* = ON** (DIP switch in Mini-RX and Mini-TX situated inside the body. To switch it, carefully disassemble the body)
- Connect the beacon via USB to your PC
- Run DfuSe
- Press the **RESET** button on your beacon
- In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode
- Choose the DFU driver (file) for the beacon




- Click the **UPGRADE** button
- 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
- Move the DIP switch into ***Power* = ON**, ***DFU* = OFF**
- Start the Dashboard and press the **RESET** button on the beacon
- Check SW on the beacon afterwards
- Everything should be OK with SW now. DFU programming is complete

- Follow the same scenario for the modem:
  - Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming

- After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v4.9) and press **Reset** button




- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program

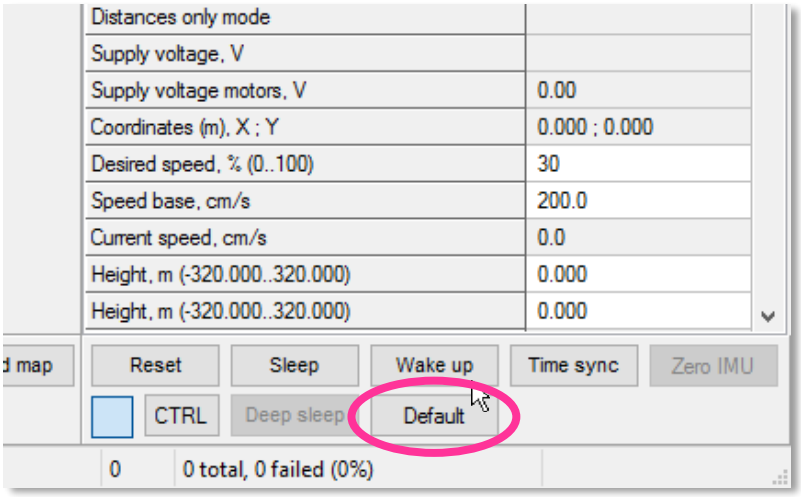
- After a couple of seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different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

- Disconnect the short circuit

- Start the Dashboard and press **RESET** button

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

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



4.5.7 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, °C | 23 |
| RSSI, dBm | -74 |
| Radio frequency band | 915 MHz |
| Carrier frequency, MHz | [illegible] |
| 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 |

4.5.8 Press the RESET button on your beacons and modem after programming

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

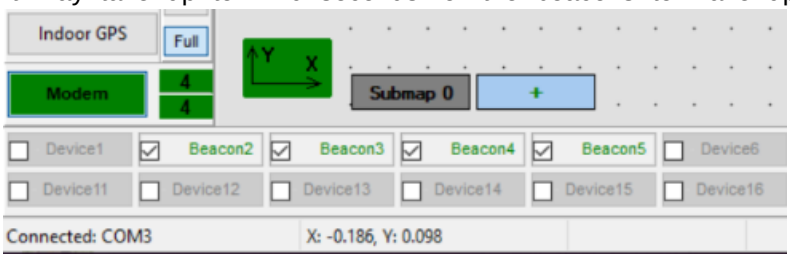
4.5.10 Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon's height for future change in the settings. The help video on installation can be found here - https://youtu.be/WY0HkLzmjys

4.5.11 Connect the modem/router via USB to a Windows PC with the Dashboard installed

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

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

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



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

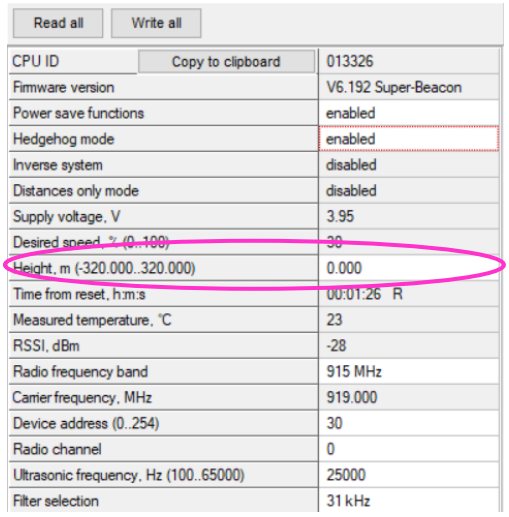
4.5.16 The system may run the frequency search, if it is the very first time you are waking up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are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

4.5.17 Check that the radio settings on the modem and the radio settings on the beacon are the same

4.5.18 Now you can check RSSI, voltage, ultrasonic filter settings, etc. on the panel on 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 |

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




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

4.5.21 In the current version one modem 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

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

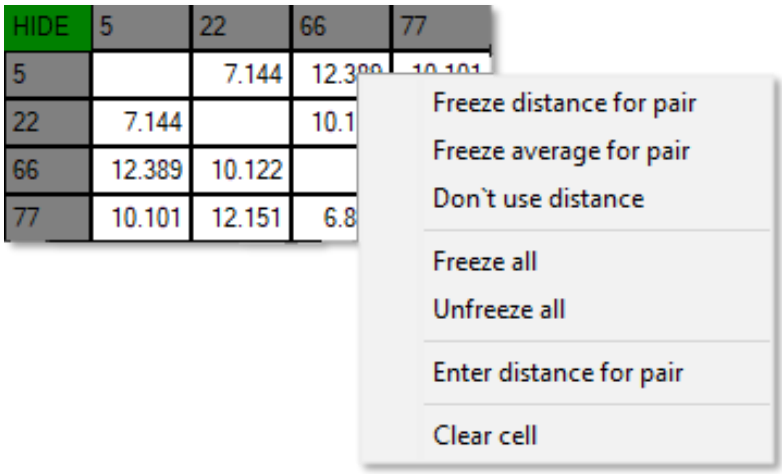
**Only 4 stationary beacons may be in 1 submap. If you wake up more beacons, create a new submap for them, otherwise it will not be displayed on the map and in the table of distances.**

4.5.23 Build the map:

Mini-RX beacons cannot build the map automatically, manual inputting of the coordinates is required

Step 9. Open the Dashboard. You will see the table of distances

Step 10. Use right mouse click on cell you want to enter the distance. Additional menu will open. There you can control the table of distances. Choose **Enter distance for pair** to enter the value

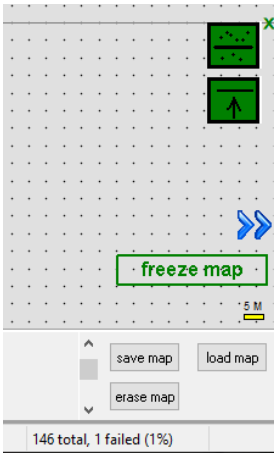



Step 11. Now, enter measured (measure it with laser distance meter or so) value. That values would not change until you unfreeze or clear it. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can cause a significant impact on your tracking

Step 12. 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 | |

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



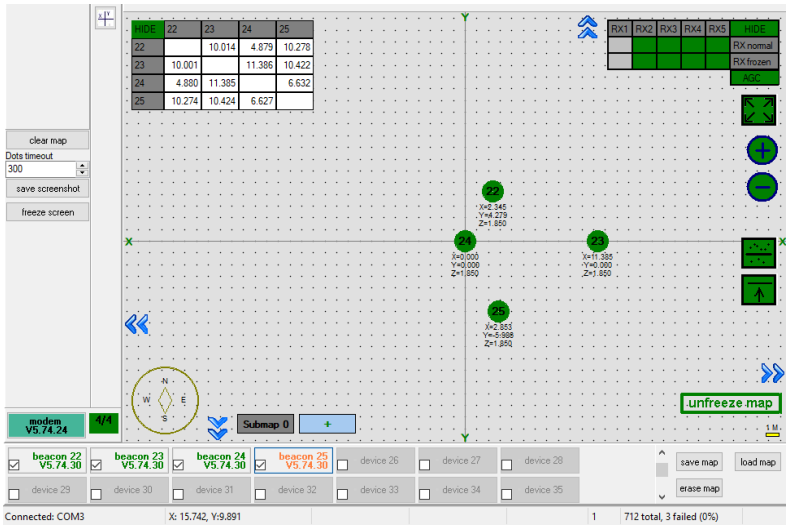

4.5.25 Turn on and wake up the mobile beacon following the same steps as with the stationary beacon: https://youtu.be/A4aRsjH2-_E

4.5.26 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 or some ultrasonic or radio settings may be different. You can change the settings for sensors manually by clicking on the panel on the upper right corner of the Dashboard to change the cells from gray to green to turn on 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.

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

4.5.28 The system is now fully operational.



## 4.6 Starter Set Industrial-NIA-01

The steps below describe the first set up 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 from HW v4.9. It has different connectors, reset and DFU activation. Read more on Industrial beacon page.**

**Industrial beacons have no battery, use power supply cable.**

**Use Industrial beacon's SW for Industrial beacons, v4.9 for v4.9.**

4.6.1 Unpack the system. Take a look at the similar unpacking video of HW v4.9. They are different, but have some similar basics: https://youtu.be/sOce7B2_6Sk

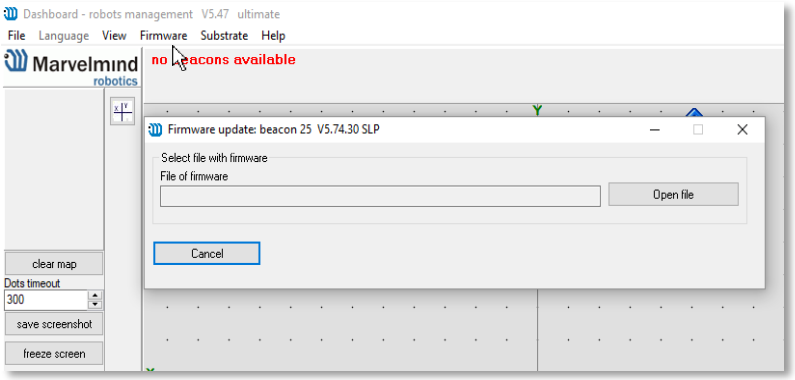
4.6.2 You do not have to charge Industrial beacons; they have no battery

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

4.6.4 Download SW Pack

4.6.5 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 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 link

at top window in the Dashboard and run the installation file, then click on the link under and install the driver

Ensure that:

(e) You are programming the modem's SW to the modem and the beacon's SW to the beacon

(f) You are using SW for 4.9, if you have HW v4.9; 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 SUCESSUFLY, 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 major changes to the system and the only possible way to update the SW is via DFU programming

- After the DFU SW upgrade, futures SW upgrades can be done in a regular manner 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 for your 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. v3.0.4 or v3.0.5, whichever works the best for your Windows: DfuSe v3.0.4 or DfuSe v.3.0.5

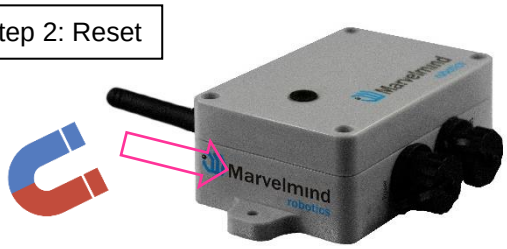
DFU Programming:

**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**

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

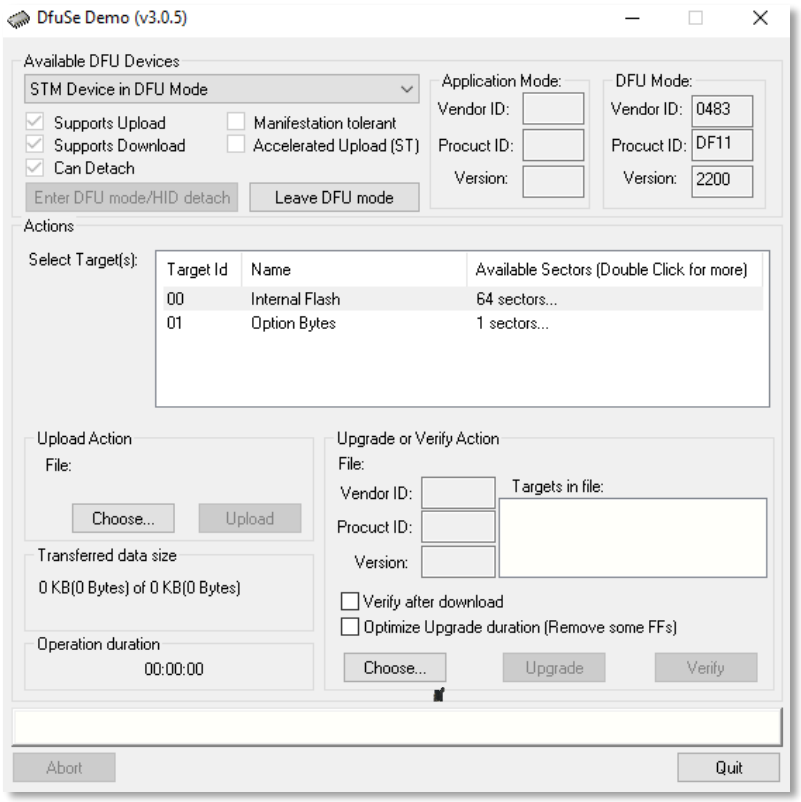
Step 1: DFU mode

Step 2: Reset




Magnet examples

- Connect the beacon via USB to your PC
- Connect power supply cable to your beacon
- Run DfuSe
- In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode
- Choose the DFU driver (file) for the beacon



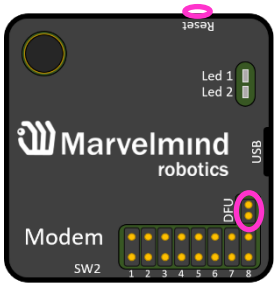

- Click the **UPGRADE** button
- After a couple of seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload

immediately, check the "Choose" button you used or change the version of DfuSe SW you selected

- Start the Dashboard
- Reset the beacon again
- Check SW on the beacon afterwards
- Everything should be OK with SW now. DFU programming is complete.

DFU Programming for the modem:

- Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming.
- After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v4.9) and press **Reset** button

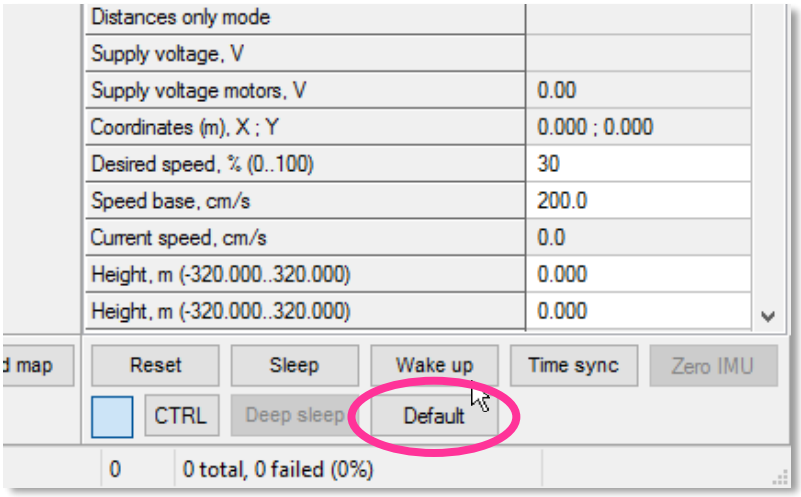



- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program
- After a couple of seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different one.
- Disconnect the short circuit.
- Start the Dashboard and press **RESET** button.

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

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

settings




4.6.7 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 | 915.000 |
| 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 |

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

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

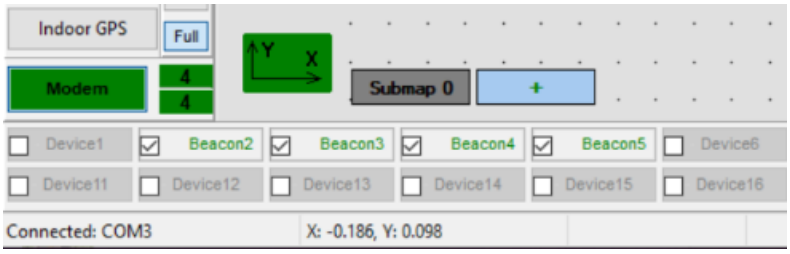
4.6.10 Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon's height for future change in the settings. The help video on installation can be found here - https://youtu.be/WY0HkLzmjys

4.6.11 Connect the modem/router via USB to a Windows PC with the Dashboard installed

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

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

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




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

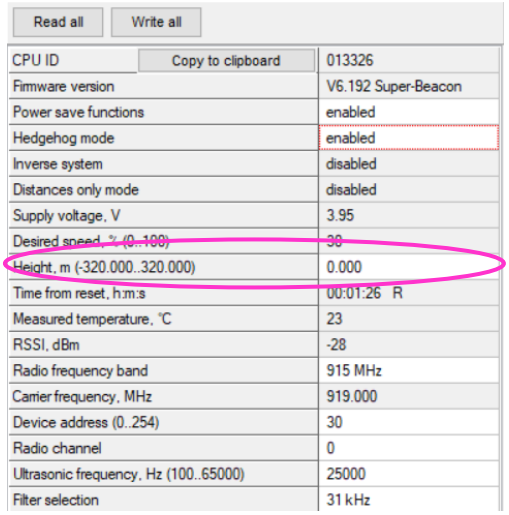
4.6.16 The system may run the frequency search, if it is the very first time you are waking up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are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

4.6.17 Check that the radio settings on the modem and the radio settings on the beacon are the same

4.6.18 Now you can check RSSI, voltage, ultrasonic filter settings, etc. on the panel on 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 |

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




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

4.6.21 In the current version one modem 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

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

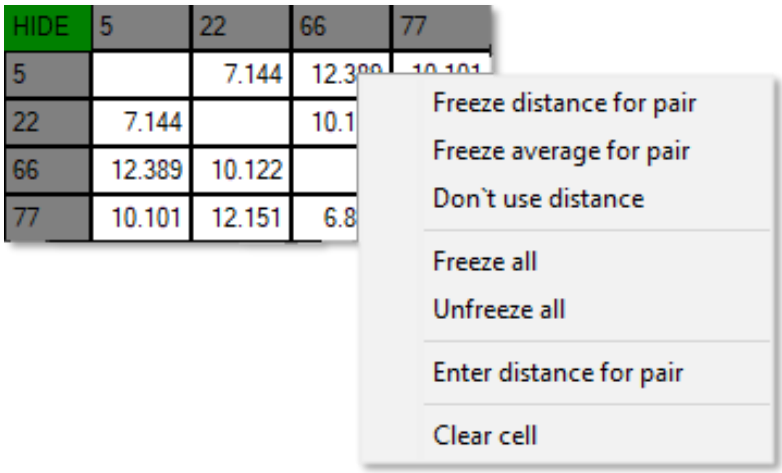
Only 4 stationary beacons may be in 1 submap. If you wake up more beacons, create new submap for them. Or it won't be displayed on the map and in the table of distances

4.6.23 Build the map:

Industrial-RX beacons are not possible to build the map automatically, so you have to build it manually

Step 1. Open the Dashboard. You will see the table of distances

Step 2. Use right mouse click on cell you want to enter the distance. Additional menu will open. There you can control the table of distances. Choose **Enter distance for pair** to enter the value



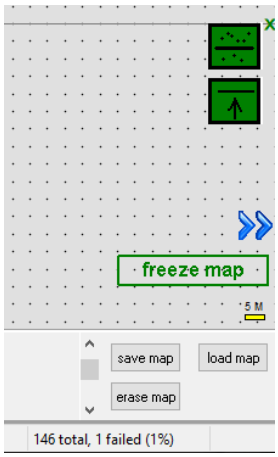

Step 3. Now, enter measured (measure it with laser distance meter or so) value. That values would not change until you unfreeze or clear it. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can cause a huge impact on your tracking

Step 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 | |

4.6.24 Freeze the map by clicking the button. Stationary beacons will stop measuring relative distances and will be ready to measure distance

from the mobile beacon(s)

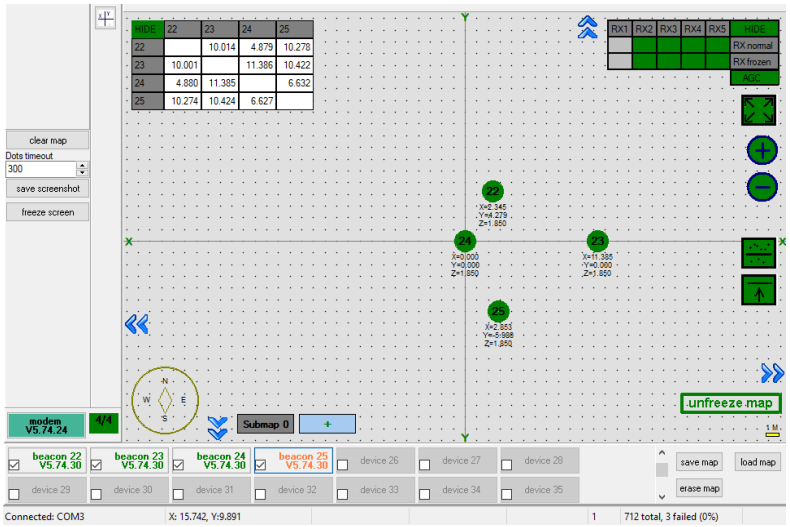



4.6.25 Turn on and wake up the mobile beacon following the same steps as with the stationary beacon: https://youtu.be/A4aRsjH2-_E

4.6.26 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 or some ultrasonic or radio settings may be different. You can change the settings for sensors manually by clicking on the panel on the upper right corner of the Dashboard to change the cells from gray to green to turn on 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

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

4.6.28 The system is now fully operational



# 5. Setting up the system (IA)

## 5.1 Starter Set Super-MP-3D

The steps below describe the very first time you set up of the system. Super-Beacons with different ultrasonic frequencies and modem required.

**This is Inverse Architecture. Super-Beacons should have different frequencies. Use IA Software ONLY.**

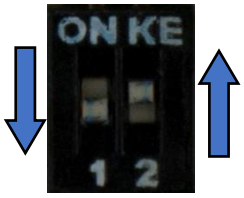
**You can't just switch Super-Beacon to another frequency, it is HW depended**

**Ultrasonic can't be changed to default. You must check the frequency on the white sticker**


5.1.1 Unpack the system. Take a look at the similar unpacking video of HW v4.9. They are different, but have some similar basics: https://youtu.be/sOce7B2_6Sk

5.1.2 Charge all the beacons using USB cable. Full charging takes about 2-4 hours

5.1.3 Turn the beacons on: Place DIP switches as shown on the picture below

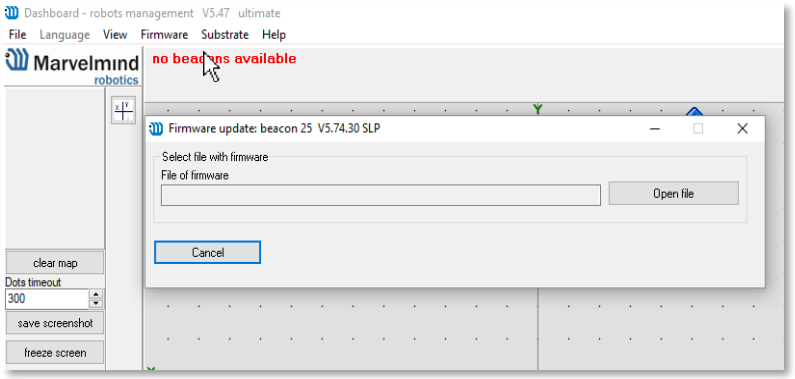



5.1.4 Download SW Pack

5.1.5 Update all the beacons

- You need Inverse Architecture SW (go to marvelmind_SW_*xxx_xx_xx*\Software_ia)

– 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 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 link at top window in the Dashboard and run the installation file, then click on the link under and install the driver

Ensure that:

(g) You are programming the modem’s SW to the modem and the beacon’s SW to the beacon

(h) You are using SW for 4.9, if you have HW v4.9; 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

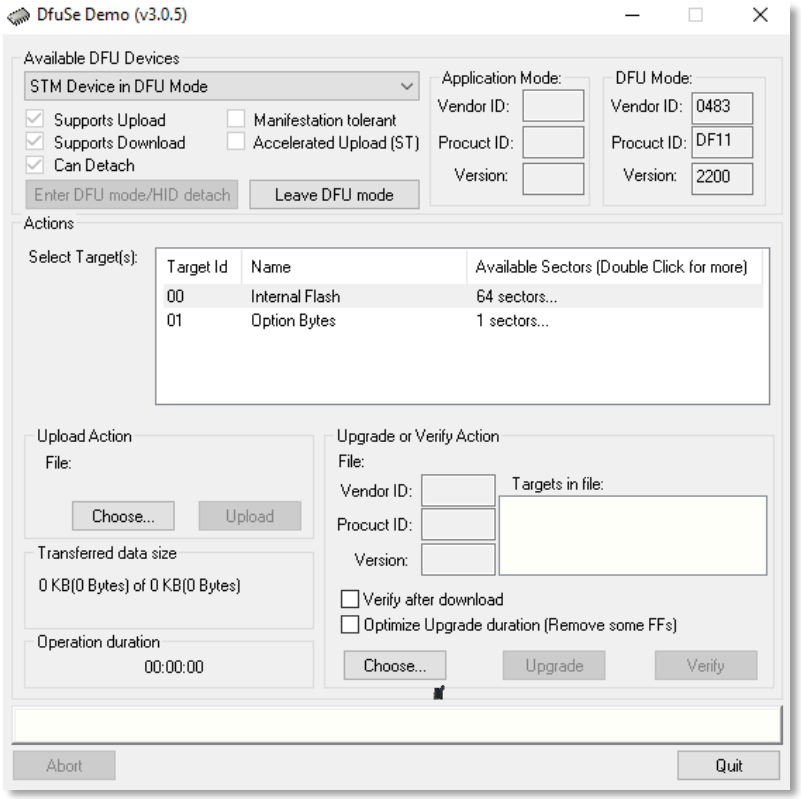
If SW flashed SUCESSUFLY, MOVE DIRECTLY TO 5.1.6. If you have some problems with HEX programming, use DFU programming:

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 major changes to the system and the only possible way to update the SW is via DFU programming

- After the DFU SW upgrade, futures SW upgrades can be done in a regular manner via the Dashboard
- To start programming, move the beacon’s DIP switch to the DFU programming mode, as described in the paragraph on DIP switch modes
- Download the latest SW package, unzip it, and select the proper version of the SW for your HW and for your 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. v3.0.4 or v3.0.5, whichever works the best for your Windows: DfuSe v3.0.4 or DfuSe v.3.0.5

DFU Programming:

- Put DIP switch into ***Power* = ON**, ***DFU* = ON**
- Connect the beacon via USB to your PC.
- Run DfuSe.
- Press the **RESET** button on your beacon.
- In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode.
- Choose the DFU driver (file) for the beacon.

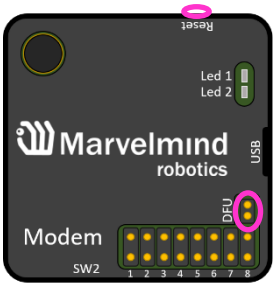



- Click the **UPGRADE** button
- After a couple of seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW you selected
- Move the DIP switch into ***Power* = ON**, ***DFU* = OFF**
- Start the Dashboard and press the **RESET** button on the beacon
- Check SW on the beacon afterwards
- Everything should be OK with SW now. DFU programming is complete

Follow the same scenario for the modem:

- Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming.

- After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v4.9) and press **Reset** button




- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program

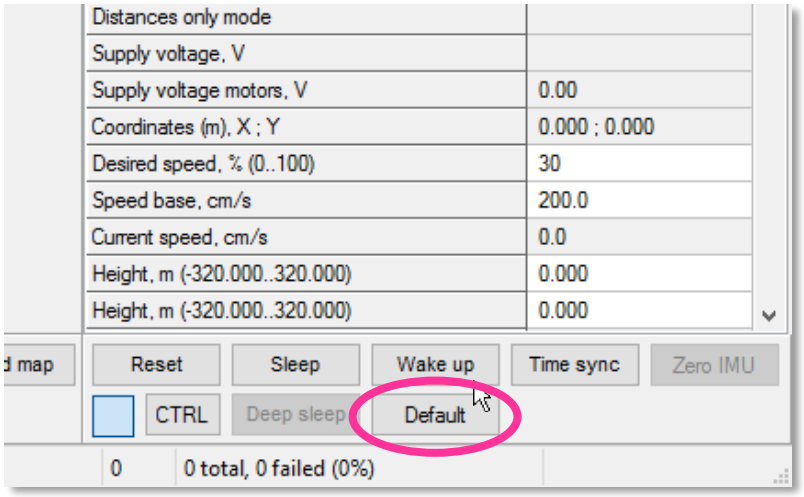
- After a couple of seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen immediately. Otherwise, the SW has not uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different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

- Disconnect the short circuit.

- Start the Dashboard and press **RESET** button

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

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



5.1.7 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 | [illegible] |
| 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 |

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

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

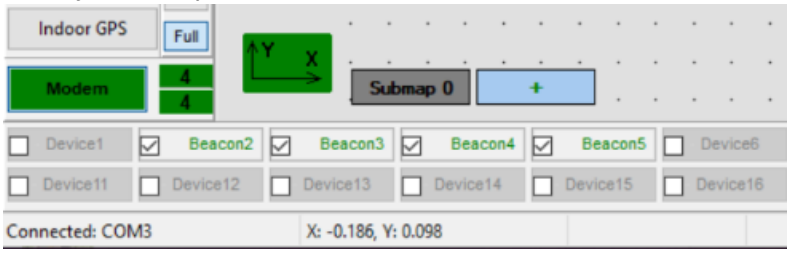
5.1.10 Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon's height for future change in the settings. The help video on installation can be found here - https://youtu.be/WY0HkLzmjys

5.1.11 Connect the modem/router via USB to a Windows PC with the Dashboard installed.

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

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

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



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

5.1.16 The system may run the frequency search, if it is the very first time you are waking 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

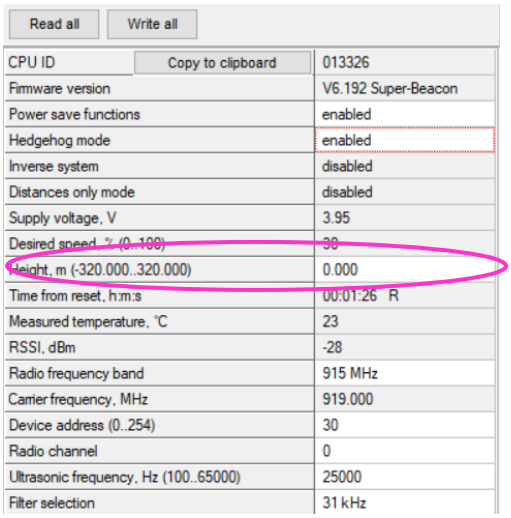
5.1.17 Check that the radio settings on the modem and the radio settings on the beacon are the same

5.1.18 Now you can check RSSI, voltage, ultrasonic filter settings, etc. on the panel on 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 |

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

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



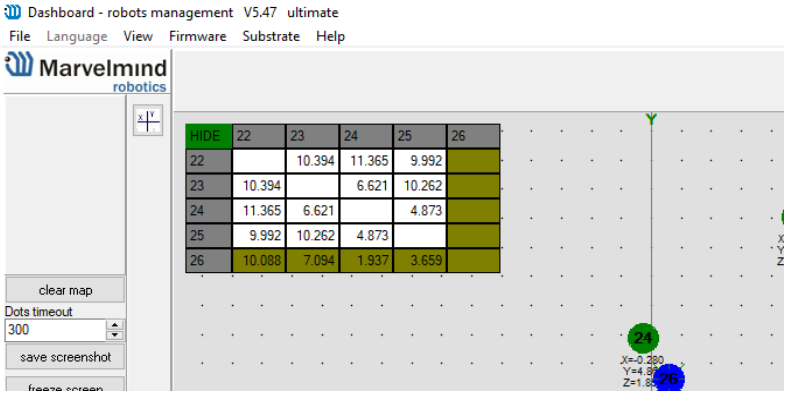

5.1.20 Enter the height for mobile beacon if you use 2D mode

5.1.21 In the current version one modem 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

5.1.22 Double click on the device both to put it into sleep mode and to wake it up

5.1.23 The map will form and zoom in automatically

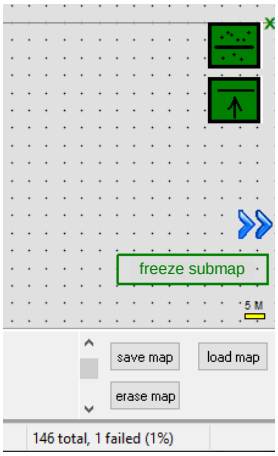
5.1.24 If the map does not form well, check the table of distances in the left corner of the Dashboard. The cells must be colored in white; it means the distances between stationary beacons are measured correctly




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

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

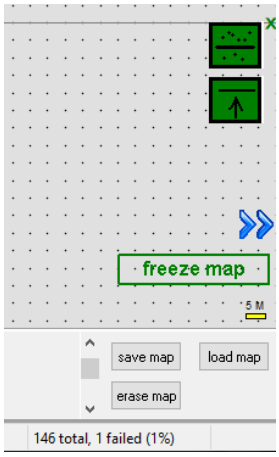
5.1.27 Freeze submap and by clicking the button. Stationary beacons will stop measuring relative distances and will be ready to measure distance from the mobile beacon(s).




5.1.28 Turn on and wake up the mobile beacon following the same steps as with the stationary beacon: https://youtu.be/A4aRsjH2-_E

5.1.29 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 or some ultrasonic or radio settings may be different. You can change the settings for sensors manually by clicking on the panel on the upper right corner of the Dashboard to change the cells from gray to green to turn on 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.

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




5.1.31 The system is now fully operational.

## 5.2 Starter Set IA-01-2D

The steps below describe the very first time you set up of the system. Mini-RX-beacon, HW v4.9 beacons and modem required.

**This is Inverse Architecture. Beacons HW v4.9 should have different frequencies. Use IA Software ONLY.**

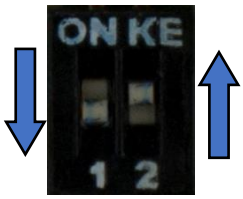
**You can't just switch HW v4.9 beacon to another frequency, it is HW depended**

**Ultrasonic can't be changed to default. You must check the frequency on the white sticker**


5.2.1 Unpack the system. Take a look at the similar unpacking video of HW v4.9. They are different, but have some similar basics: https://youtu.be/sOce7B2_6Sk

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

5.2.3 Turn the beacons on (To turn Mini-RXs on, carefully disassemble its housing and find DIP switches inside. It is necessary only for the first start. You can also turn it off with switches for long-term storage): Place DIP switches as shown on the picture below

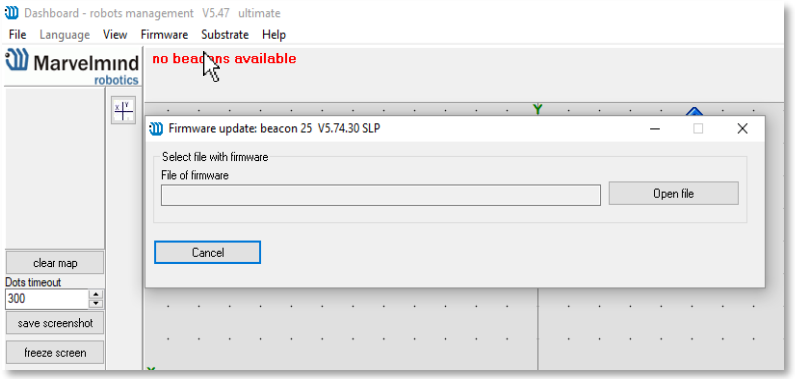



5.2.4 Download SW Pack

5.2.5 Update all the beacons

- You need Inverse Architecture SW (go to marvelmind_SW_*xxx_xx_xx*\Software_ia)

– 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 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 link at top window in the Dashboard and run the installation file, then click on the link under and install the driver

Ensure that:

(i) You are programming the modem’s SW to the modem and the beacon’s SW to the beacon

(j) You are using SW for 4.9, if you have HW v4.9; 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

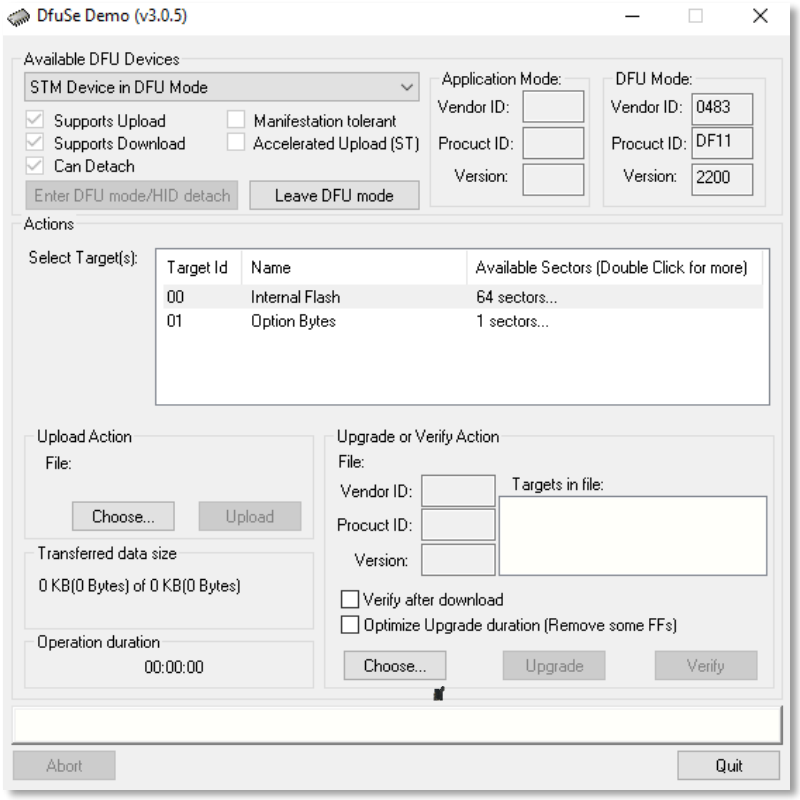
If SW flashed SUCESSUFLY, MOVE DIRECTLY TO 6.1.7. If you have some problems with HEX programming, use DFU programming:

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 major changes to the system and the only possible way to update the SW is via DFU programming

- After the DFU SW upgrade, futures SW upgrades can be done in a regular manner via the Dashboard
- To start programming, move the beacon’s DIP switch to the DFU programming mode, as described in the paragraph on DIP switch modes
- Download the latest SW package, unzip it, and select the proper version of the SW for your HW and for your 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. v3.0.4 or v3.0.5, whichever works the best for your Windows: DfuSe v3.0.4 or DfuSe v.3.0.5

DFU Programming:

- Put DIP switch into ***Power* = ON**, ***DFU* = ON** (DIP switch in Mini-RX and situated inside the body. To switch it, carefully disassemble the body).
- Connect the beacon via USB to your PC.
- Run DfuSe.
- Press the **RESET** button on your beacon.
- In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode.
- Choose the DFU driver (file) for the beacon.

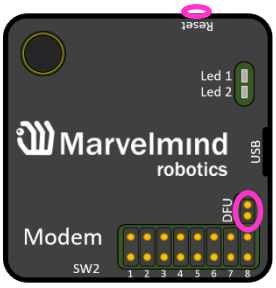



- Click the **UPGRADE** button
- After a couple of seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW you selected
- Move the DIP switch into ***Power* = ON**, ***DFU* = OFF**
- Start the Dashboard and press the **RESET** button on the beacon
- Check SW on the beacon afterwards
- Everything should be OK with SW now. DFU programming is complete

Follow the same scenario for the modem:

- Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming.

- After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v4.9) and press **Reset** button




- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program

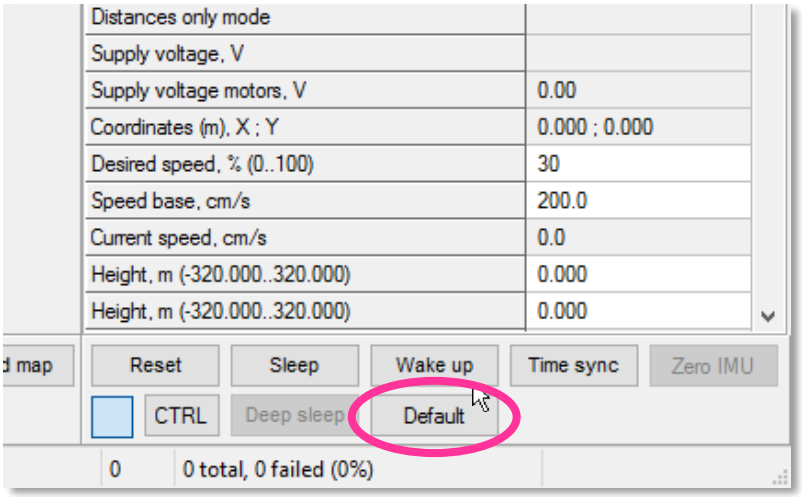
- After a couple of seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen immediately. Otherwise, the SW has not uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different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

- Disconnect the short circuit.

- Start the Dashboard and press **RESET** button

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

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



5.2.7 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 | [illegible] |
| 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 |

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

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

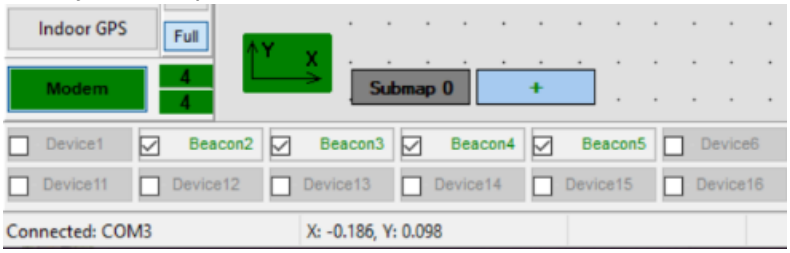
5.2.10 Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon's height for future change in the settings. The help video on installation can be found here - https://youtu.be/WY0HkLzmjys

5.2.11 Connect the modem/router via USB to a Windows PC with the Dashboard installed.

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

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

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



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

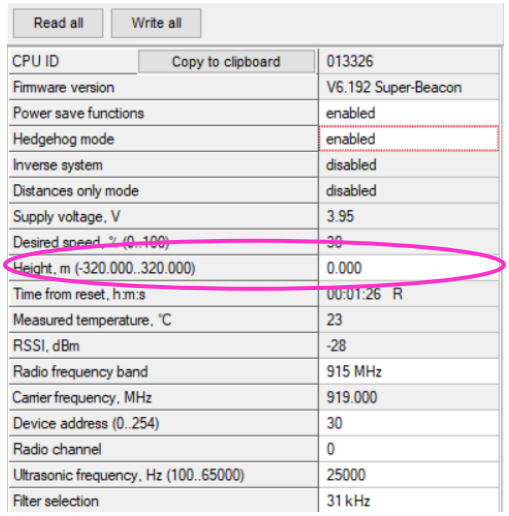
5.2.16 The system may run the frequency search, if it is the very first time you are waking up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are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

5.2.17 Check that the radio settings on the modem and the radio settings on the beacon are the same

5.2.18 Now you can check RSSI, voltage, ultrasonic filter settings, etc. on the panel on 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 |

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




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

5.2.21 In current version one modem 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.

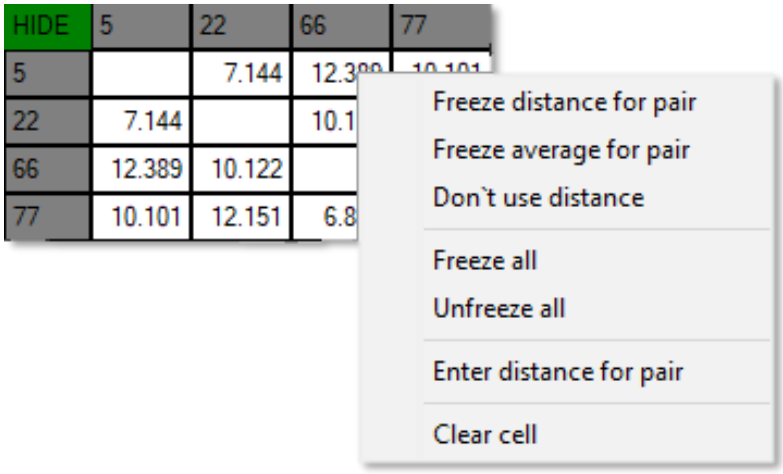
**Only 4 stationary beacons may be in 1 submap. If you wake up more beacons, create new submap for them. Or it won't be displayed on the map and in the table of distances.**

5.2.22 Build the map:

Beacons with different frequencies are not able to build the map automatically, so you have to build it manually

Step 1. Open the Dashboard. You will see the table of distances.

Step 2. Use right mouse click on cell you want to enter the distance. Additional menu will open. There you can control the table of distances. Choose **Enter distance for pair** to enter the value.

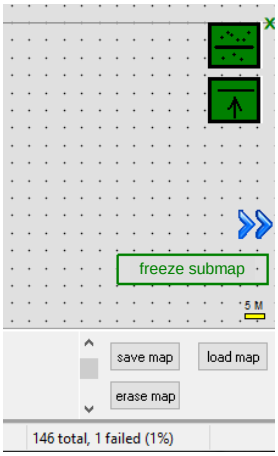



Step 3. Now, enter measured (measure it with laser distance meter or so) value. That values would not change until you unfreeze or clear it. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can cause a huge impact on your tracking.

Step 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 | |

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

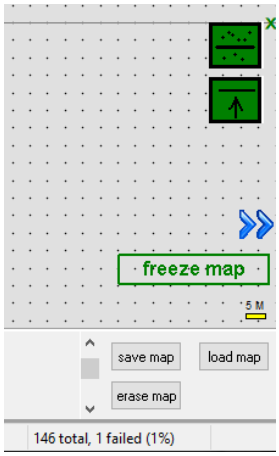



5.2.24 Turn on and wake up the mobile beacon following the same steps as with the stationary beacon: https://youtu.be/A4aRsjH2-_E

5.2.25 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 or

some ultrasonic or radio settings may be different. You can change the settings for sensors manually by clicking on the panel on the upper right corner of the Dashboard to change the cells from gray to green to turn on 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.

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




5.2.27 The system is now fully operational.

## 5.3 Starter Set IA-02-3D

The steps below describe the very first time you set up of the system. Mini-RX-beacon, HW v4.9 beacons and modem required.

**This is Inverse Architecture. Beacons HW v4.9 should have different frequencies. Use IA Software ONLY.**

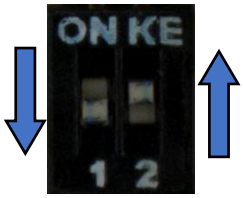
**You can't just switch HW v4.9 beacon to another frequency, it is HW depended**

**Ultrasonic can't be changed to default. You must check the frequency on the white sticker**

5.3.1 Unpack the system. Take a look at the similar unpacking video of HW v4.9. They are different, but have some similar basics: https://youtu.be/sOce7B2_6Sk

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

5.3.3 Turn the beacons on (To turn Mini-RXs on, carefully disassemble its housing and find DIP switches inside. It is necessary only for the first start. You can also turn it off with switches for long-term storage): Place



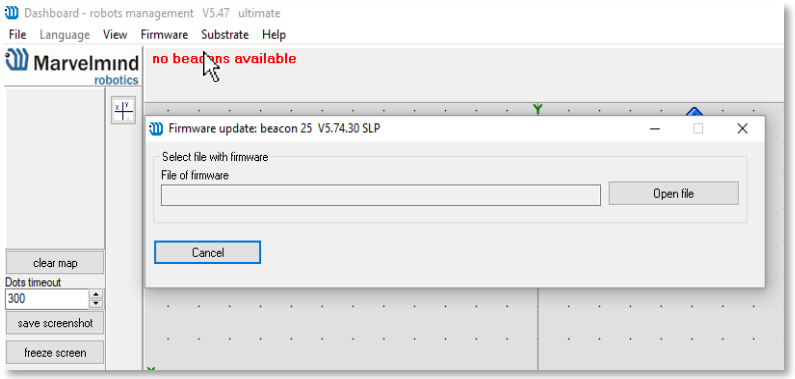

DIP switches as shown on the picture below

5.3.4 Download SW Pack

5.3.5 Update all the beacons

- You need Inverse Architecture SW (go to marvelmind_SW_*xxx_xx_xx*\Software_ia)

– 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 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 link at top window in the Dashboard and run the installation file, then click on the link under and install the driver

Ensure that:

(k) You are programming the modem’s SW to the modem and the beacon’s SW to the beacon

(l) You are using SW for 4.9, if you have HW v4.9; 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

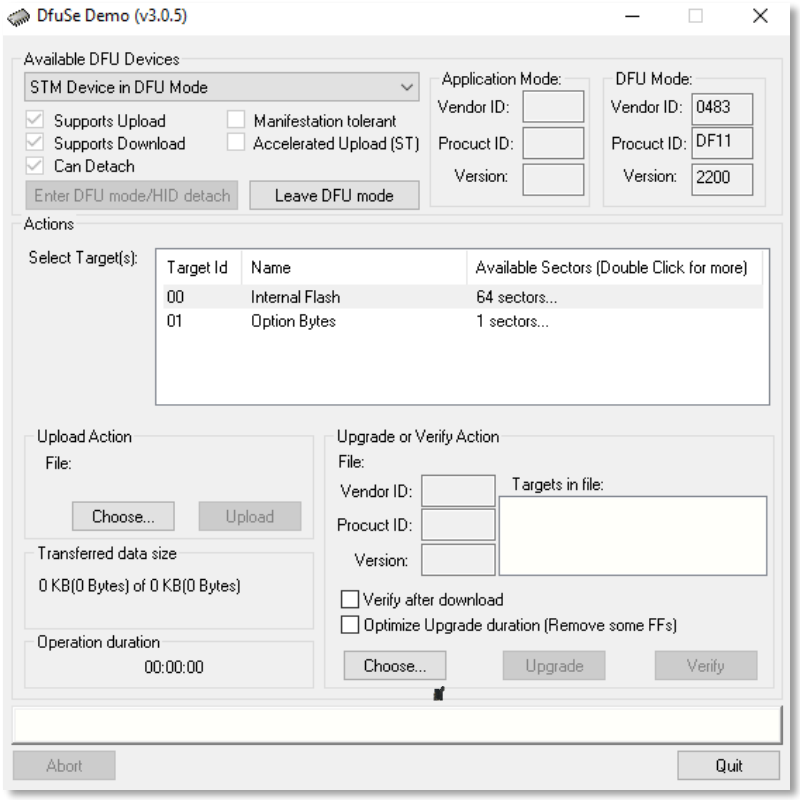
If SW flashed SUCESSUFLY, MOVE DIRECTLY TO 5.2.6. If you have some problems with HEX programming, use DFU programming:

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 major changes to the system and the only possible way to update the SW is via DFU programming

- After the DFU SW upgrade, futures SW upgrades can be done in a regular manner via the Dashboard
- To start programming, move the beacon’s DIP switch to the DFU programming mode, as described in the paragraph on DIP switch modes
- Download the latest SW package, unzip it, and select the proper version of the SW for your HW and for your 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. v3.0.4 or v3.0.5, whichever works the best for your Windows: DfuSe v3.0.4 or DfuSe v.3.0.5

DFU Programming:

- Put DIP switch into ***Power* = ON**, ***DFU* = ON** (DIP switch in Mini-RX and situated inside the body. To switch it, carefully disassemble the body).
- Connect the beacon via USB to your PC.
- Run DfuSe.
- Press the **RESET** button on your beacon.
- In the upper left corner of the DfuSe program, you will see a device connected in the DFU mode.
- Choose the DFU driver (file) for the beacon.

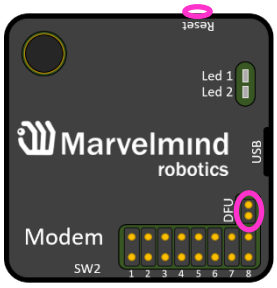



- Click the **UPGRADE** button
- After a couple of seconds, the DFU will be uploaded to the beacon. Make sure it takes 1–3 seconds and does not happen instantly. Otherwise, the SW has not been uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW you selected
- Move the DIP switch into ***Power* = ON**, ***DFU* = OFF**
- Start the Dashboard and press the **RESET** button on the beacon
- Check SW on the beacon afterwards
- Everything should be OK with SW now. DFU programming is complete

Follow the same scenario for the modem:

- Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming.

- After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v4.9) and press **Reset** button




- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program

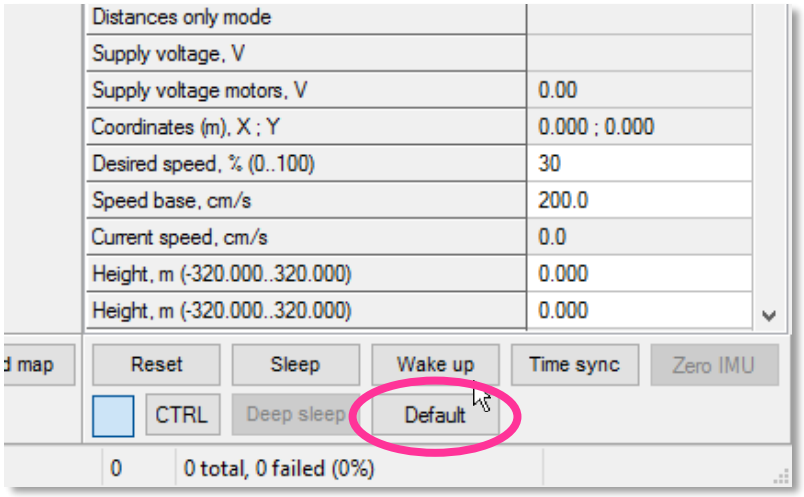
- After a couple of seconds, the DFU will be uploaded to the modem. Make sure it takes 1-3 seconds and does not happen immediately. Otherwise, the SW has not uploaded correctly. If the DFU appears to upload immediately, check the "Choose" button you used or change the version of DfuSe SW to a different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

- Disconnect the short circuit.

- Start the Dashboard and press **RESET** button

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

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



5.3.7 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 | [illegible] |
| 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 |

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

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

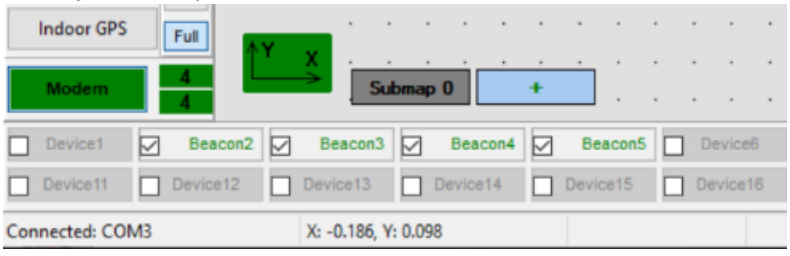
5.3.10 Place the stationary beacons high on the walls vertically in a way that will provide optimal ultrasonic coverage. Write down the beacon's height for future change in the settings. The help video on installation can be found here - https://youtu.be/WY0HkLzmjys

5.3.11 Connect the modem/router via USB to a Windows PC with the Dashboard installed.

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

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

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



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

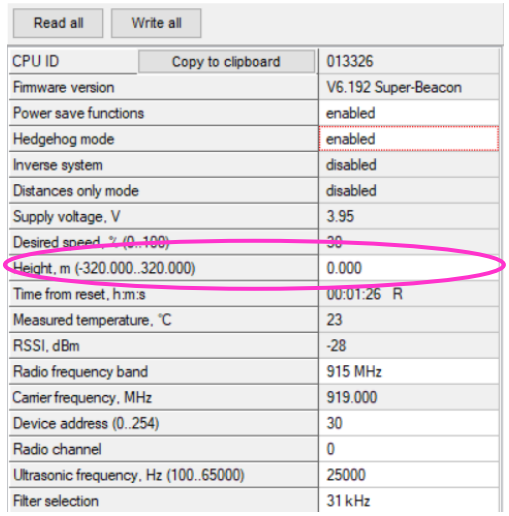
5.3.16 The system may run the frequency search, if it is the very first time you are waking up the beacons. If this step does not work, disconnect the modem and connect that beacon again via USB. Press the DEFAULT button in the Dashboard and the Read All button to make sure that the radio settings are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

5.3.17 Check that the radio settings on the modem and the radio settings on the beacon are the same

5.3.18 Now you can check RSSI, voltage, ultrasonic filter settings, etc. on the panel on 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 |

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




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

5.3.21 In current version one modem 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.

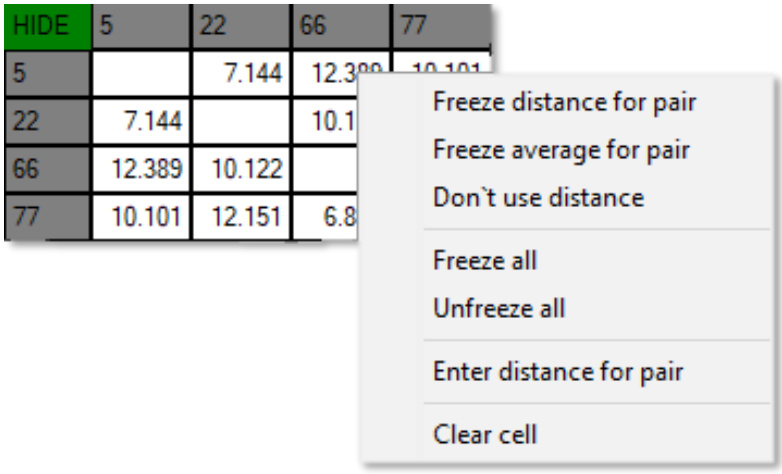
**Only 4 stationary beacons may be in 1 submap. If you wake up more beacons, create new submap for them. Or it won't be displayed on the map and in the table of distances.**

5.3.22 Build the map:

Beacons with different frequencies are not able to build the map automatically, so you have to build it manually

Step 5. Open the Dashboard. You will see the table of distances.

Step 6. Use right mouse click on cell you want to enter the distance. Additional menu will open. There you can control the table of distances. Choose **Enter distance for pair** to enter the value.

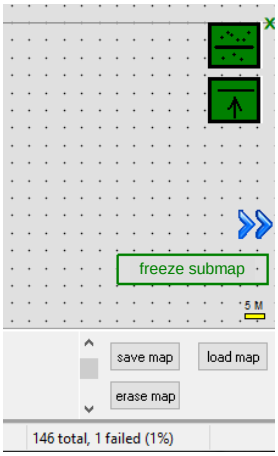



Step 7. Now, enter measured (measure it with laser distance meter or so) value. That values would not change until you unfreeze or clear it. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can cause a huge impact on your tracking.

Step 8. 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 | |

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

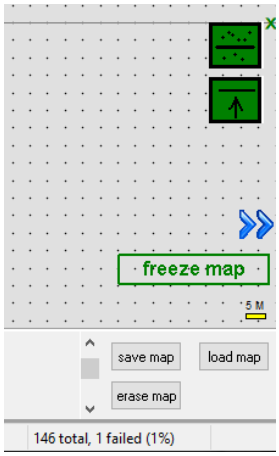



5.3.24 Turn on and wake up the mobile beacon following the same steps as with the stationary beacon: https://youtu.be/A4aRsjH2-_E

5.3.25 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 or

some ultrasonic or radio settings may be different. You can change the settings for sensors manually by clicking on the panel on the upper right corner of the Dashboard to change the cells from gray to green to turn on 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.

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

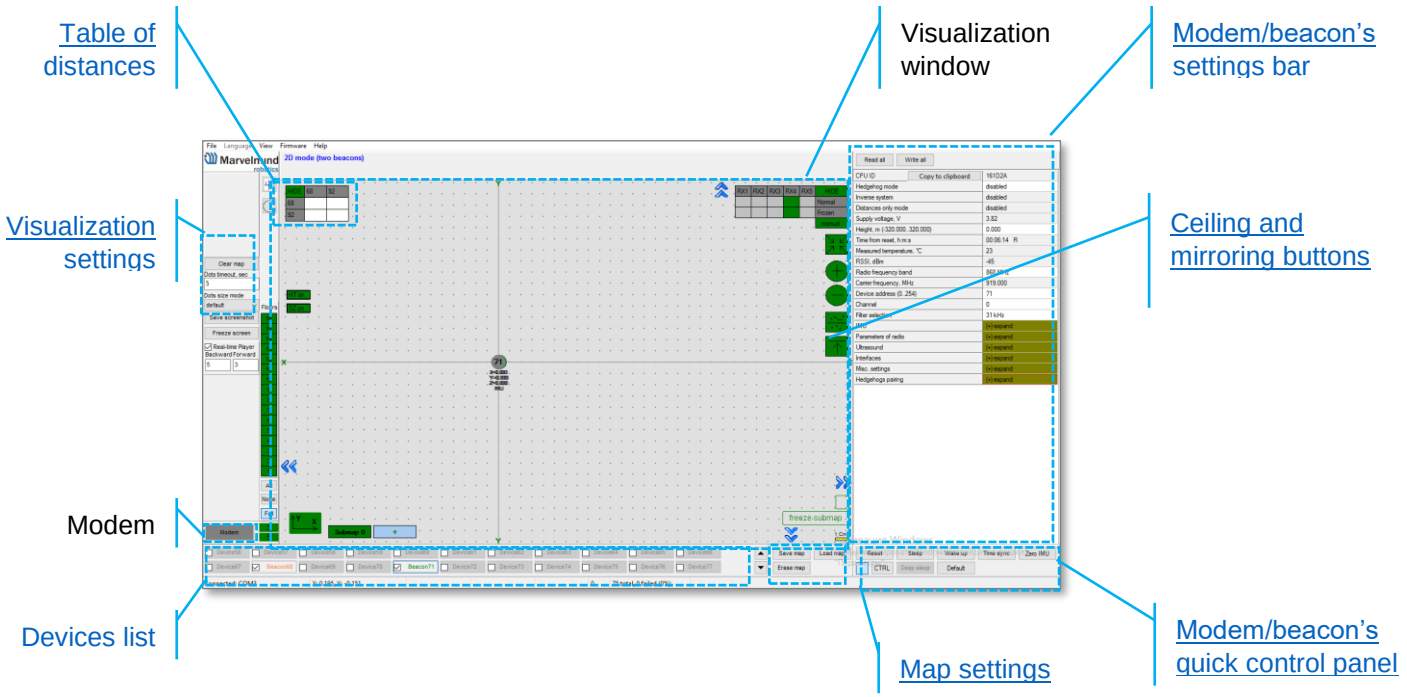



5.3.27 The system is now fully operational.

# 6. Dashboard menu and parameters

## 6.1 Dashboard general view

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



## 6.2 Table of distances

Table of distances shows the measured distance between all beacons. The map and its graphical visualization depend on distances, which is a very important part of the system.

There are two ways of measuring:

1) Measuring by ultrasound (automatic)
2) Measuring by user (manual)

***Measuring by ultrasound is impossible for Mini-RX and Industrial-RX beacons**

***In noisy cases and cases with long distances it is better to use manual input**

1) Measuring by ultrasound:

- In most cases, the system builds the table of distances automatically. If everything is good, there would be figures in cells, they would be changing 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 | |

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

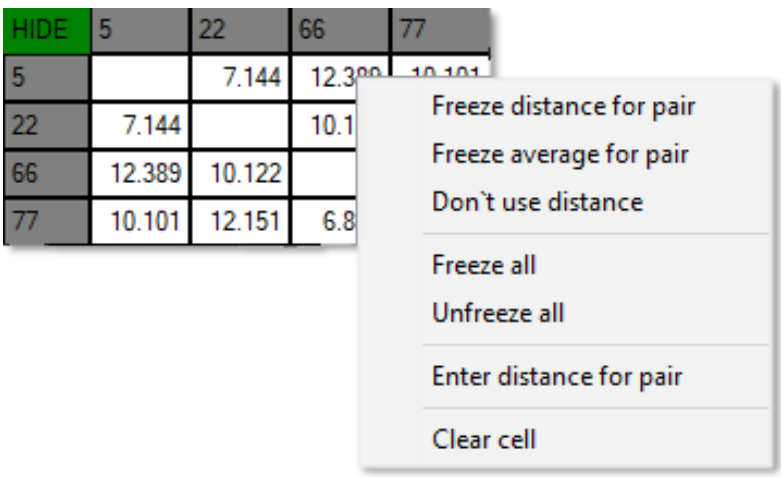
2) Measuring by user **(necessary for Mini-RX beacons and noisy cases)**:

- Use manual input if table of distances didn't build. It may happen if environment is very noisy, or distances are very huge
- In that case, cells' color would be green
- Be careful with figures because a small mistake in the values will cause mistakes in location

How to freeze/enter distance manually:

Step 1. Open the Dashboard. You will see the table of distances

Step 2. Use right mouse click on cell you want to freeze/enter. Additional menu will open. There you can control the table of distances. Choose **Freeze distance for pair** to freeze it



Step 3. Now, cells are frozen. That values would not change until you unfreeze it. Even if beacons had been moved, distance would stay. Be careful with frozen cells because a small mistake can cause a huge impact on 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 | |

Step 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

## 6.3 Devices list

Devices list contains information about all the beacons in the system. It also allows to search, add and delete it.

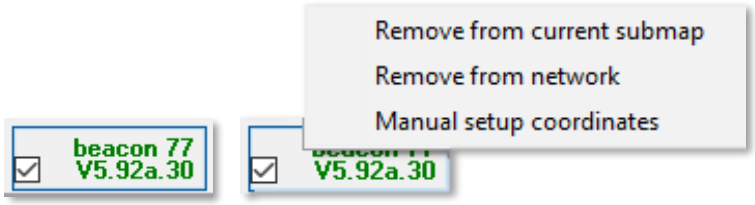

Devices in this section are divided into two types:

1) Stationary beacon (beacon)
2) Mobile beacon (hedge)

- Devices list allows user to manage devices
- Use double click to put beacon into sleep mode

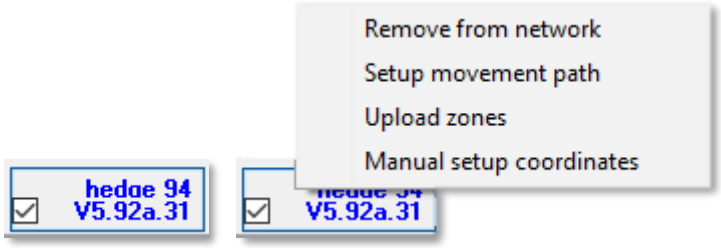
1) Stationary beacon (beacon)

- Press right mouse button and additional menu will open
- There you can:
  - Remove beacon from current submap
  - Remove beacon from the whole network
  - Manually setup coordinates (x, y, z)




2) Mobile beacon (hedge)

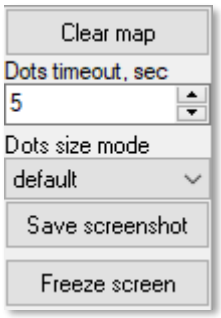
- Press right mouse button and additional menu will open
- There you can:
  - Remove beacon from the network
  - Setup movement path
  - Upload zones (allowed and denied)
  - Manually setup coordinates (x, y, z)



## 6.4 Visualization settings

Visualization settings window has some functions to control visualization process:

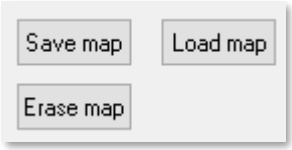
- Clear map – clear all movement path
- Dots timeout – time of path's existence (Video: Help: Dots timeout)
- Dots size mode – size of dots
- Save screenshot – files save to **Dashboard's folder/screenshots**
- Freeze screen – The map freeze, no updates of the path



## 6.5 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

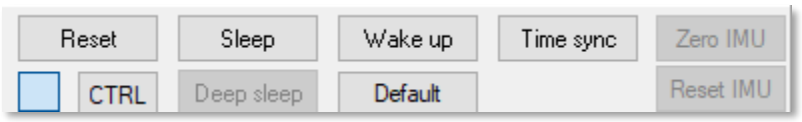


## 6.6 Modem/beacon’s quick control panel

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

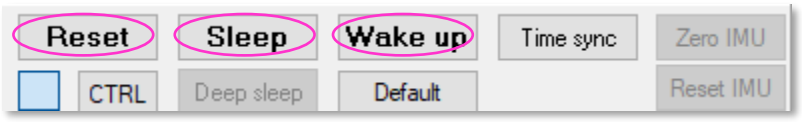
List of functions:

Reset – Resets device
Sleep – Send device asleep (battery economy mode)
Wake up – Wakes up 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)



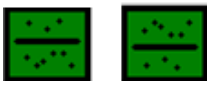

Additional Ctrl feature:

To apply action to all beacons in the system, use **Ctrl + left mouse click** on button.
Applicable only for buttons that turn **bold** while Ctrl is pressed.



## 6.7 CEILLING and MIRRORING buttons on the Dashboard

- The **MIRRORING** button allows the map to be display as a mirror reflection



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

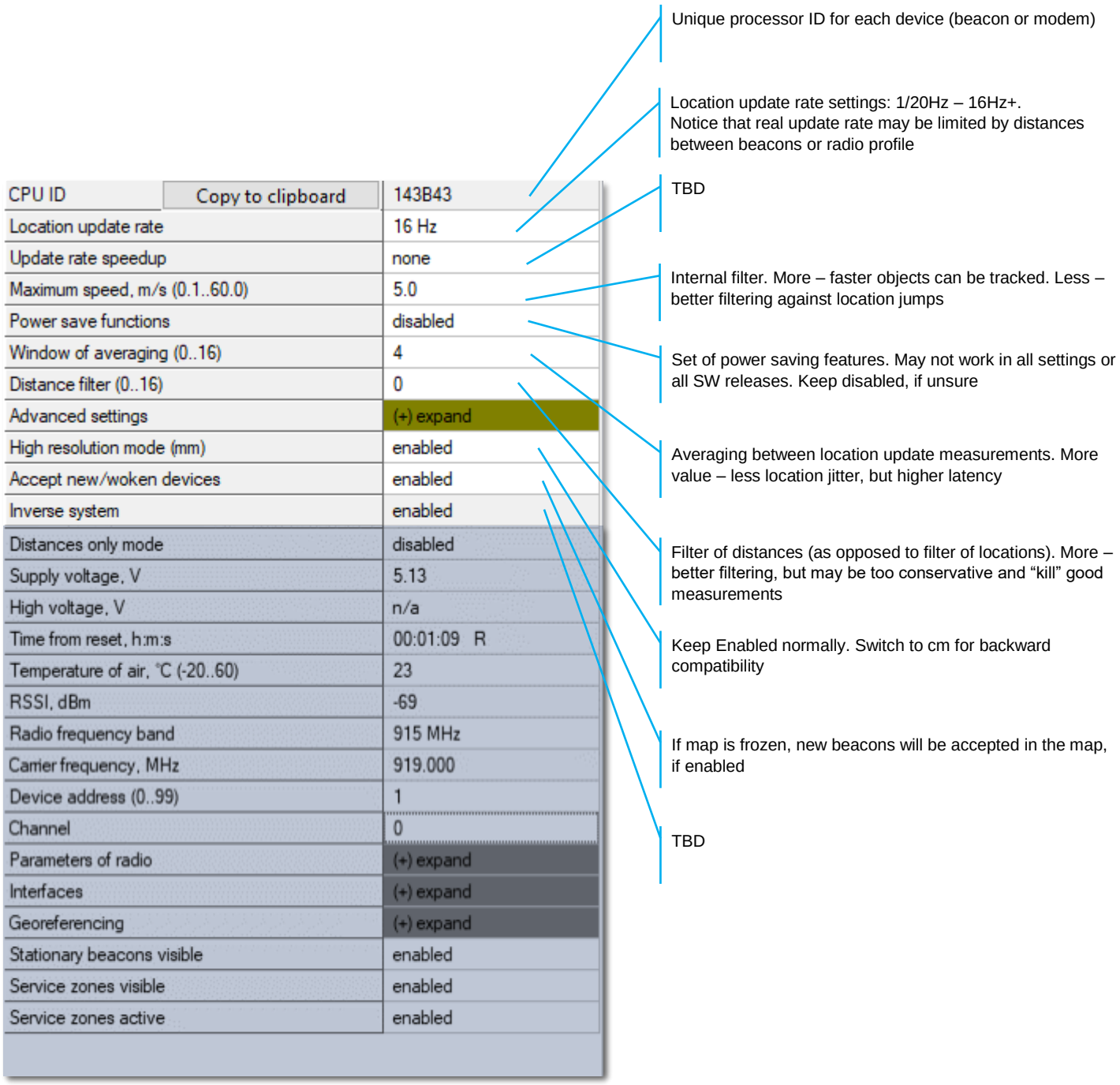
- When the arrow points up, it means that the mobile beacon is below the stationary beacons

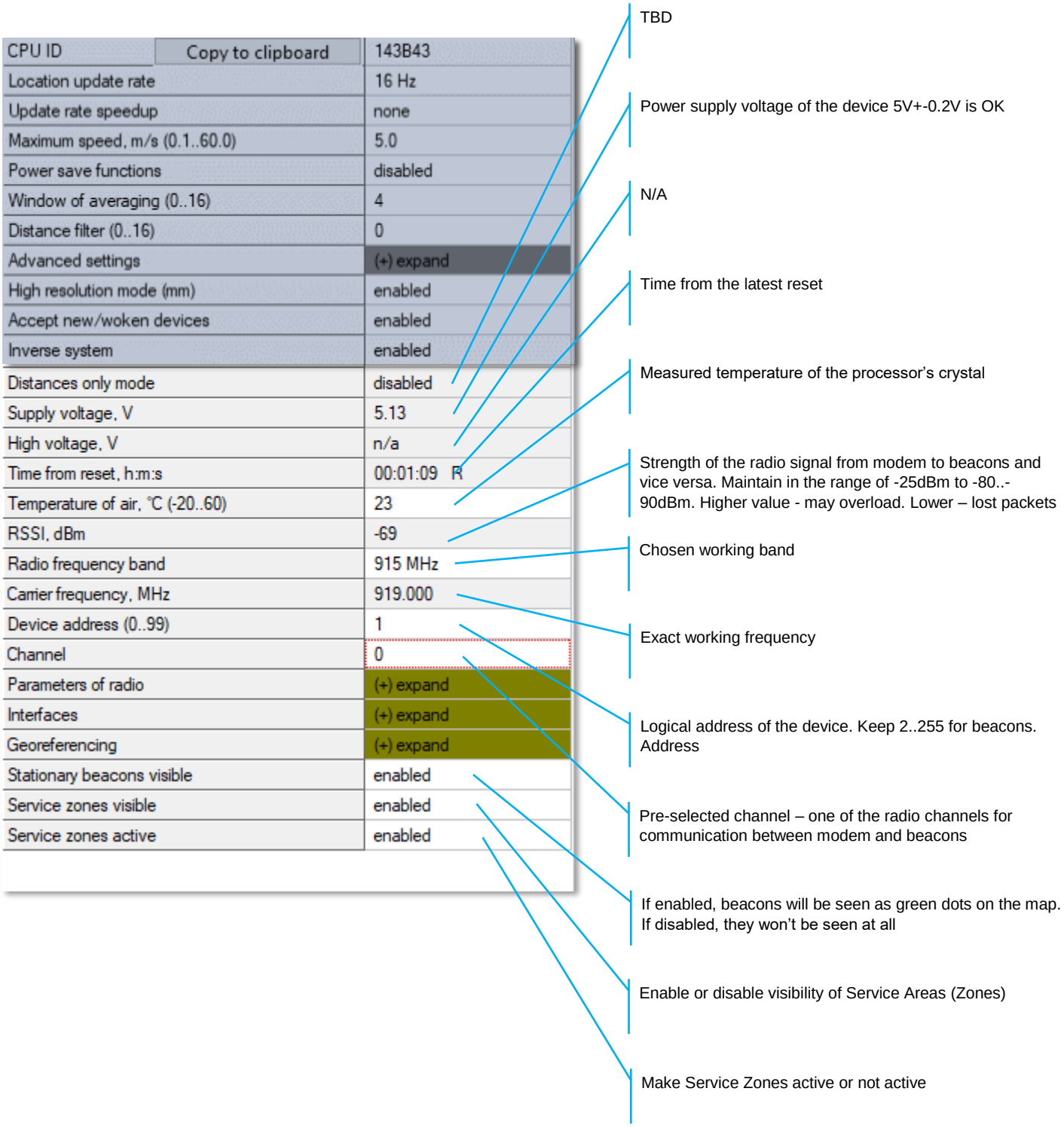
- When the arrow points down, it means that the mobile beacon is **above the stationary beacons**

## 6.8 Detailed settings

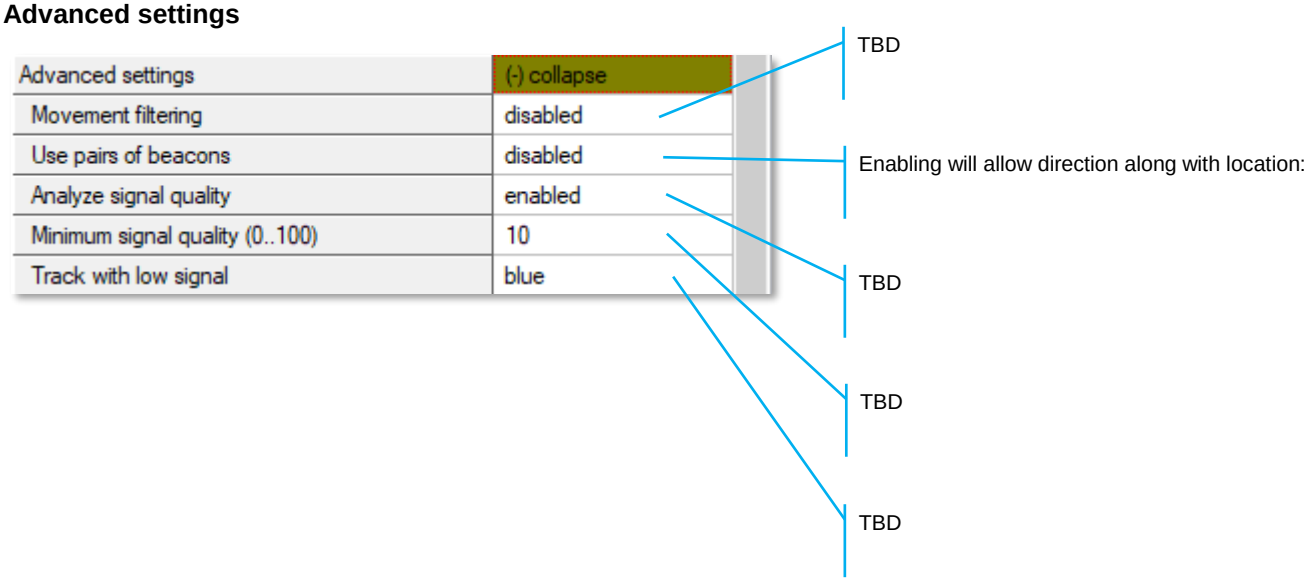
This bar allows user to adjust devices very precisely. It contains a lot of parameters for advanced usage

**Modem Settings**

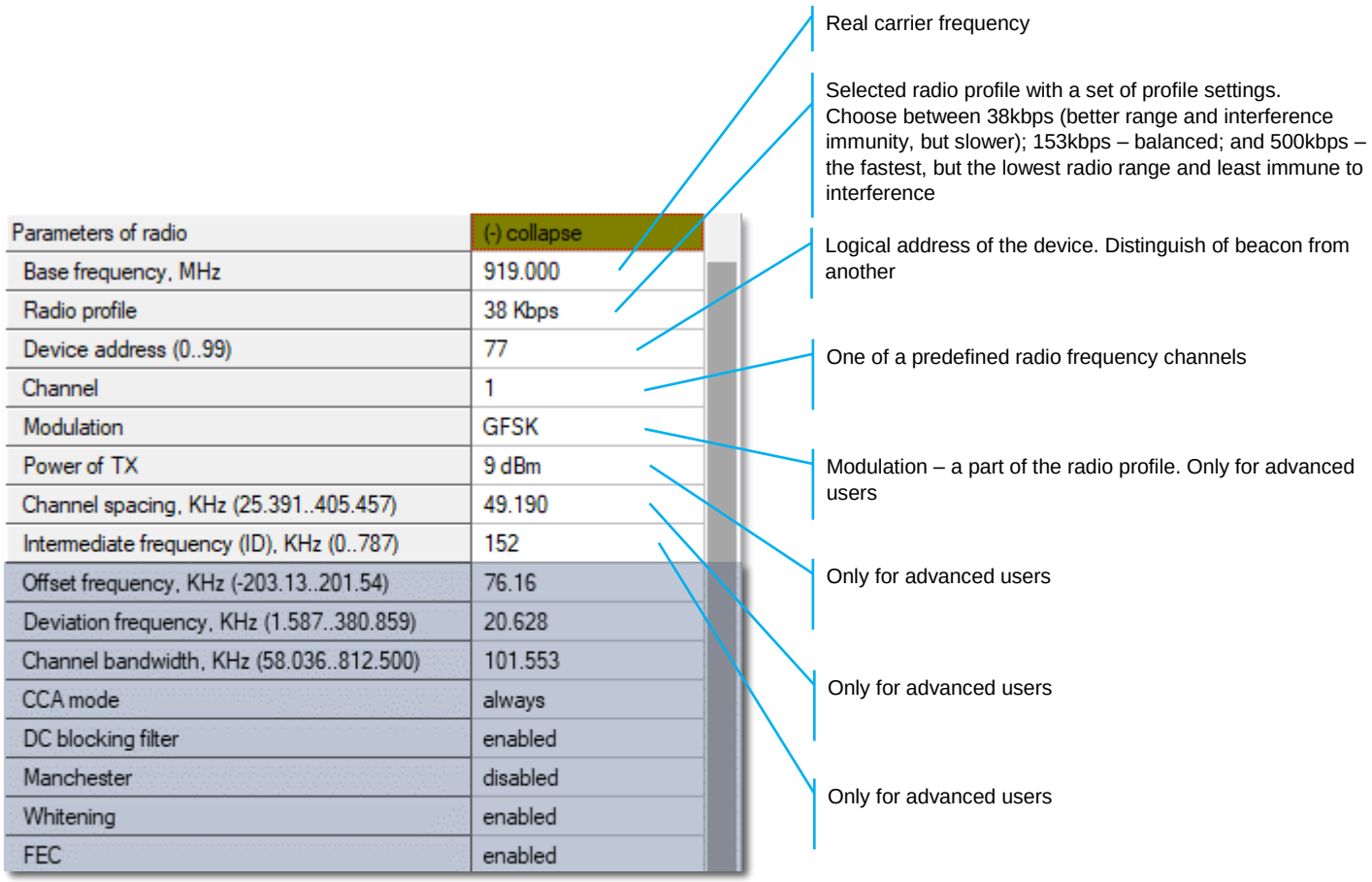


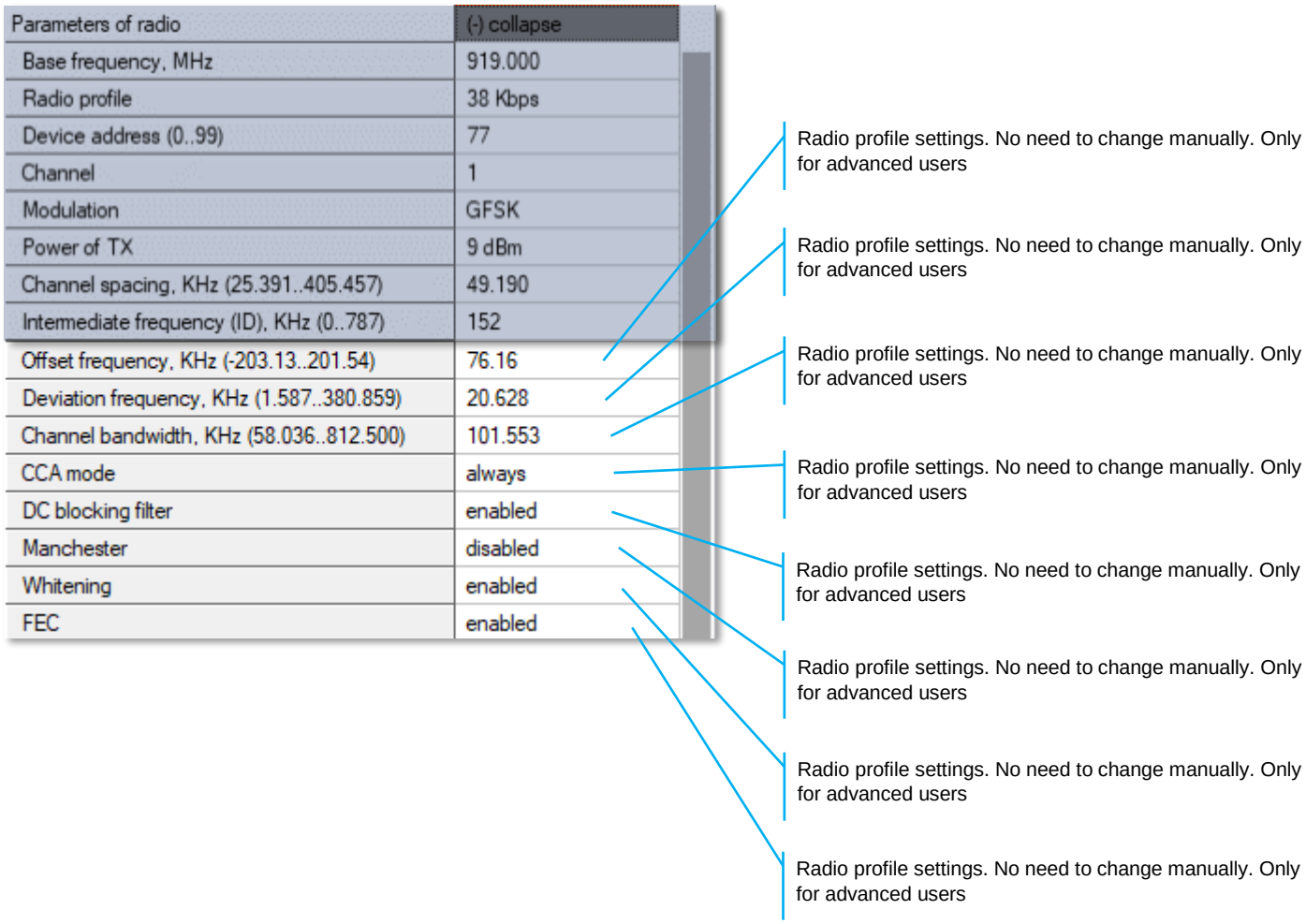

CPU ID
Copy to clipboard
143B43
Location update rate
16 Hz
Update rate speedup
none
Maximum speed, m/s (0.1..60.0)
5.0
Power save functions
disabled
Window of averaging (0..16)
4
Distance filter (0..16)
0
Advanced settings
(+) expand
High resolution mode (mm)
enabled
Accept new/woken devices
enabled
Inverse system
enabled
Distances only mode
disabled
Supply voltage, V
5.13
High voltage, V
n/a
Time from reset, h:m:s
00:01:09 R
Temperature of air, °C (-20..60)
23
RSSI, dBm
-69
Radio frequency band
915 MHz
Carrier frequency, MHz
919.000
Device address (0..99)
1
Channel
0
Parameters of radio
(+) expand
Interfaces
(+) expand
Georeferencing
(+) expand
Stationary beacons visible
enabled
Service zones visible
enabled
Service zones active
enabled
TBD
Power supply voltage of the device 5V+-0.2V is OK
N/A
Time from the latest reset
Measured temperature of the processor's crystal
Strength of the radio signal from modem to beacons and vice versa. Maintain in the range of -25dBm to -80..-90dBm. Higher value - may overload. Lower – lost packets
Chosen working band
Exact working frequency
Logical address of the device. Keep 2..255 for beacons. Address
Pre-selected channel – one of the radio channels for communication between modem and beacons
If enabled, beacons will be seen as green dots on the map. If disabled, they won't be seen at all
Enable or disable visibility of Service Areas (Zones)
Make Service Zones active or not active

### Advanced settings

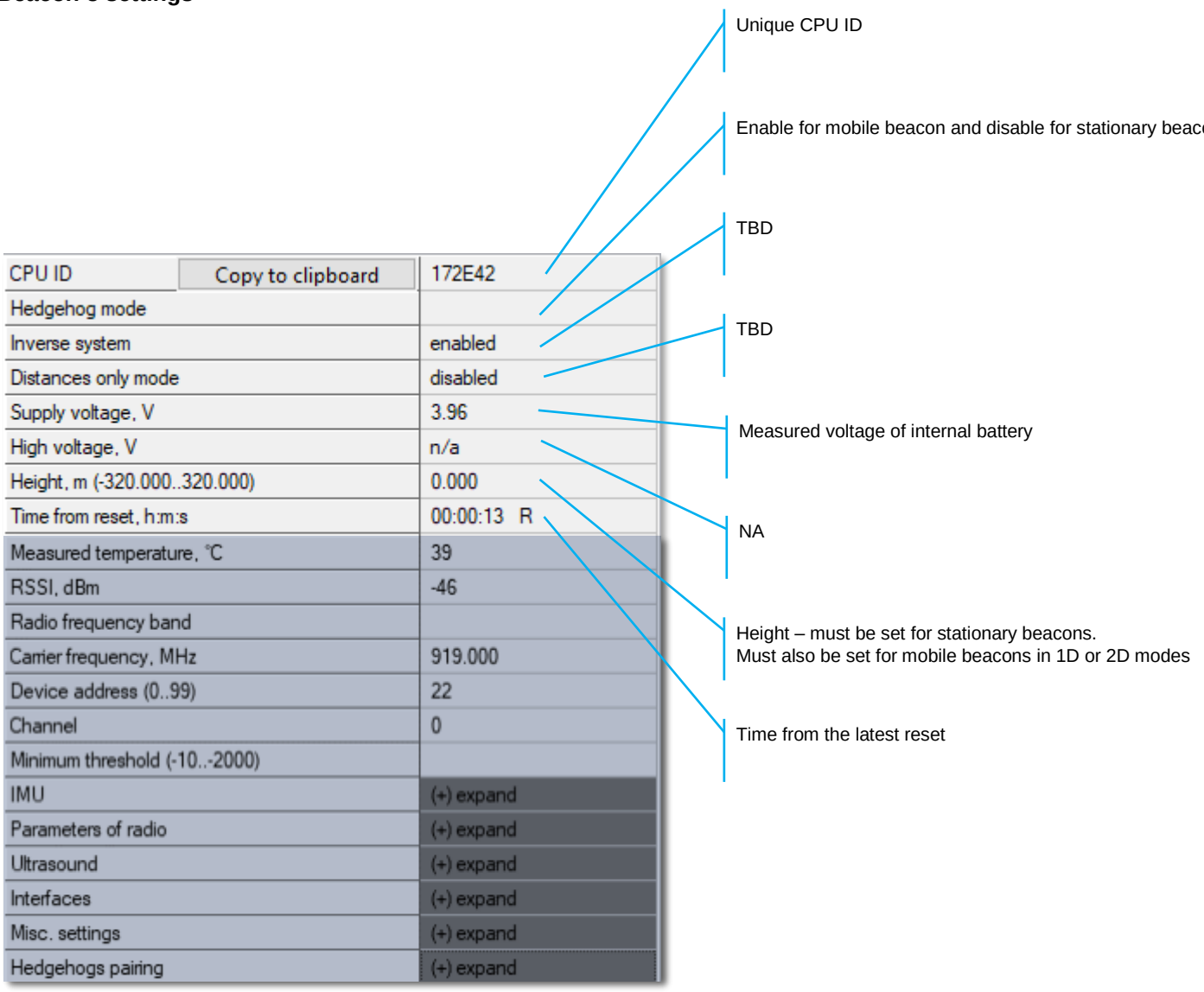


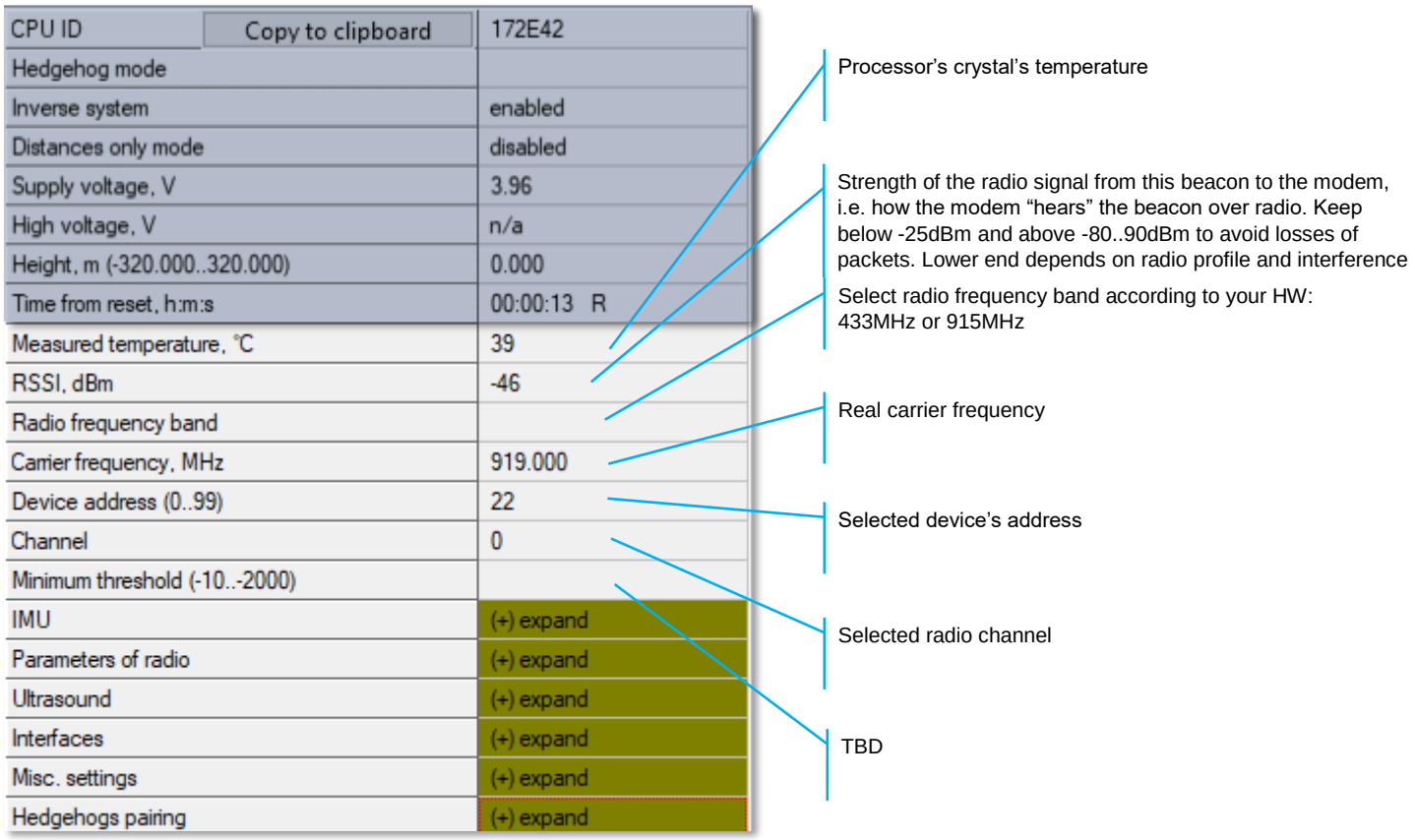
### Parameters of radio



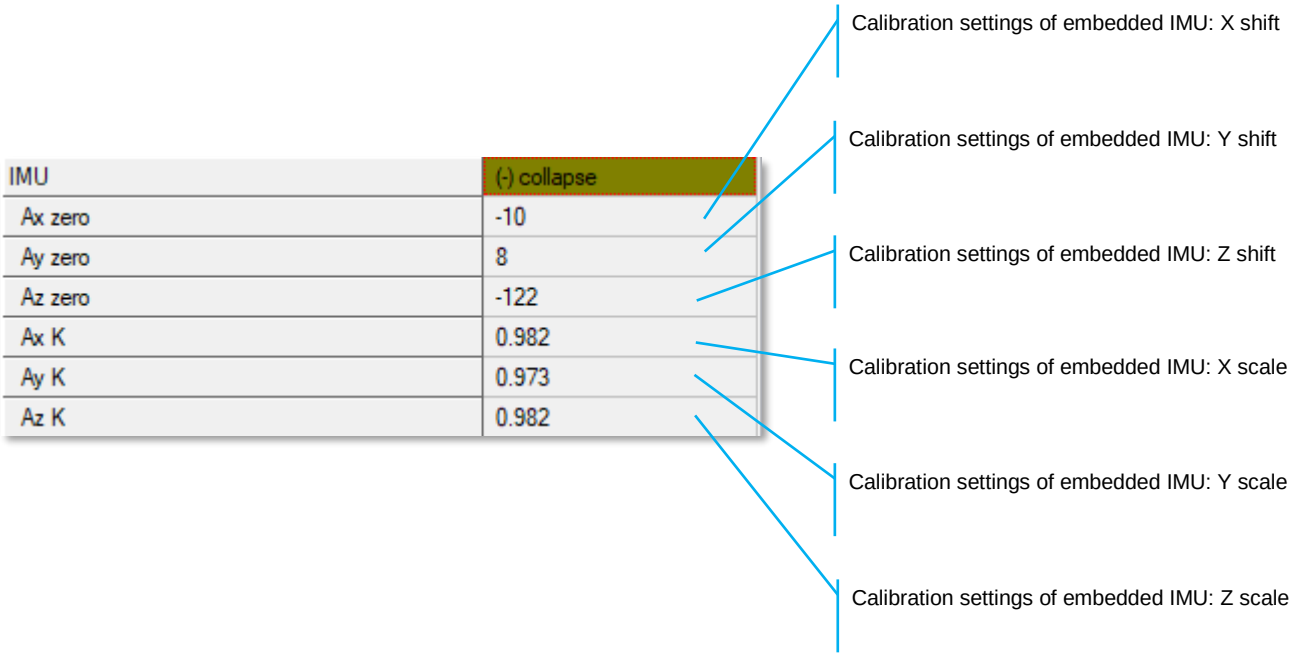


**Beacon’s settings**

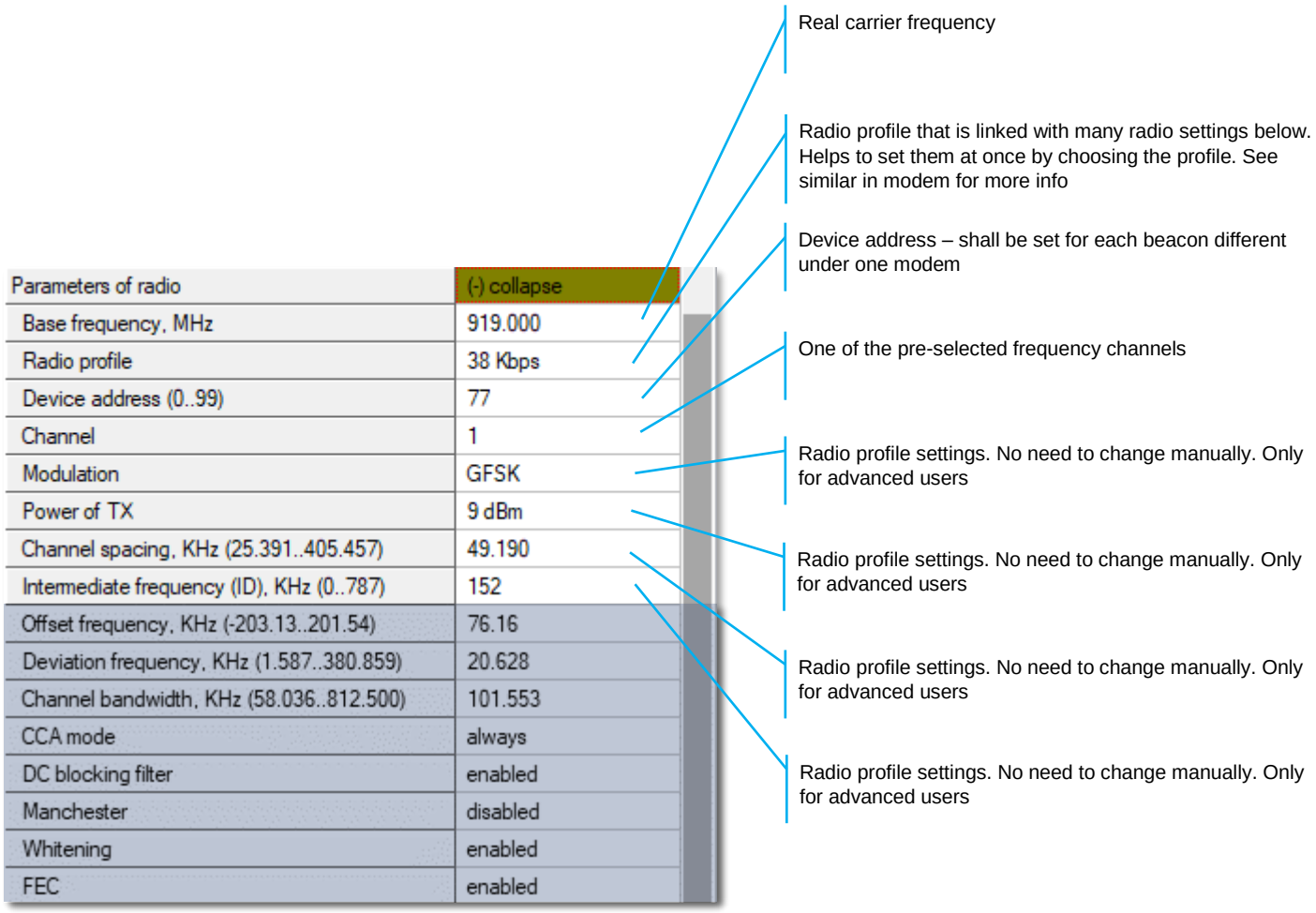


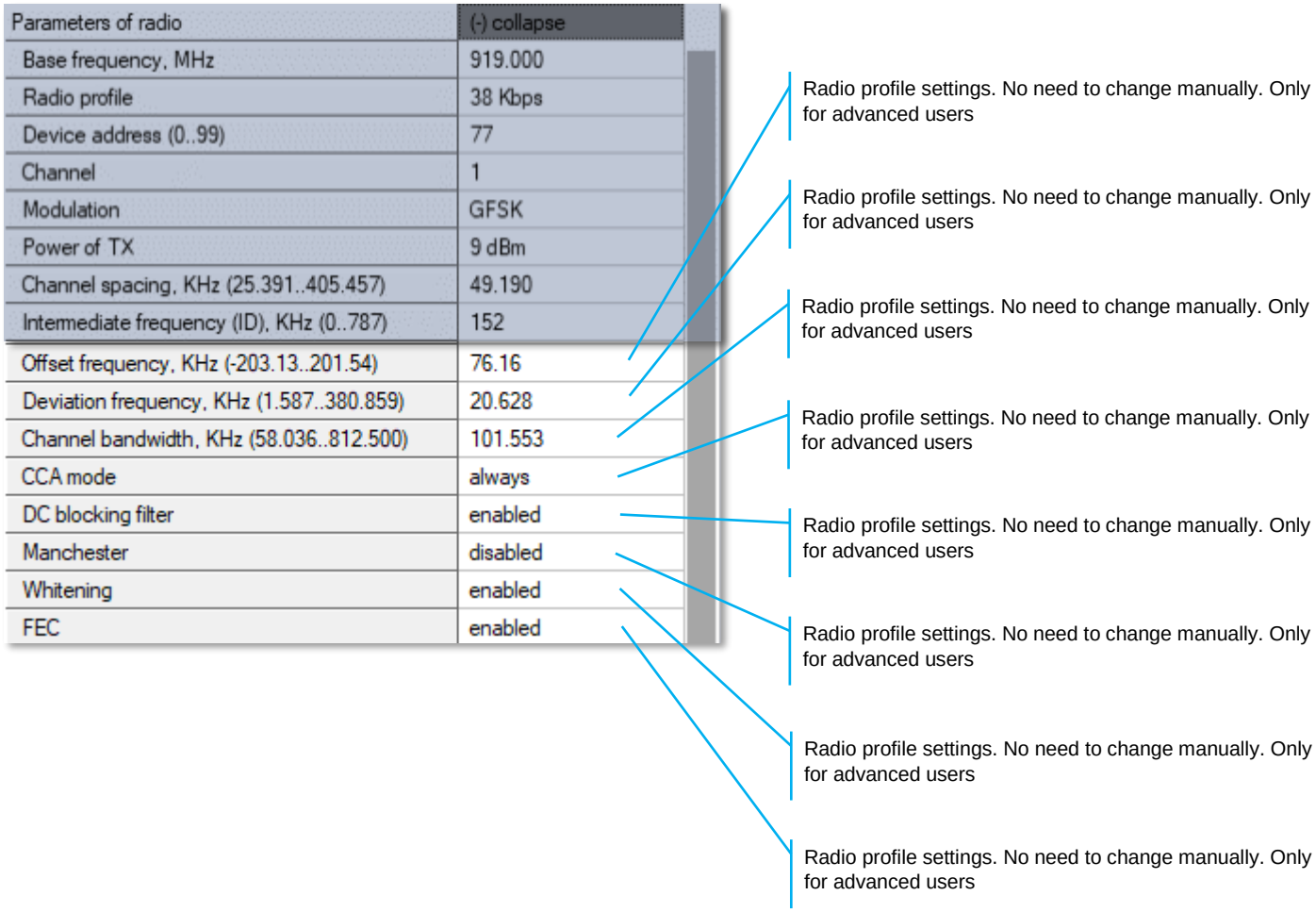

CPU ID
Copy to clipboard
172E42
Hedgehog mode
Inverse system
enabled
Distances only mode
disabled
Supply voltage, V
3.96
High voltage, V
n/a
Height, m (-320.000..320.000)
0.000
Time from reset, h:m:s
00:00:13 R
Measured temperature, °C
39
RSSI, dBm
-46
Radio frequency band
Carrier frequency, MHz
919.000
Device address (0..99)
22
Channel
0
Minimum threshold (-10..-2000)
IMU
(+) expand
Parameters of radio
(+) expand
Ultrasound
(+) expand
Interfaces
(+) expand
Misc. settings
(+) expand
Hedgehogs pairing
(+) expand
Processor's crystal's temperature
Strength of the radio signal from this beacon to the modem, i.e. how the modem "hears" the beacon over radio. Keep below -25dBm and above -80..90dBm to avoid losses of packets. Lower end depends on radio profile and interference
Select radio frequency band according to your HW: 433MHz or 915MHz
Real carrier frequency
Selected device's address
Selected radio channel
TBD

**IMU**

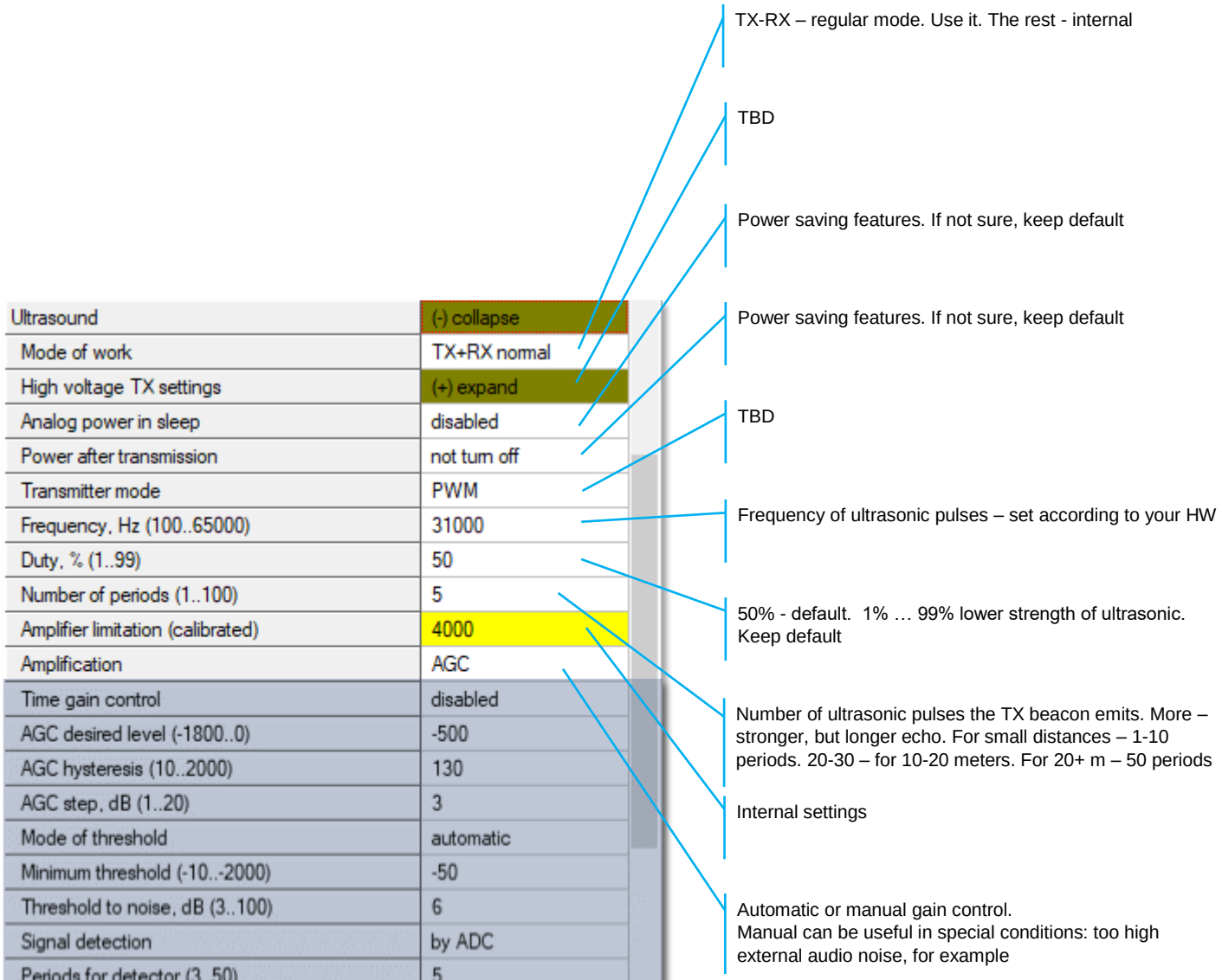


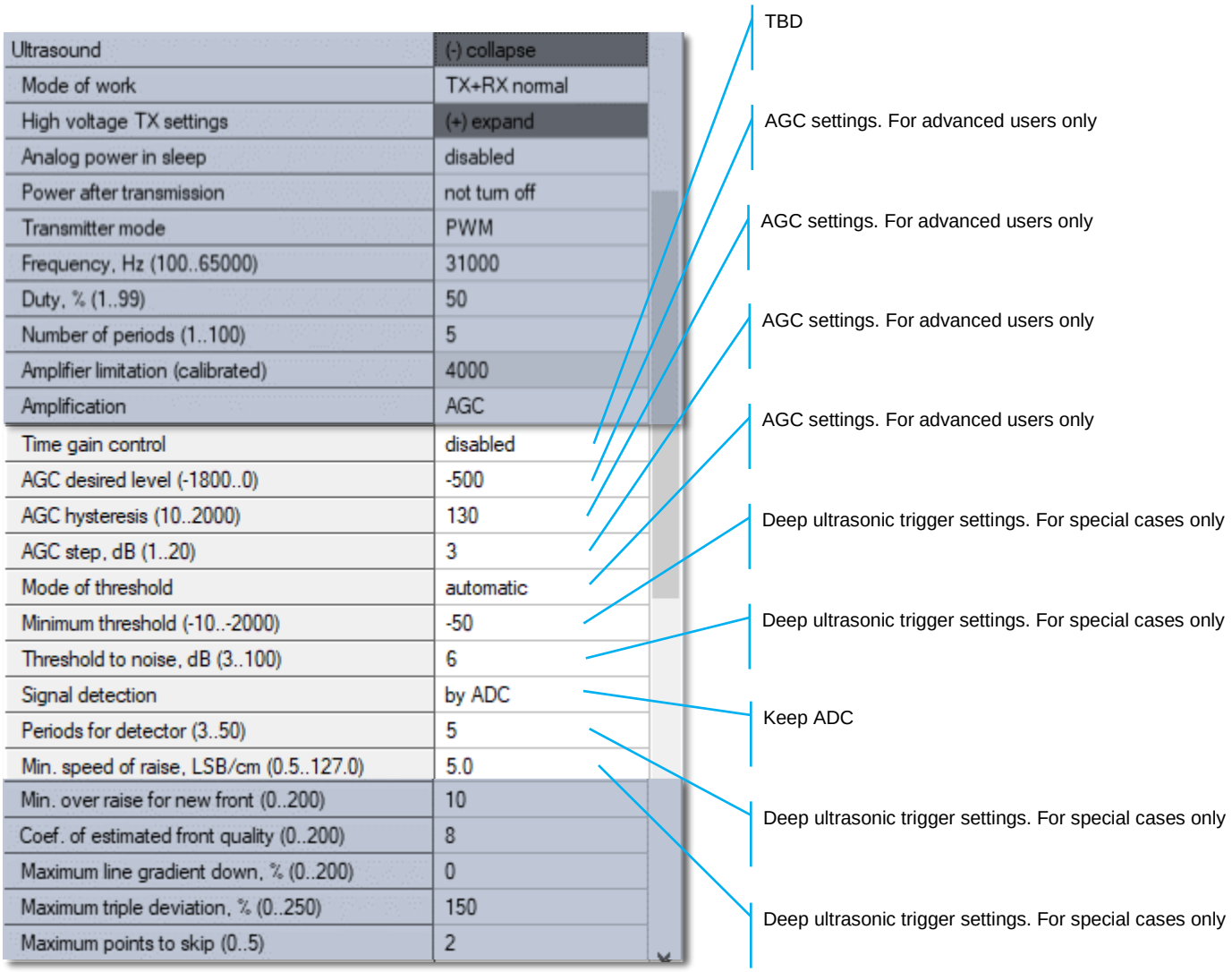
**Parameters of radio**

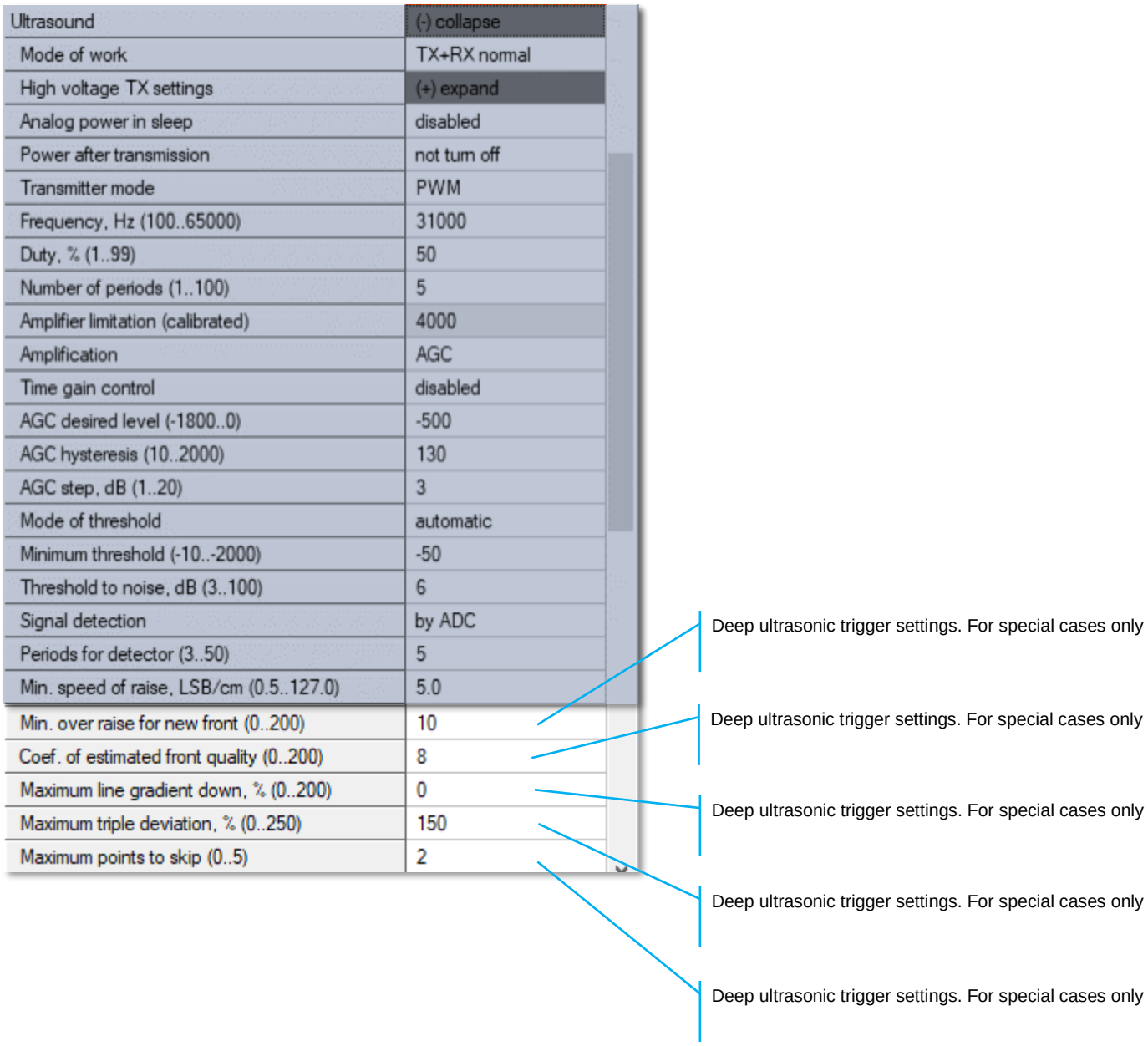


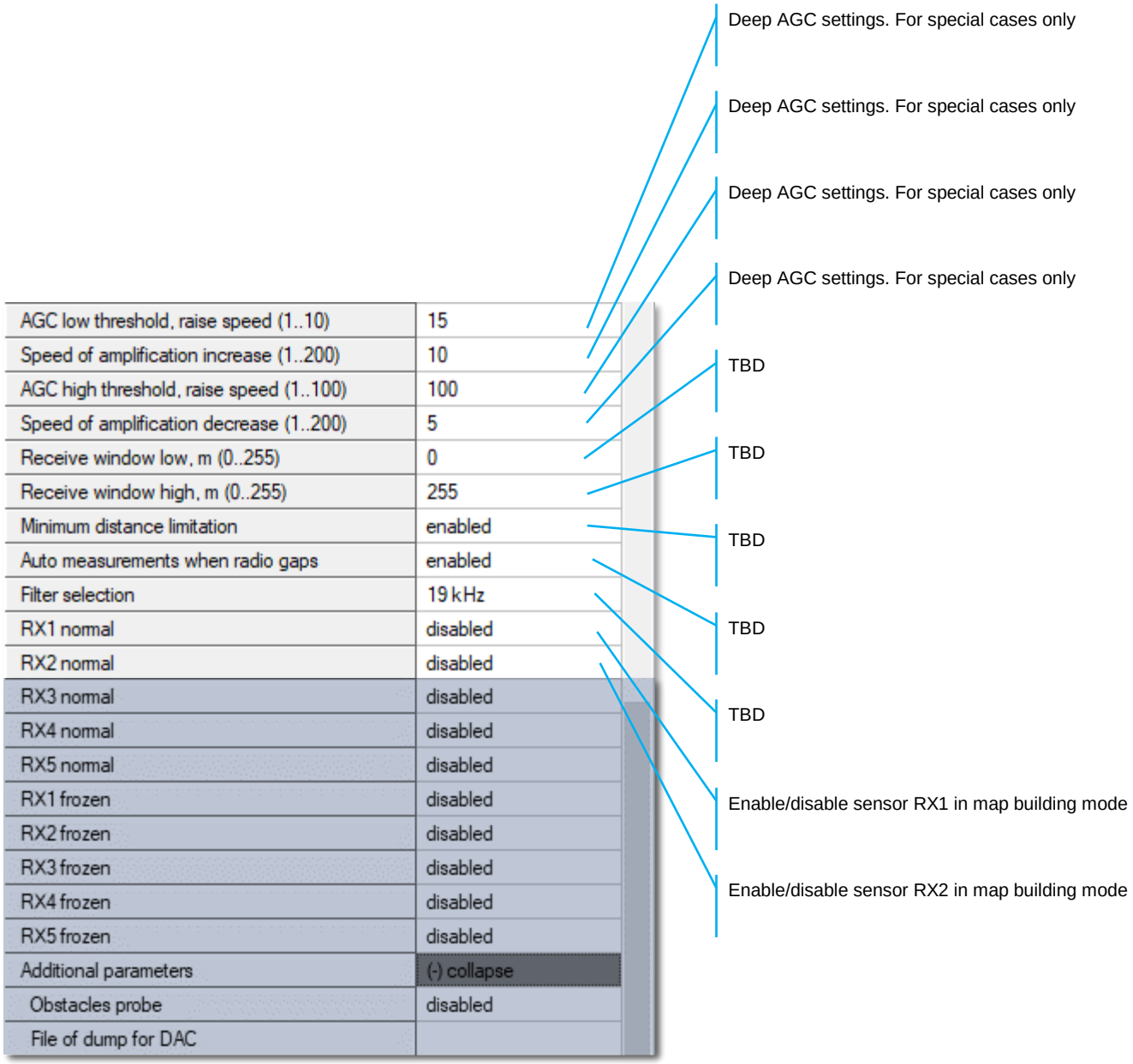


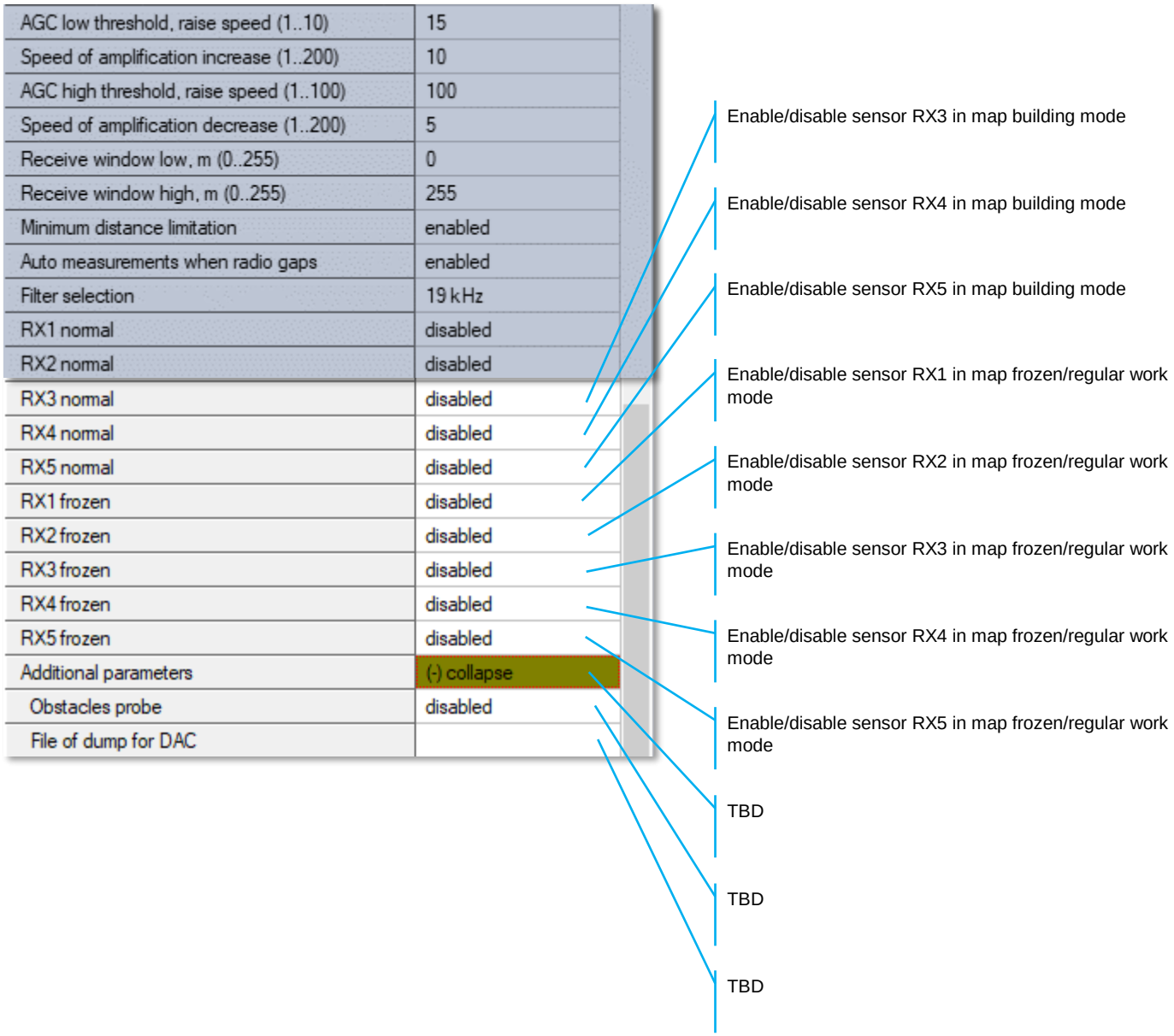
## Ultrasound



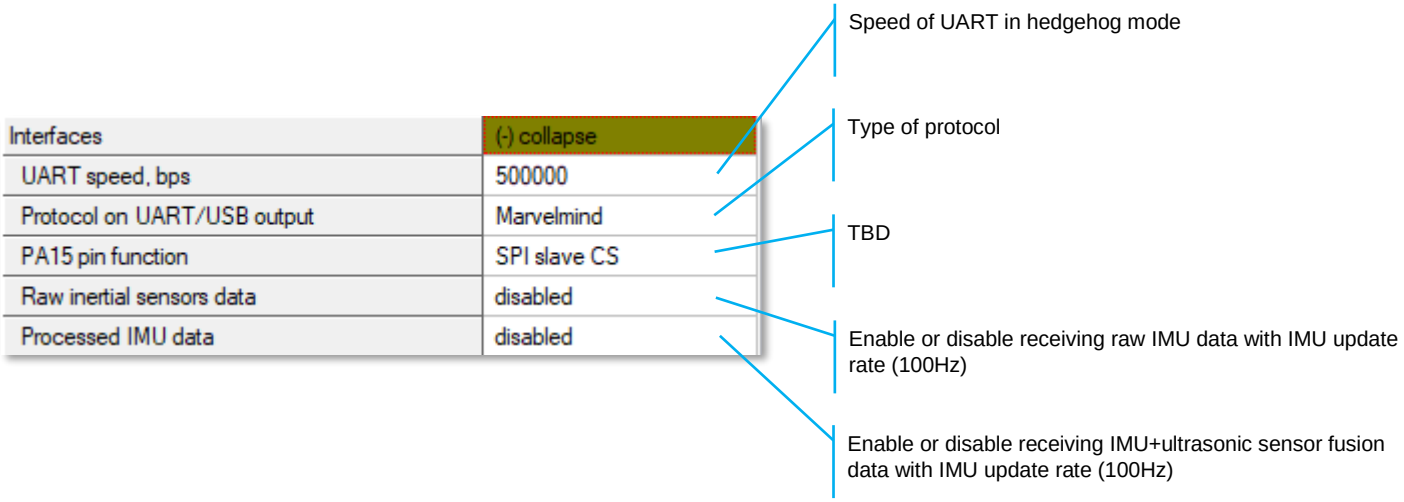

Ultrasound
(-) collapse
Mode of work
TX+RX normal
High voltage TX settings
(+) expand
Analog power in sleep
disabled
Power after transmission
not turn off
Transmitter mode
PWM
Frequency, Hz (100..65000)
31000
Duty, % (1..99)
50
Number of periods (1..100)
5
Amplifier limitation (calibrated)
4000
Amplification
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
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

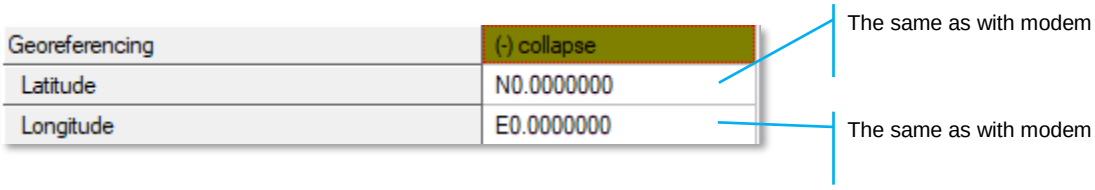

AGC low threshold, raise speed (1..10)
15
Speed of amplification increase (1..200)
10
AGC high threshold, raise speed (1..100)
100
Speed of amplification decrease (1..200)
5
Receive window low, m (0..255)
0
Receive window high, m (0..255)
255
Minimum distance limitation
enabled
Auto measurements when 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


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
Enable/disable sensor RX3 in map building mode
Enable/disable sensor RX4 in map building mode
Enable/disable sensor RX5 in map building mode
Enable/disable sensor RX1 in map frozen/regular work mode
Enable/disable sensor RX2 in map frozen/regular work mode
Enable/disable sensor RX3 in map frozen/regular work mode
Enable/disable sensor RX4 in map frozen/regular work mode
Enable/disable sensor RX5 in map frozen/regular work mode
TBD
TBD
TBD

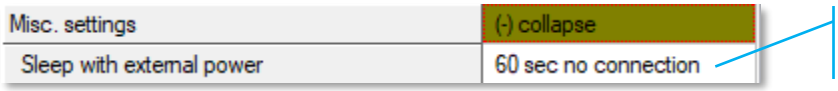
### Interfaces




### Georeferencing




### Misc. settings




### Hedgehogs pairing

## 6.9 Radio frequency band and Carrier frequency

- For devices with HW 433 MHz allowable Radio bands 315 and 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 both 315 and 433 MHz

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

It is possible to change the frequency of radio, 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 | 315 MHz |
| Carrier frequency, MHz | 315.000 |

| | |
|---|---|
| Radio frequency band | 915 MHz |
| Carrier frequency, MHz | 919.000 |

| | |
|---|---|
| Radio frequency band | 868 MHz |
| Carrier frequency, MHz | 869.504 |

## 6.10 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** - normal 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

## 6.11 Different stationary beacons' colors in the Dashboard

Stationary beacons v4.9 can have different ultrasonic frequency. Because of that, they have different colors to make it easy to distinguish it:

- 19KHz beacon
- 25KHz beacon
- 31KHz beacon
- 37KHz beacon
- 45KHz beacon

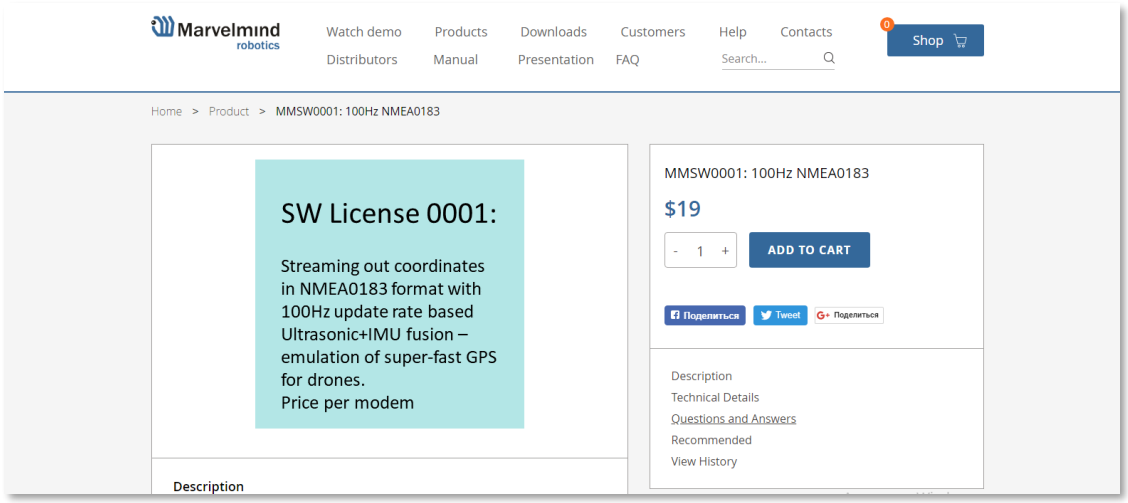
# 7. SW feature/settings descriptions

## 7.1 Licenses

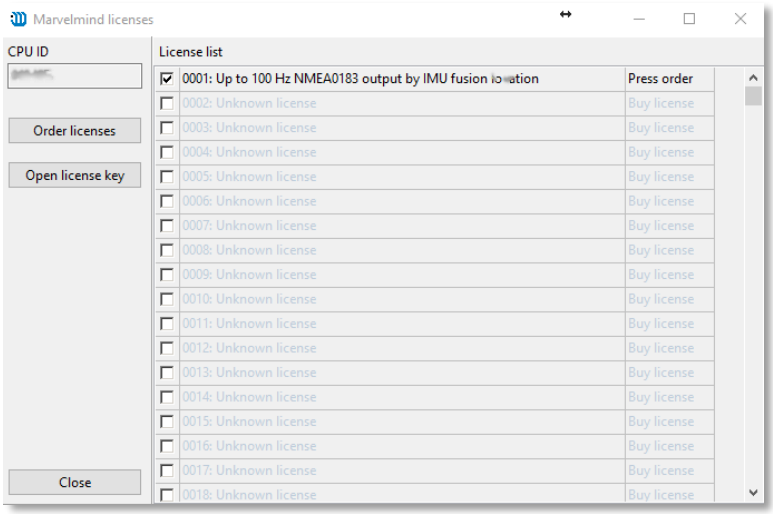
We added the licenses system. Now, you can order some additional features. It is not available in the basic Dashboard version, but you can easily purchase it if necessary. You can see the list on Marvelmind.com -> Products

To order:

- Go to Marvelmind.com -> Products
- Choose features which you want to get (e.g. MMSW0001: 100Hz NMEA0183)

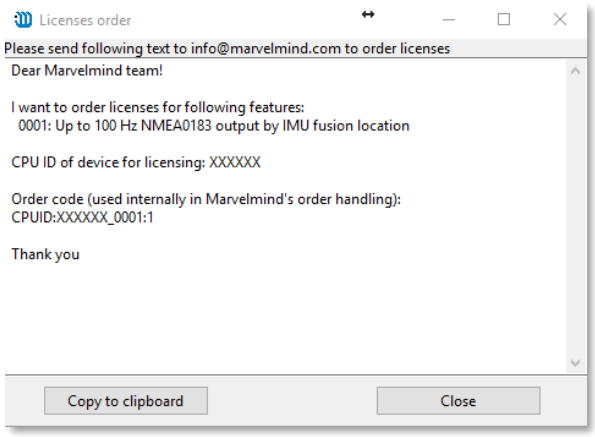



- Make an order.
- Pay for the feature (via PayPal or other methods).
- Order the feature via the Dashboard by providing modem's CPU ID or send us email with the modem's CPU ID:
  - Open Dashboard SW
  - Connect modem to the Dashboard via USB
  - Go to **Licenses → View/activate licenses**




  - Choose the licenses which 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 to you via email
- Place the license key into Dashboard/Licenses folder:
  - Connect modem 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.

## 7.2 Dashboard Monitoring Mode

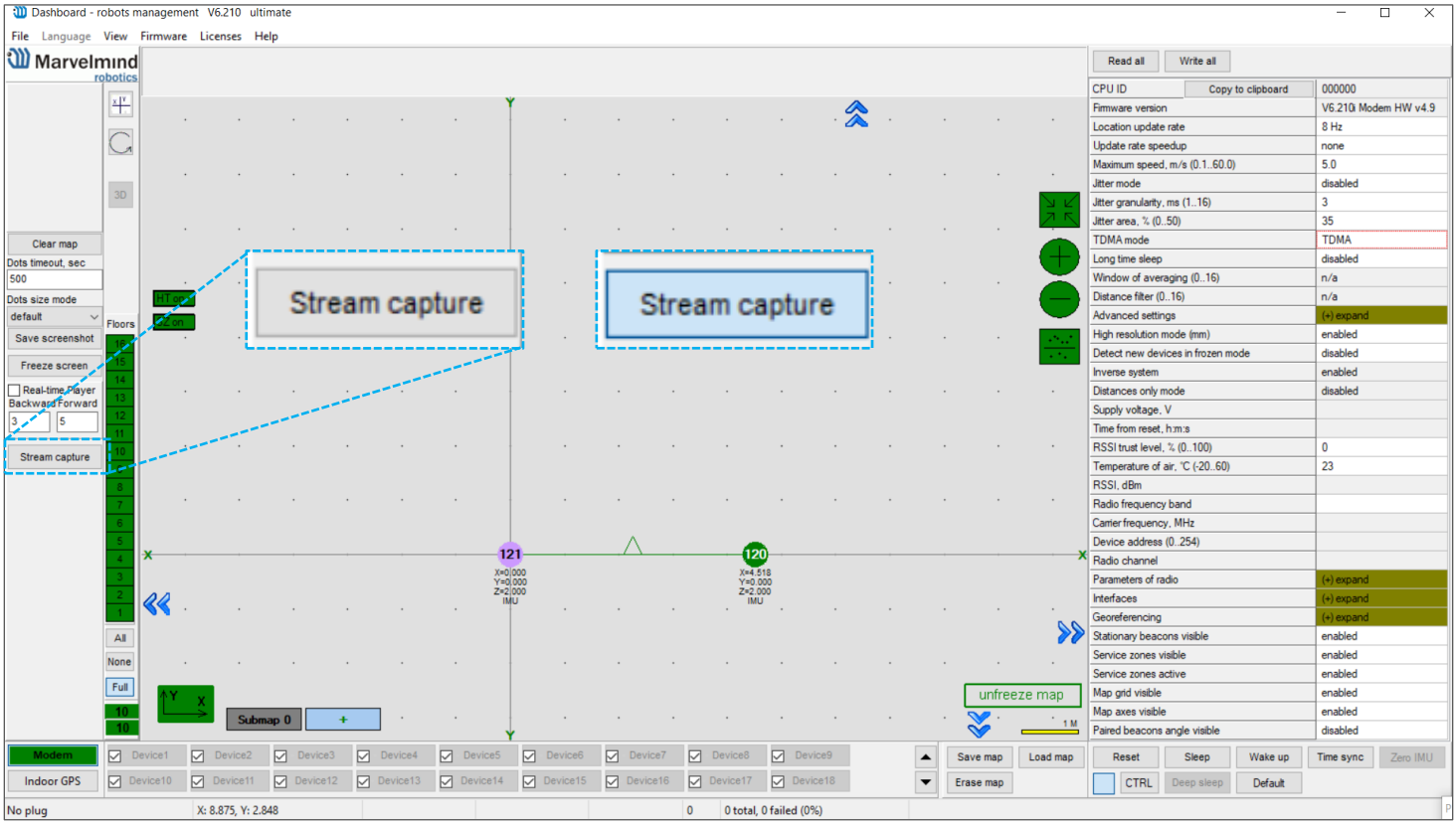
Dashboard Monitoring Mode is a mode which allows you to observe tracking without any ability to control and modify the system.

Now, you can divide permissions between users for avoidance of accidental change of any settings and corrupting the system. That is something like safety button.

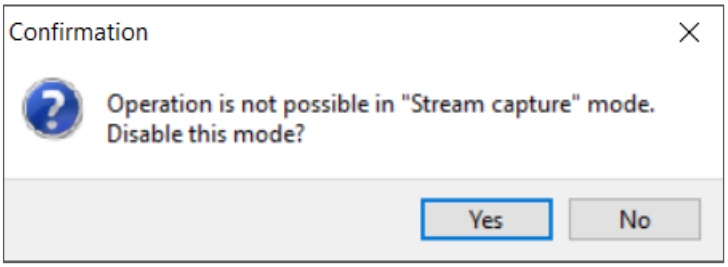
*This is the first version of Dashboard Monitoring Mode. New functionality and appearance may come with future SW updates*

**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

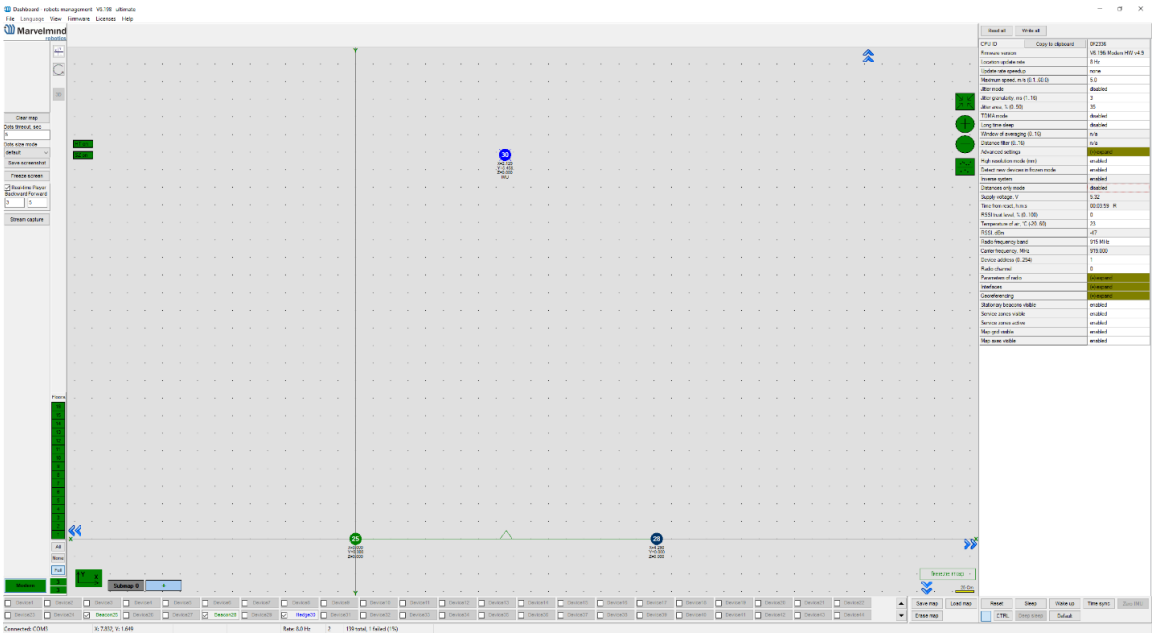


## 7.3 Geofencing zones

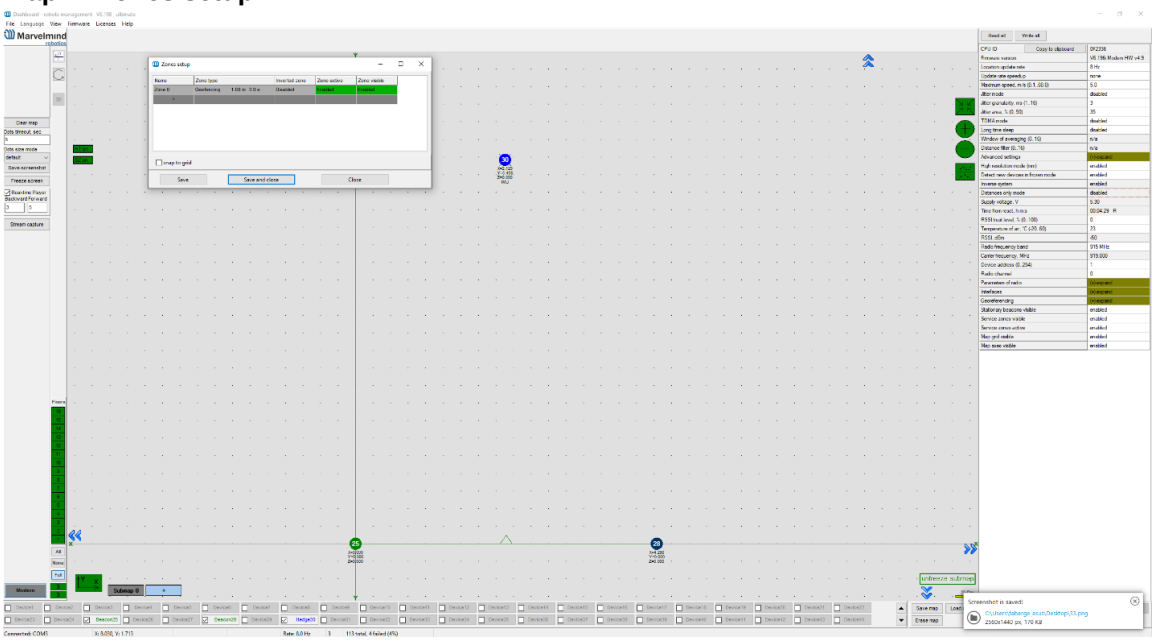
Geofencing zones is a subset of zones which can be created to prevent people crossing dangerous zones. Zones violations leads to alarm and will be written into CSV-file.

**How to create geofencing zone:**

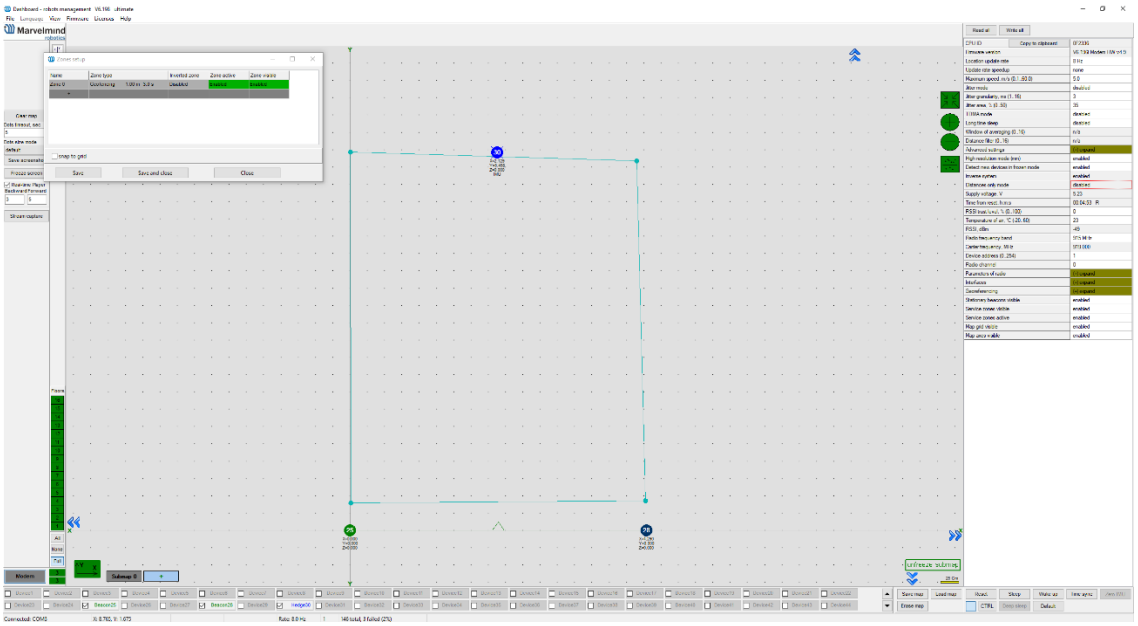
- Unfreeze map, submap may be frozen



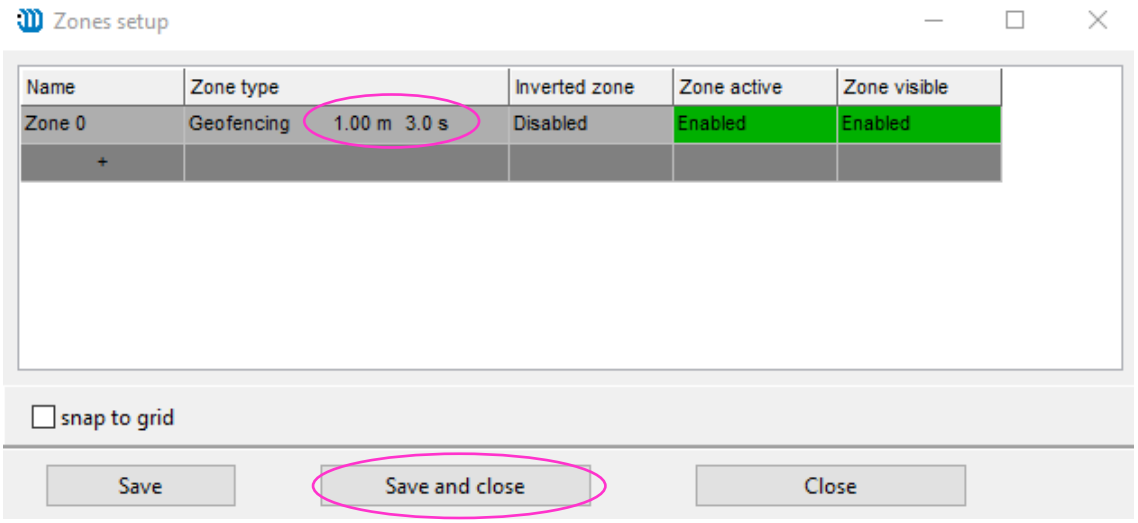
- Choose submap (**Left mouse click on its icon**) and **Right mouse button click on the map -> Zones setup**



- Create a zone using **Shift+Left mouse click** and clicking on map, click on point removes it



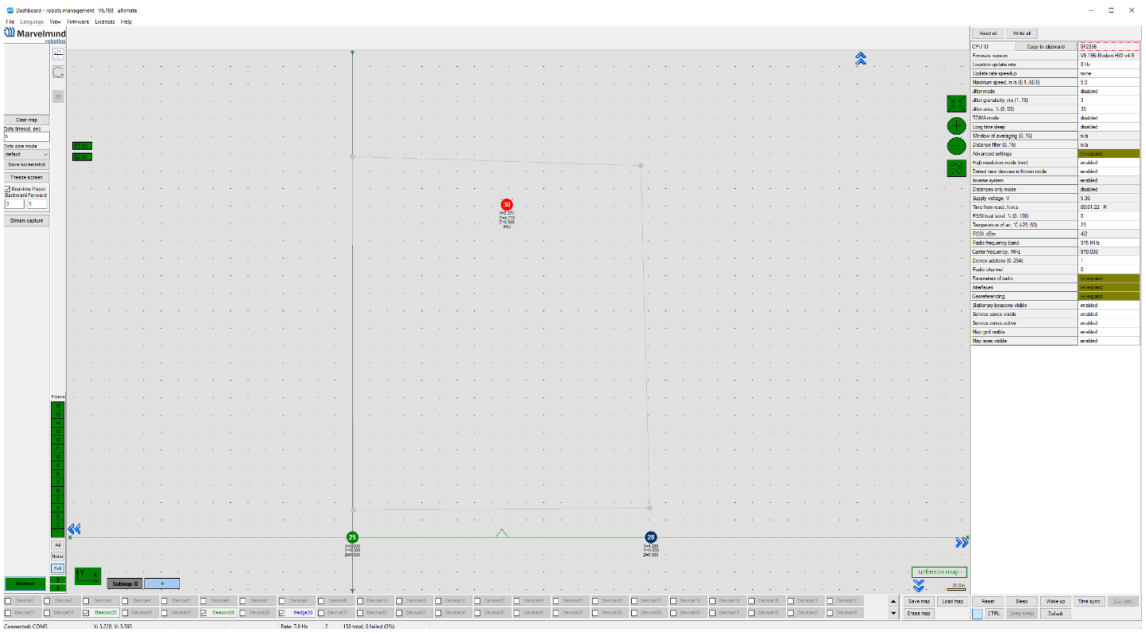
- You can **tune zone with entering distance and entering time**. If zone created, press **Save and close** to save zone




- Freeze map

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

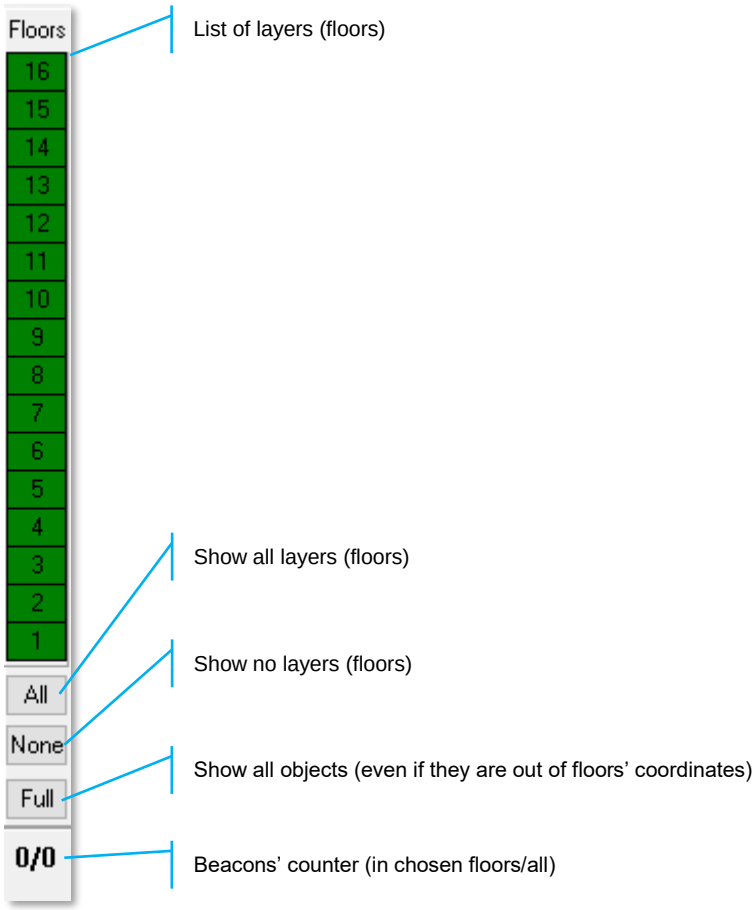
in the Dashboard



## 7.4 Floors feature (FN0011)

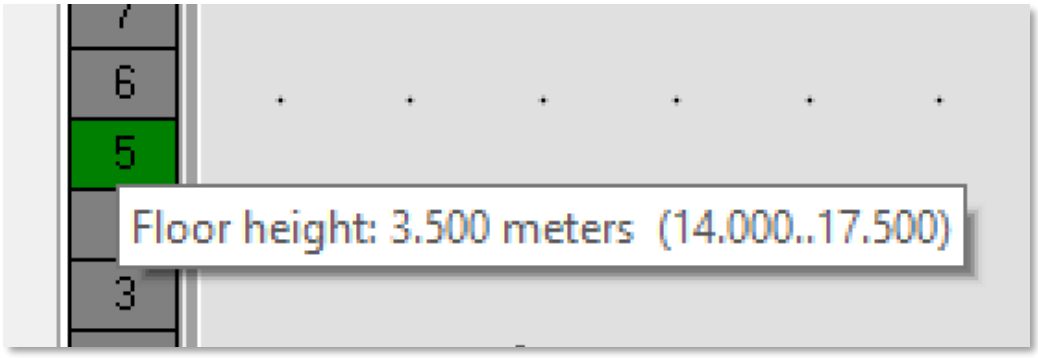
### The general view

Floor feature allows to build complicated multi-level maps. Every submap correspond some height, height corresponds to floors.

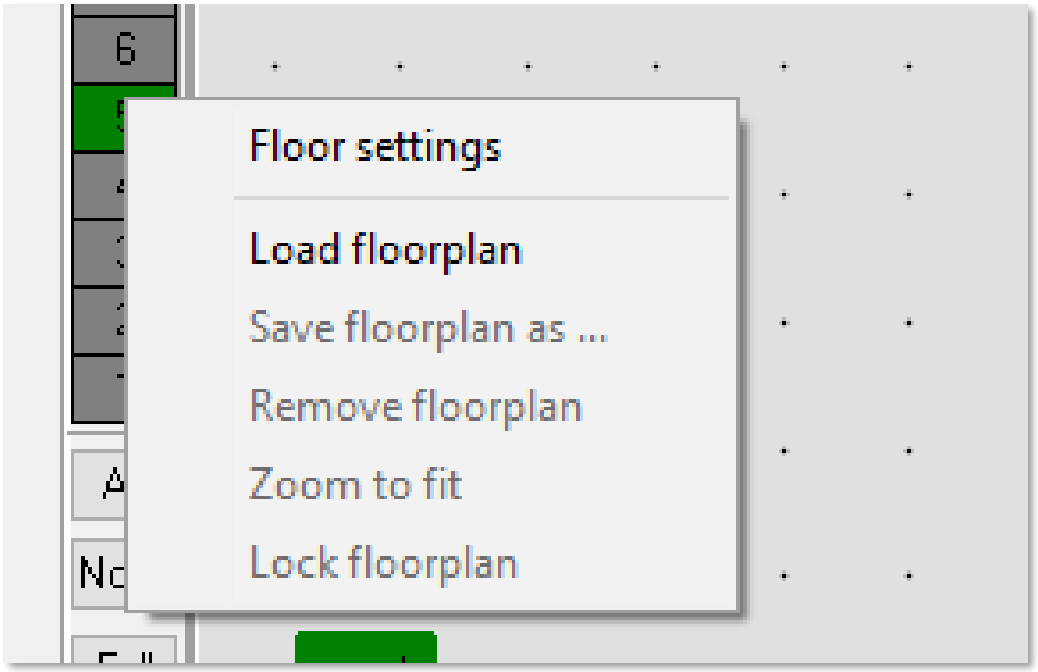


**Floor Settings**

- Every floor has its own adjustable height and its own floor plan

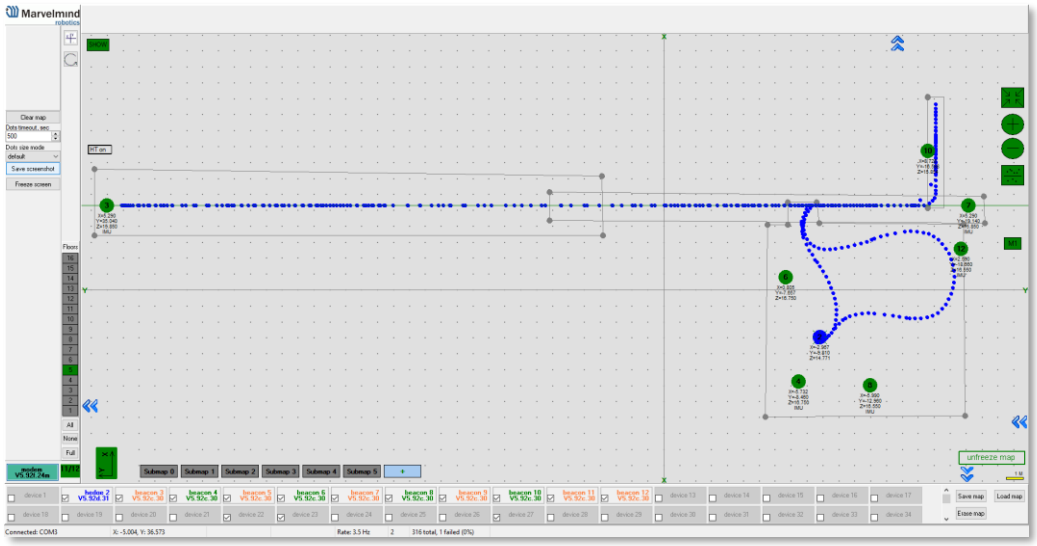



- Use right mouse button on the floor area to see an additional menu. There you can change floor's height. You can also insert your floorplan for that floor (.png, .jpeg, .bmp, .tiff)

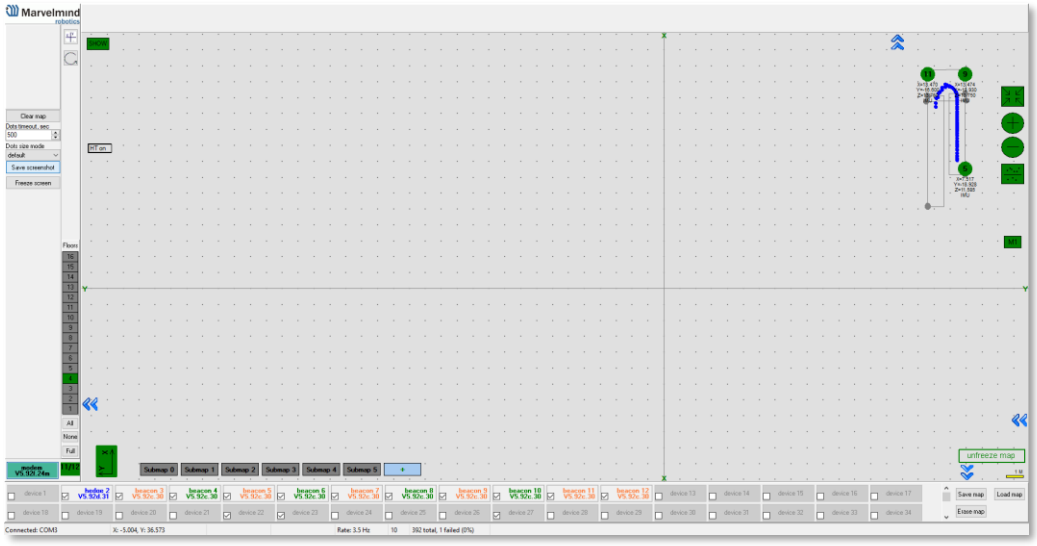



Floor 4 and 5 are enabled:

Floor 5 is enabled:

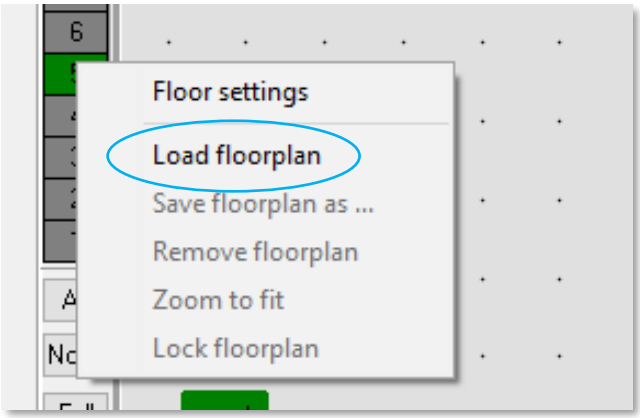


Floor 4 is enabled:



**Loading the Floorplan (Substrate)**

- **Right mouse button click on the floor -> Load floorplan -> Choose file** (.png, .jpeg, .bmp, .tiff).




- When the picture is loaded, you can drag the beacons to the points where they are actually located. After dragging two beacons, the picture with beacons will be combined in scale

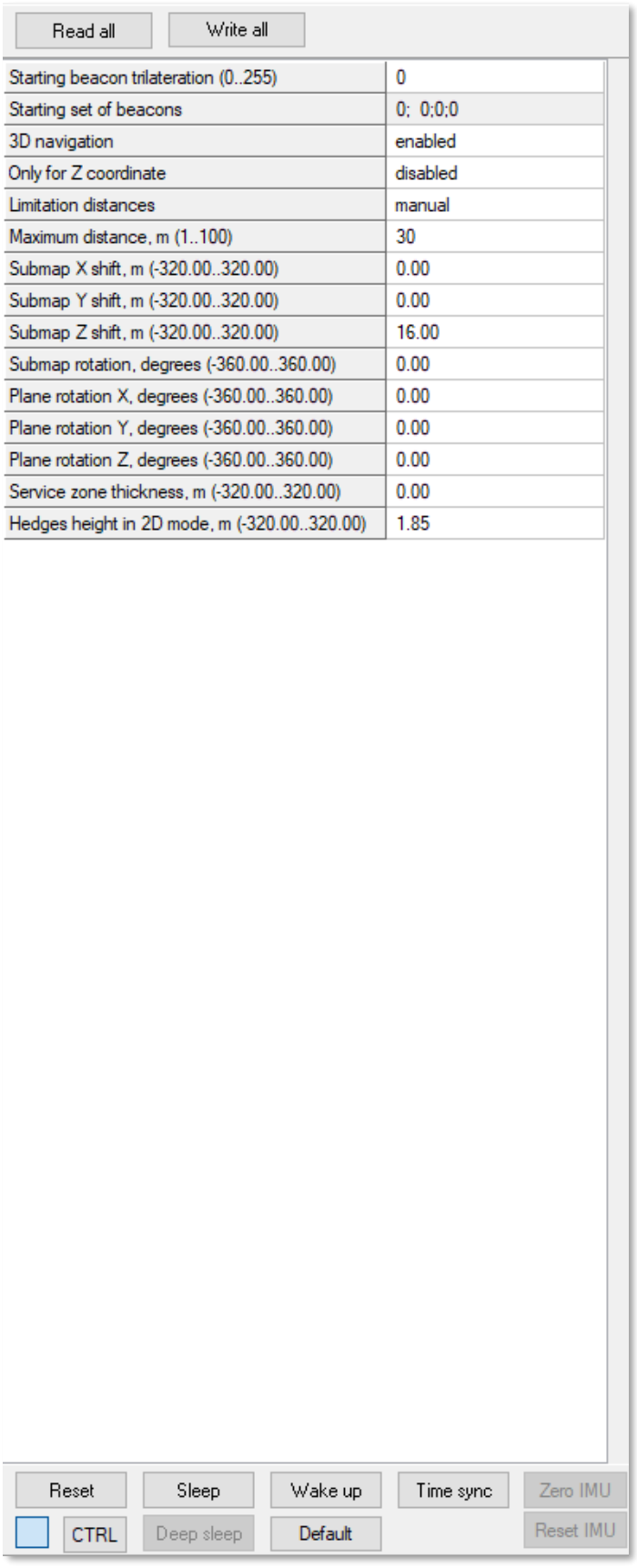
- Help video: https://www.youtube.com/watch?v=NHUnCtJIYXc

## 7.5 Submap Settings

Every submap has its own settings. To correspond your submap to a certain floor you need to adjust the height:

- To open that settings, use **left mouse button** on the **submap icon** - 

- Change **Submap Z shift** value

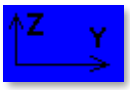


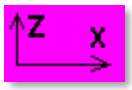
## 7.6 Axis rotation feature (FN0002)

### General view

Axis extension allows user to rotate the map. There are 90° gaps between views. It helps in case of multifloor tracking, when it is important to have a side view.

There are 3 directions of view:

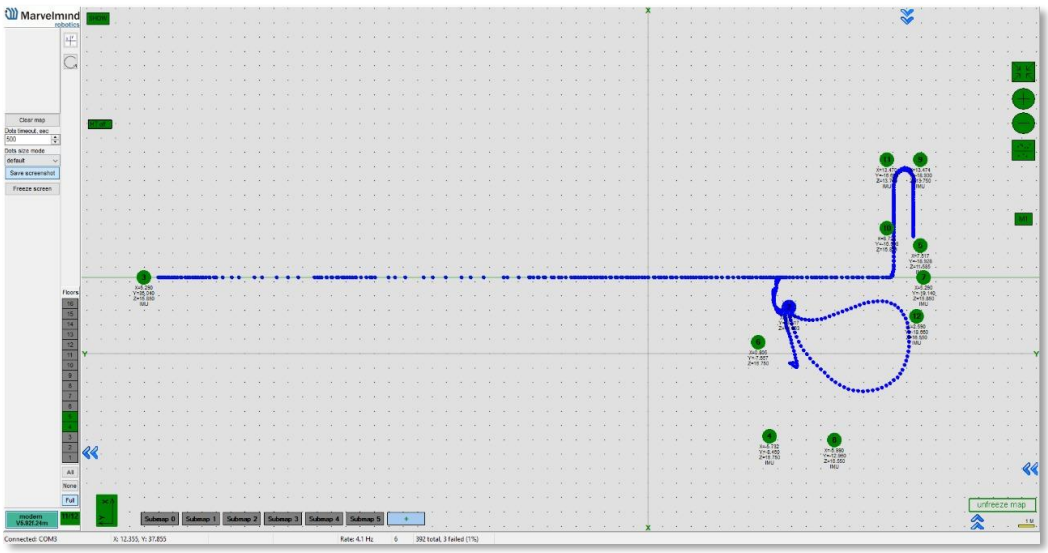




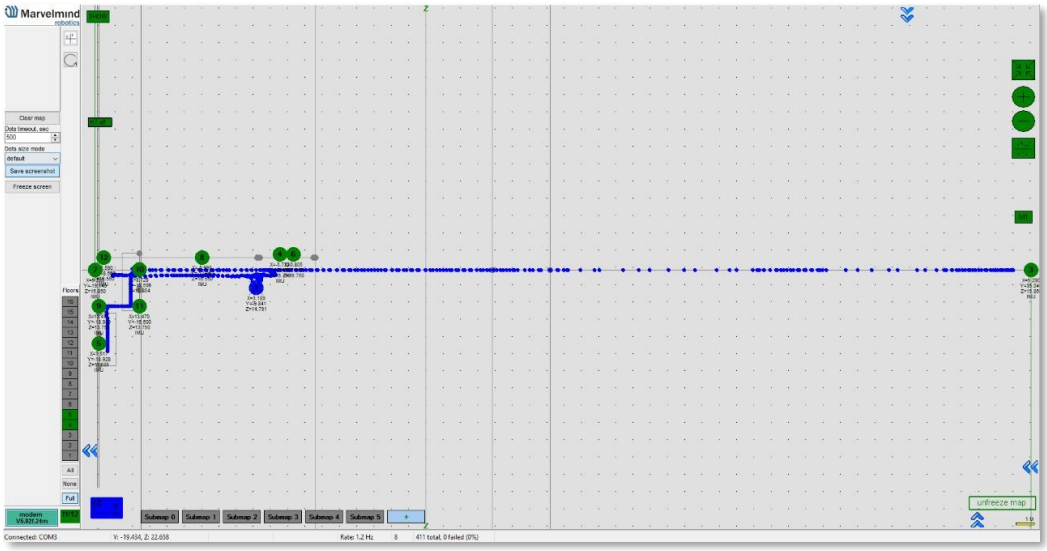

- To change view, click on the icon

**Example of views:**

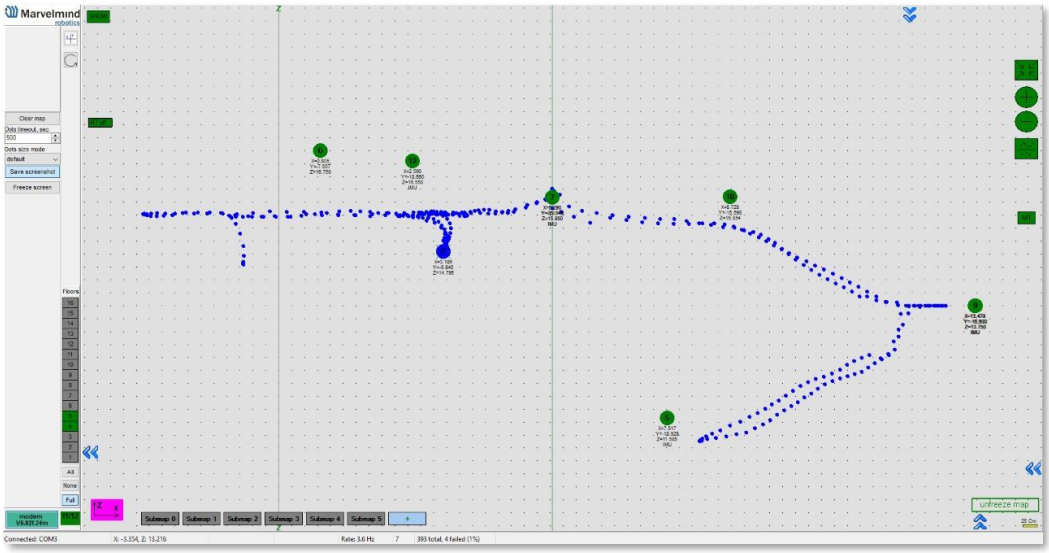
**Y, X**




**X, Y**



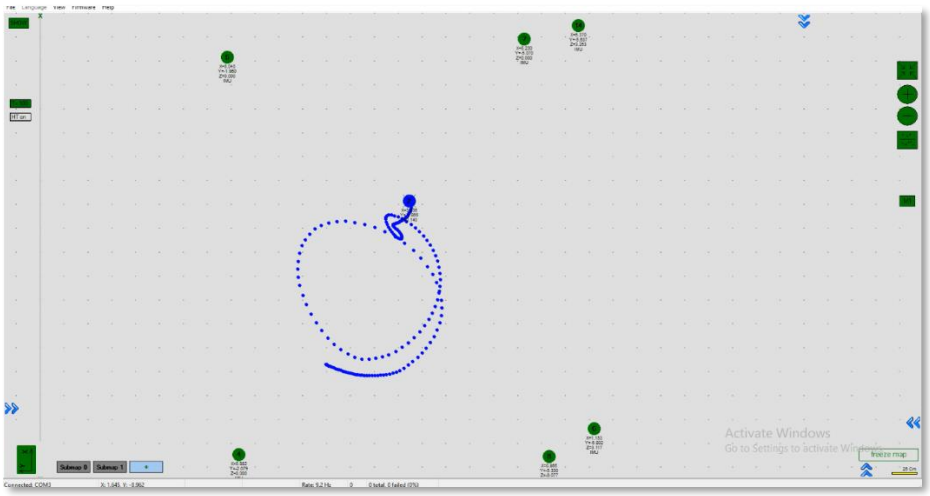
Z, X

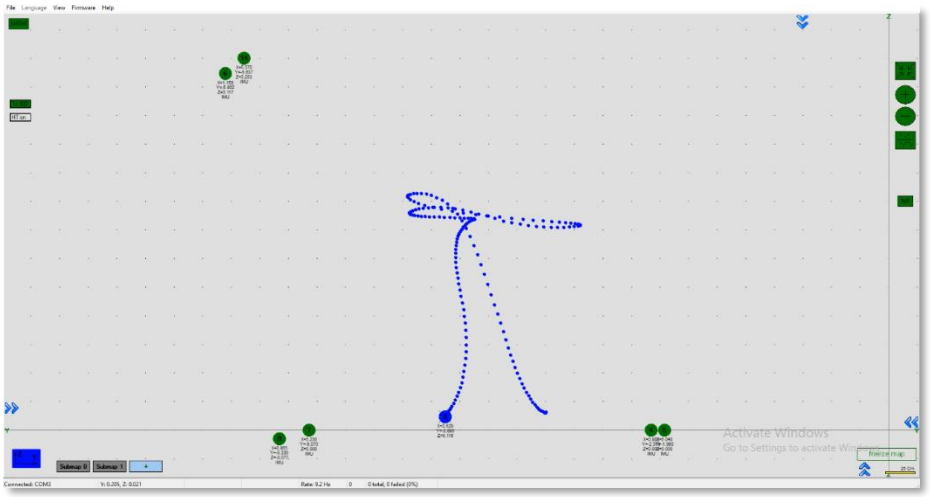

Marvelmind
robotics
Clear map
Data timeout, sec
500
Dots size mode
default
Save screenshot
Freeze screen
Floors
All
None
Full
Submap 0
Submap 1
Submap 2
Submap 3
Submap 4
Submap 5
unfreeze map

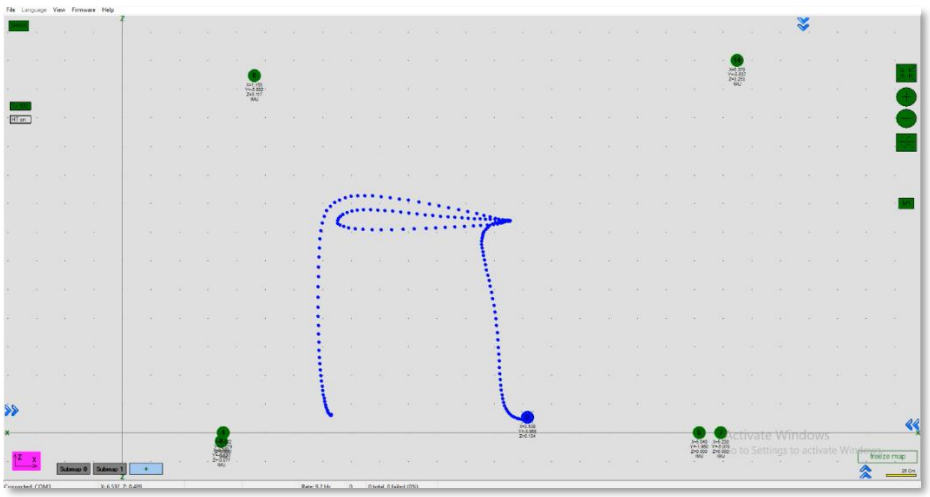
## 7.7 Vertical submaps feature (FN0003)

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

Example: The drone flight







How to build vertical submap for stable Z:

8.5.1 For this configuration you need 6 stationary beacons

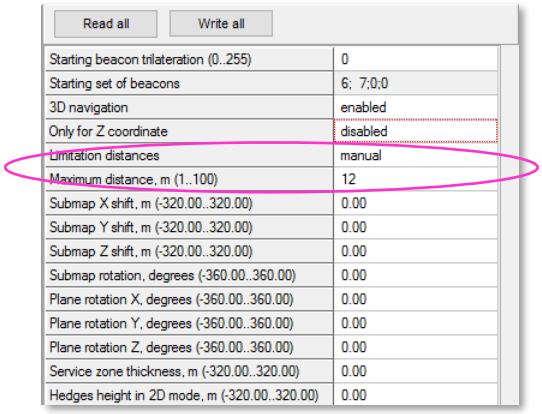
8.5.2 Place 4 beacons on the ground, facing each other. (make a square, where the edge points are beacons, looking in the center)

8.5.3 Place two beacons high on a wall

8.5.4 Turn on RX4 only for beacons on the ground and RX4 and RX2 for beacons on the wall

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

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




8.5.7 Freeze and lock it

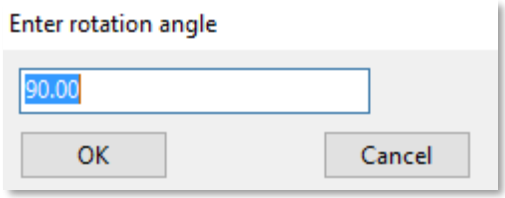

8.5.8 Build the second submap (vertical) horizontally consisting of two wall beacons and two ground beacons (neighboring with wall beacons)

8.5.9 Now, freeze it

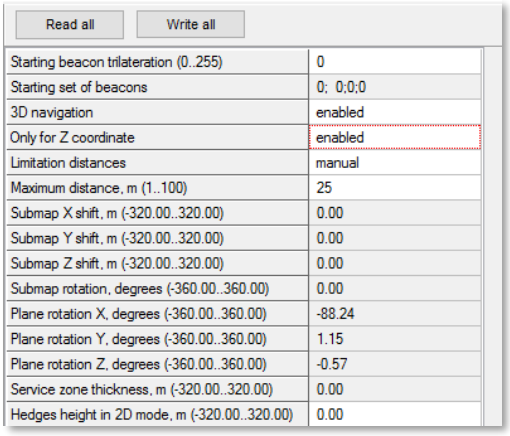
8.5.10 Press axis rotation button 

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

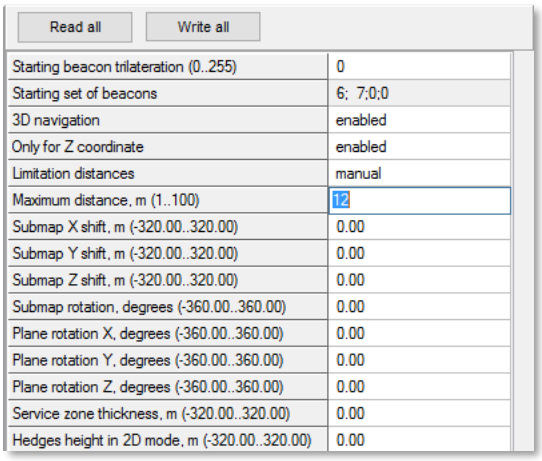
8.5.12 Enter the corner value (90° usually)



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




8.5.14 Change **Limitation distance** value




8.5.15 Change views and check the map

8.5.16 Wake up mobile beacon

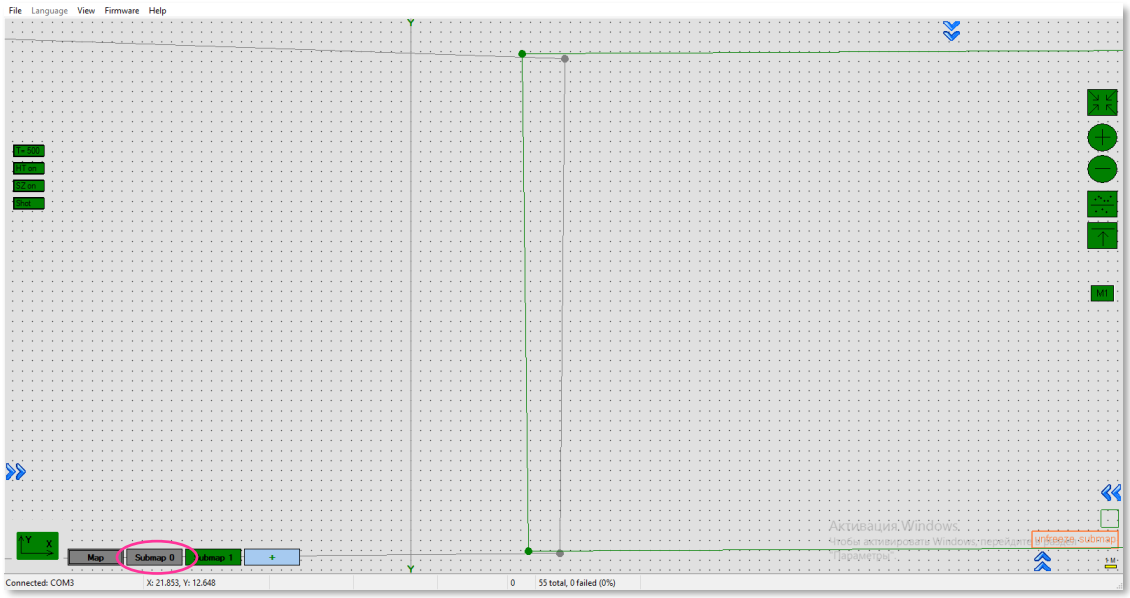
8.5.17 Track

## 7.8 Handover Zones Setting

User must setup handover zones between submaps to guarantee handover quality for complex maps with multi-floor and similar.

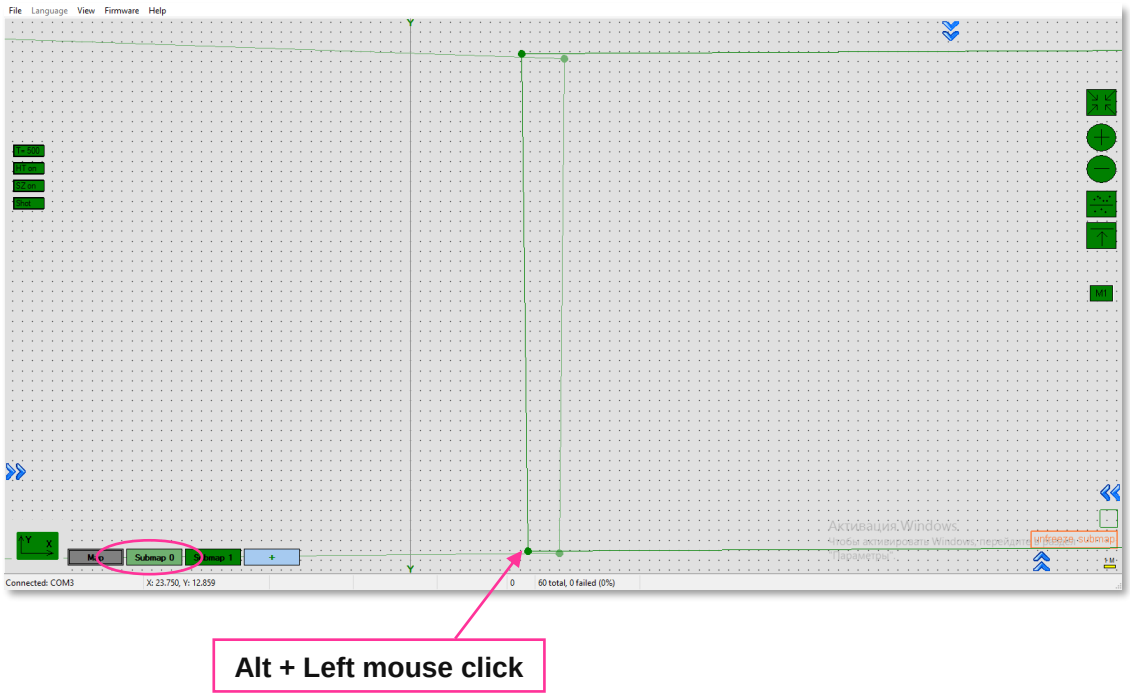
**How to setup handover zones:**

– Choose any submap

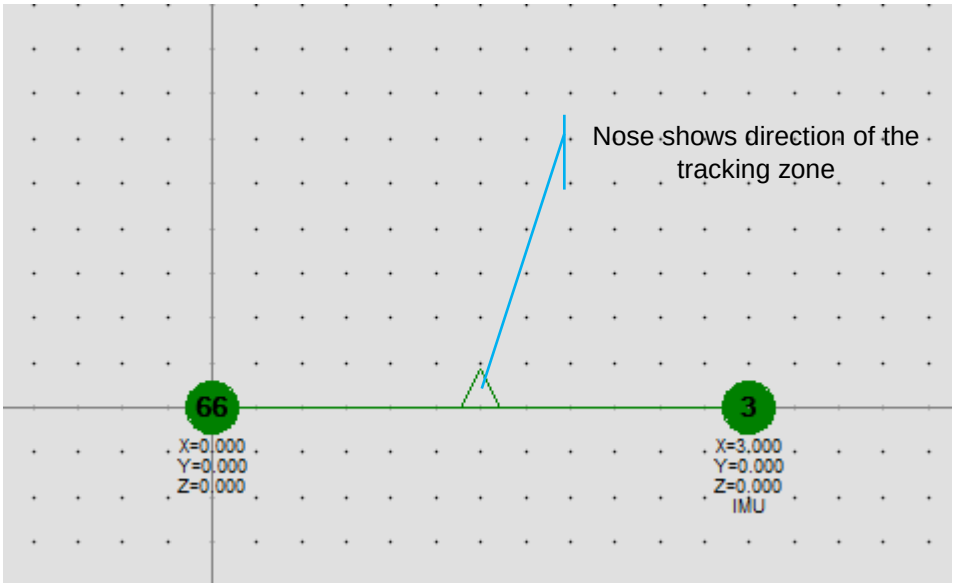



– Use **Alt + Left mouse click** on the other submap's service zone border (neighboring)

– Now, neighboring service zones are colored with green (dark green for chosen submap and light green for neighboring submaps)



## 7.9 Submaps feature (FN0004)




*2D submap example*

Submaps is a very powerful feature that allows building large maps (full business center, factory, warehouse with total area of 10,000..300,000 or more) based on smaller submaps (30..1000m2).

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

Follow these steps:

Step 1. Choose the beacons which will be added to certain submap0…submapN

Step 2. Connect the modem and put all the beacons into sleeping mode

Step 3. Click “erase map” button for removing some current settings of beacons and submaps

Step 4. Wake up all the beacons which should be served by submap0

Step 5. Wait a little for map will automatically build. If needed use mirroring function

Step 6. Freeze the submap

Step 7. Add the new submap by clicking “+” button. New submap is automatically chosen as active

Step 8. Wake up the beacons which should be served by submap1. By default, all the beacons are served by the last unfrozen submap

Step 9. If the new submap should include beacons which are at the moment served by previous submaps (intersected submaps) click on each beacon, then right-mouse-click=>Add to current submap

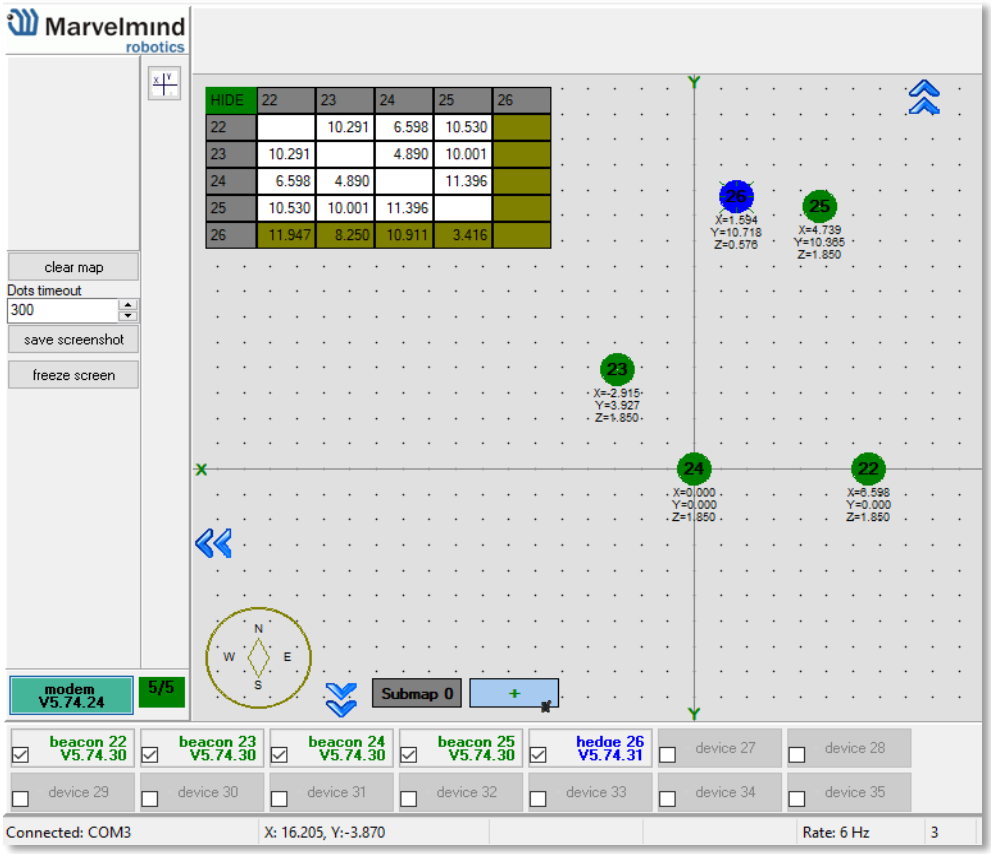
Step 10. If the new submap has 1 or 2 common beacons with previous submaps, it will settle as a part of the already built map. Two common beacons give a tight binding. If there is only one common beacon it’s possible to drag and drop the submap. If submaps do not have common beacons it is needed to drag and drop the selected submap using the mouse and holding down the CTRL button. Rotation of submap can be executed by using the mouse wheel

Step 11. Align submaps using M1/M2 parameter

Step 12. Set Service Zones for each submap

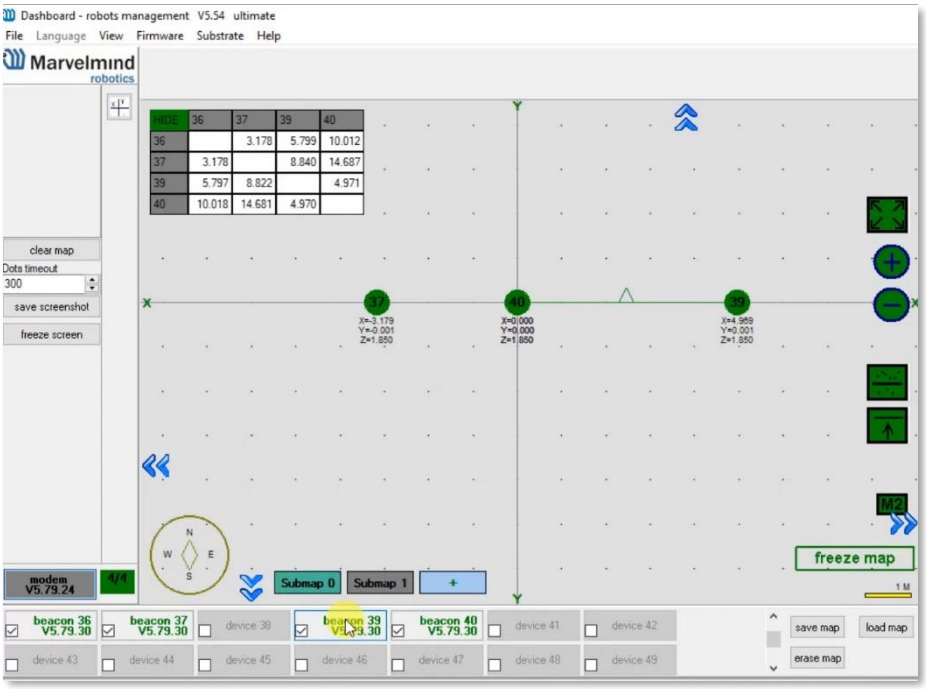
## Starting submaps

- 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)
- After adding new beacons to the system (waking them up), they appear in the first not frozen submap or in Submap0 if all beacons are frozen
- Pressing the “+” button will add a new empty submap to the system



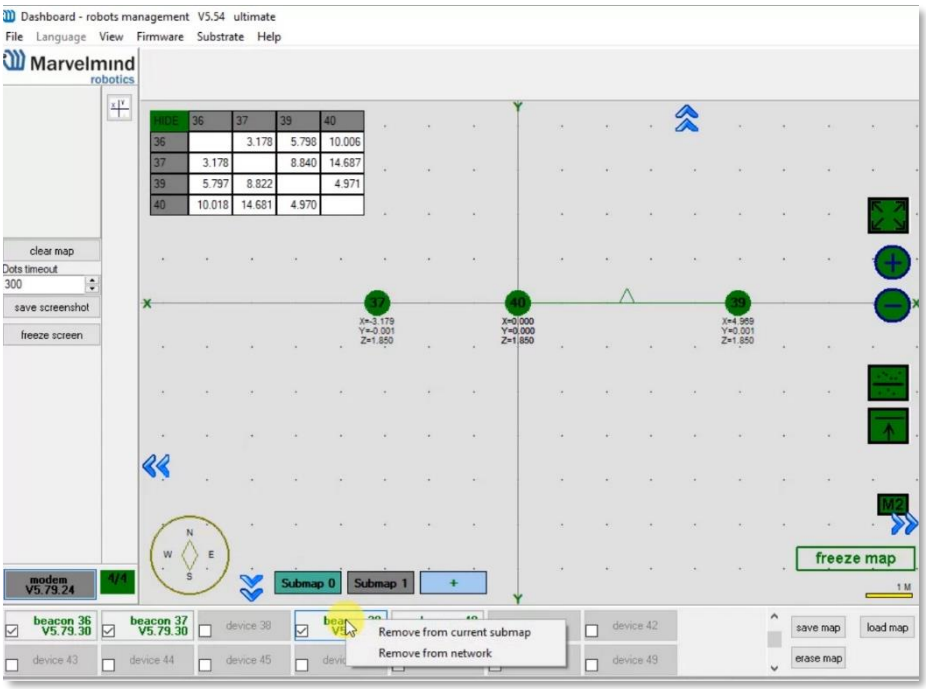

- Press the button with the submap number (Submap0, Submap1 etc.) - select the corresponding submap
- In this state, if the modem button is pushed, the list of parameters on the right side represents some of the parameters of the selected submap, for example, “Starting beacon trilateration,” “Starting set of beacons,” etc.

- The system after adding beacons to the Submap0, adding new submap and the selection of Submap0




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

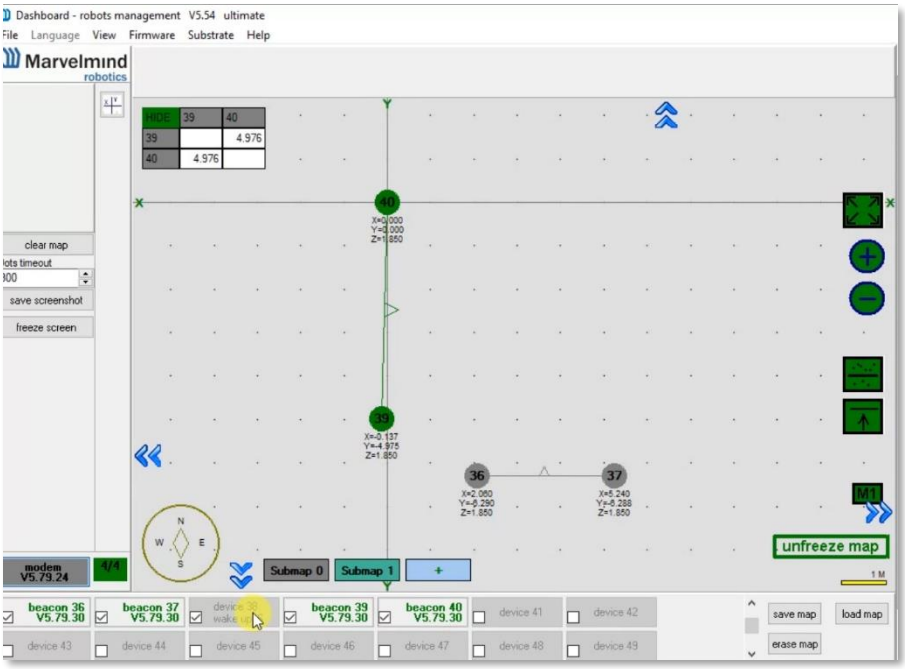
- When the submap selected, the context menu of beacons buttons (available by right clicking the mouse) have the functions of adding and removing the beacons from the submap. In the picture above, we are removing beacon 3 from Submap0." Then we switch to Submap1 and add this beacon to the submap




- 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

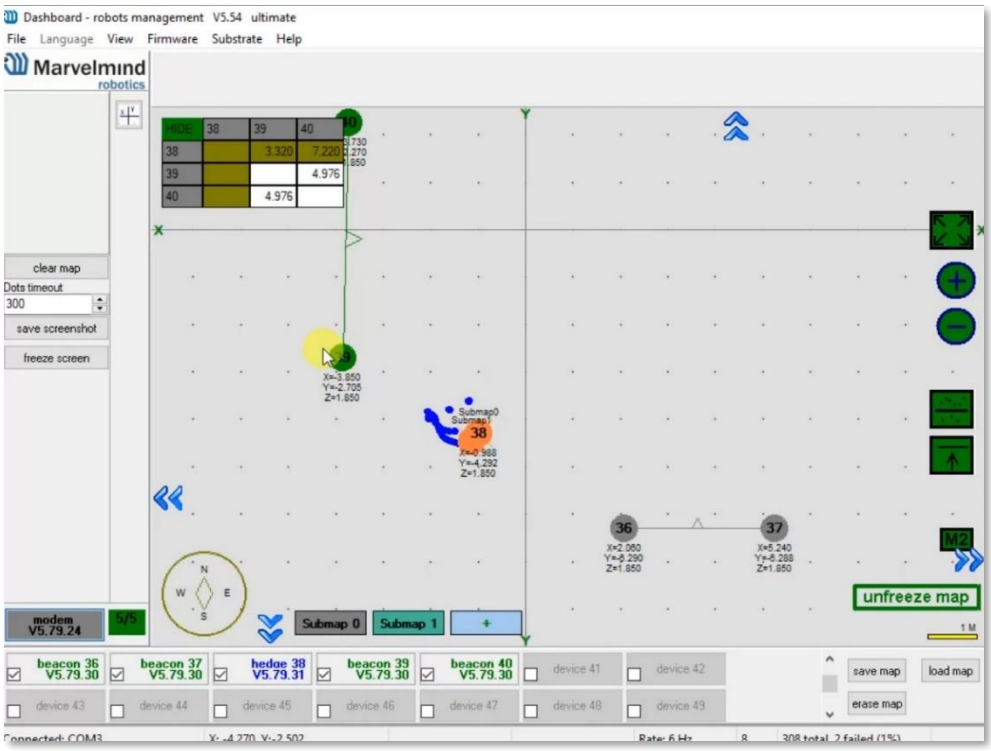
- Now there are two beacons in Submap1, so this submap is built. "Submap 0" is built as well. Now we can freeze both submaps

- Pressing the “freeze map” button when the submap is selected will only freeze the selected submap. Pressing the “freeze map” button when the modem button is selected will freeze all submaps.
- Now we have two good submaps, but they are not correctly located relative to each other. On the right side exist the parameters of shift and rotation for the selected submap; they can be filled in by hands. But a more user friendly way is to drag and drop the selected submap using the mouse and holding down the CTRL button.
- Rotation of submap can be executed by using the mouse wheel. The mirroring button can also be used; it affects only submaps that are selected



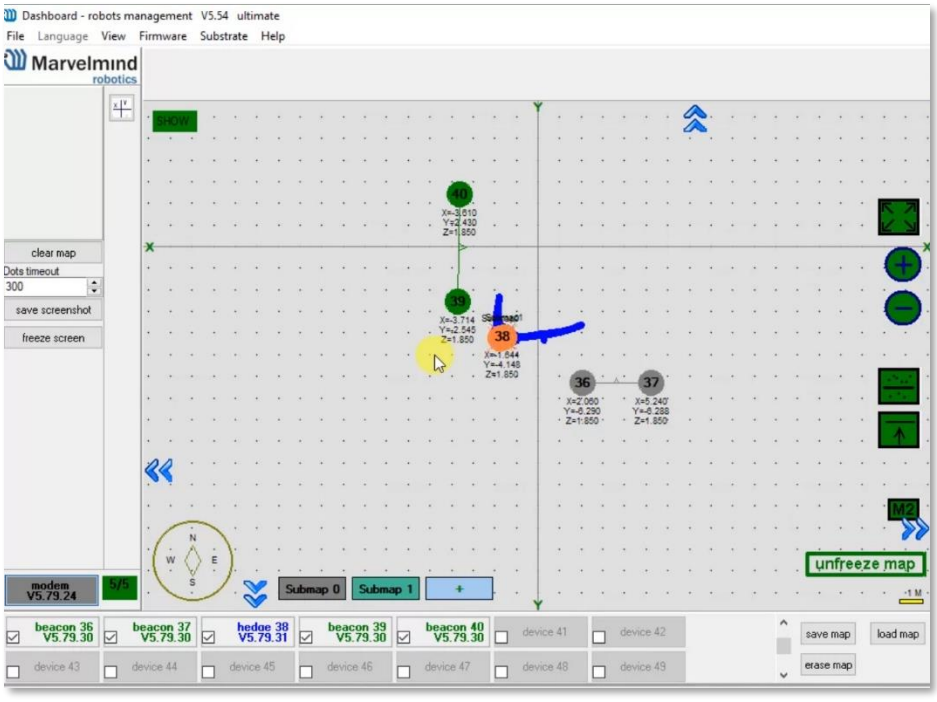

- After some movement, rotation, and mirroring of submaps, we can locate the submaps close to their real relative location
- Now the system is ready to use; we can wake up and track the mobile hedgehog
- In some cases, the hedgehog can be lost between the submaps if this area is not covered by any of the submaps.

- Submaps can be removed from the system by using the context menu of the submap selection button (available with a right mouse click) M1/M2 parameter used for precise superposing submaps which do not have common beacons. This means that submaps cannot be aligned automatically




To align submaps:

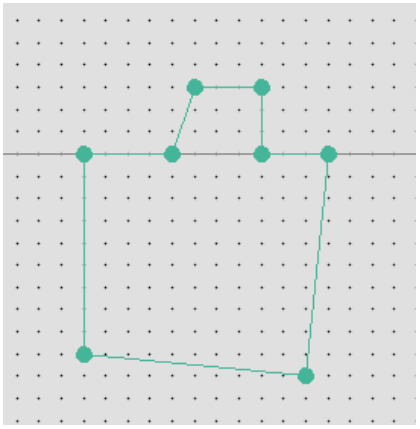
1. Build the system like in previous instruction
2. Put M2 in mode on by clicking the icon. Place the hedgehog near the boundary between two submaps. You will see 2 orange hedgehogs blinking, this is how the hedge is seen in two submaps
3. To align submaps correctly (CTRL + scroll/drag) against each other, until the orange mobile beacons are fully overlapped
4. Replace hedgehog to 1 or 2 points and repeat replacing submap for better superposing



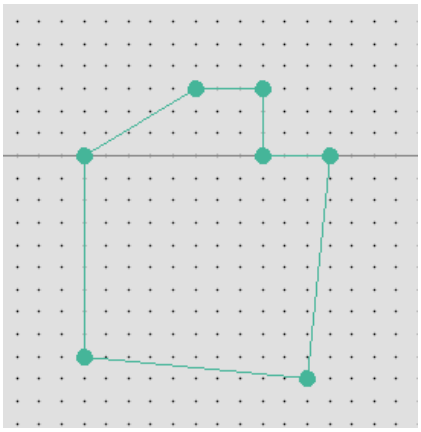
- The next step is to set Service zones, which are zones where tracking is possible. If a mobile beacon is out of a service zone it cannot be tracked. If you built a complicated map, you have to make service zones correctly. Service zones must be crossing in order to provide correct and glide tracking.

## How to create a service zone:

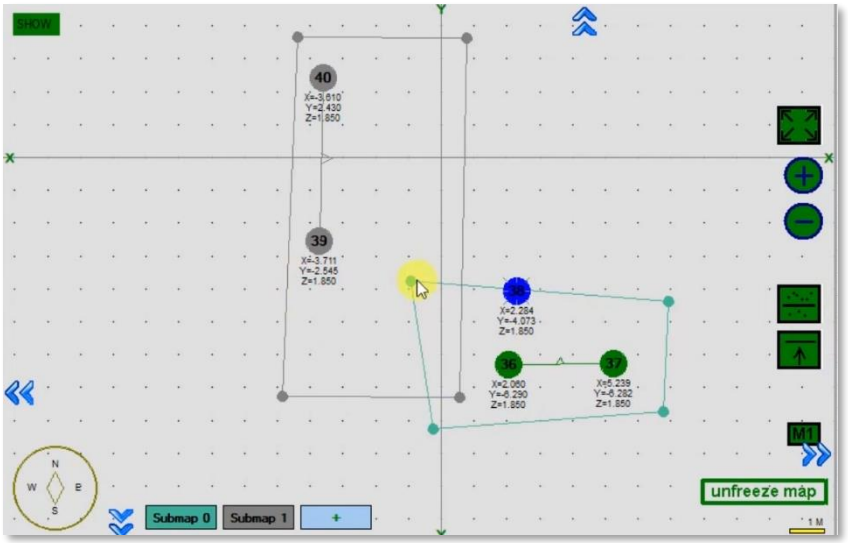
- **Choose submap (click on the submap icon)**
- Use **SHIFT + Left mouse button** on the map to create point.



- Use **SHIFT + Left mouse button** on the point to delete it.



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

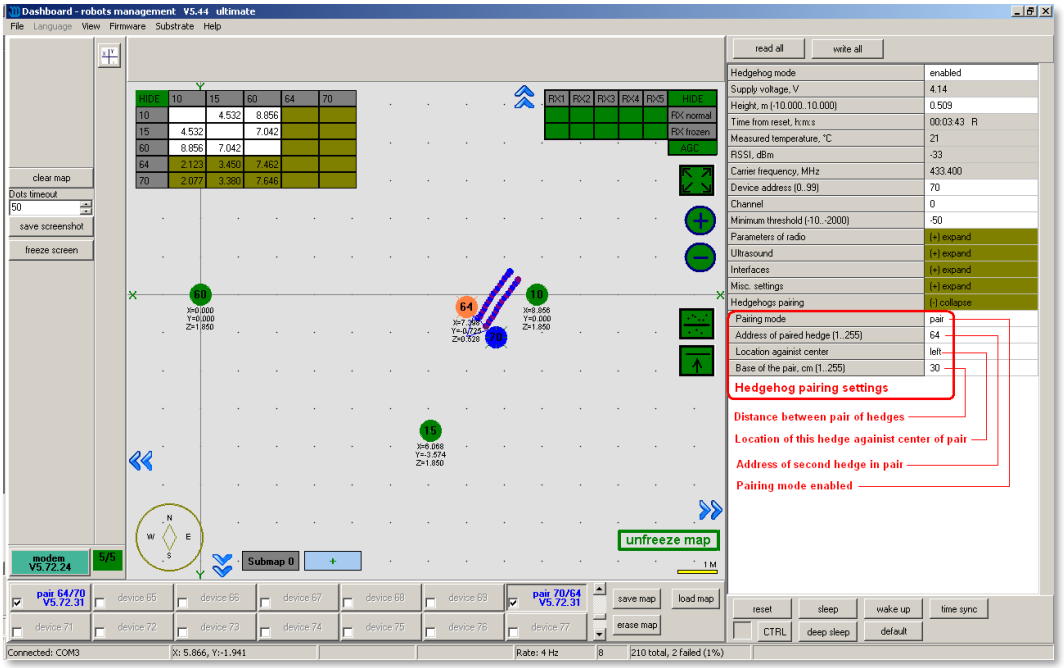


## 7.10 Paired beacons (FN0005)

- Two hedgehogs can be paired and work together as a single beacon without update rate reduction.
- Moreover, each beacon streams out in this mode not only its own location, but 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.

Follow these steps:

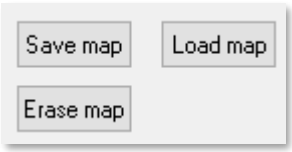
1. Wake up stationary beacons and freeze the map
2. Wake up two hedgehogs which were pre-installed on robot/copter/drone
3. Choose one beacon and go to “Pairing mode” parameter and activate
4. Write the “Address of paired beacon”, means number of the beacon, current selected hedgehog is paired with
5. Now choose location against center in parameters relatively the second beacon
6. Go to “Base of the pair” parameter and write actual distance between paired hedgehogs. Do the same for 2nd hedgehog.



## 7.11 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



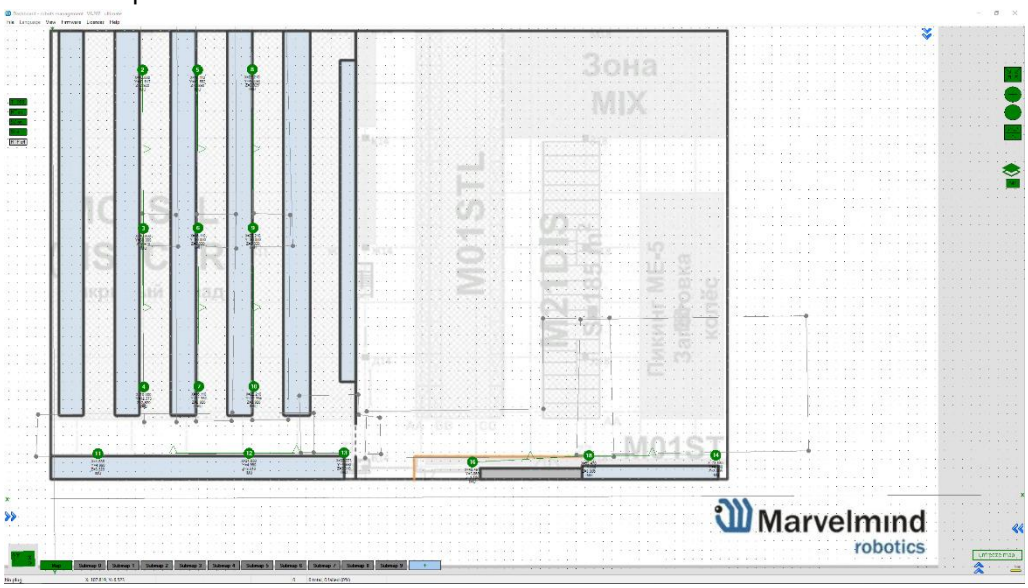
## 7.12 Background color

Starting from v6.200 Dashboard supports background color change.

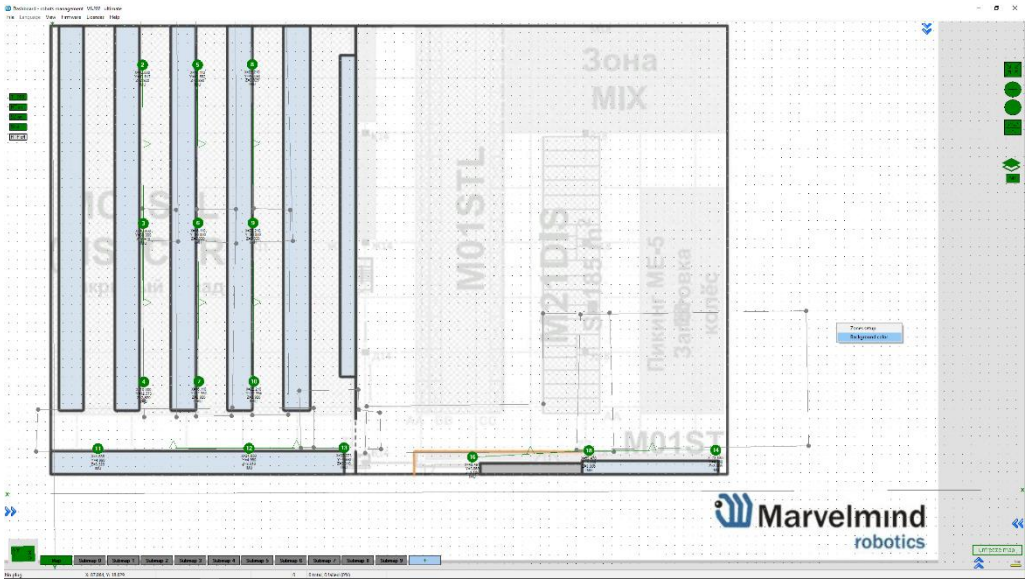
This is a small feature that helps make tracking look better. If you uploaded a floorplan and it is white, you can tune Dashboard's background color to make it suit.

**How to choose background color:**

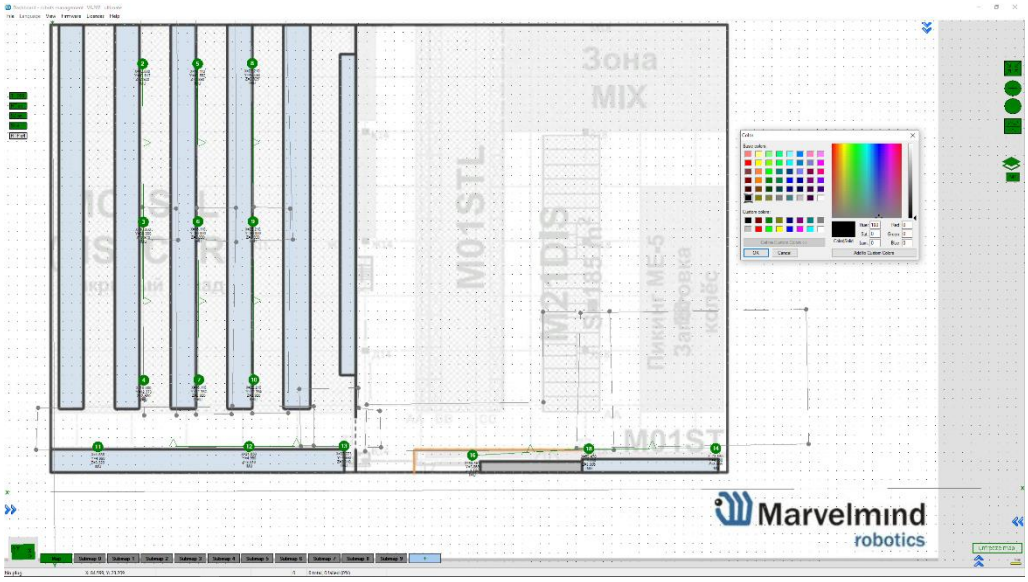
- Load floorplan



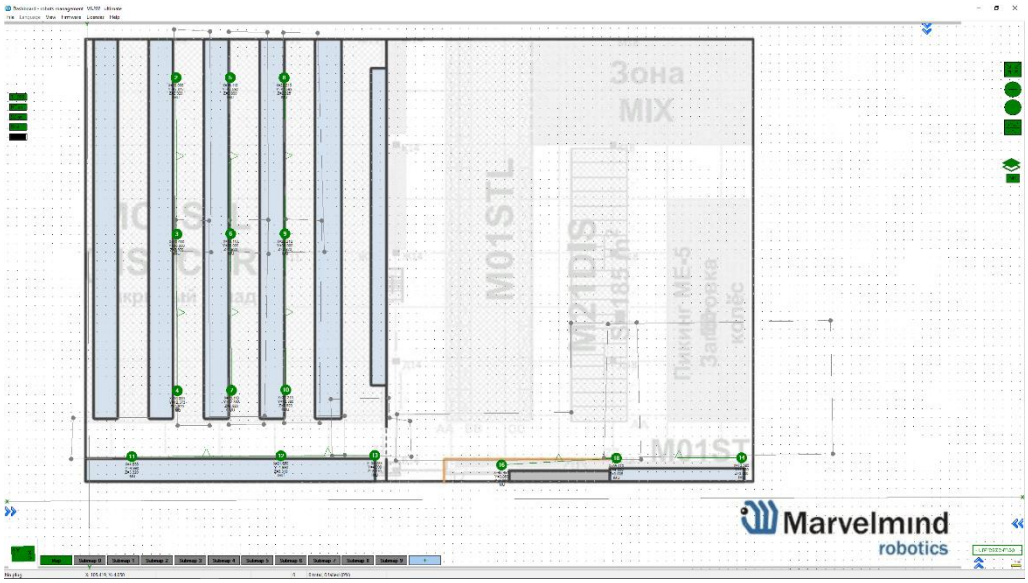

- **Right mouse button click** on the background



- Choose color and press “OK”

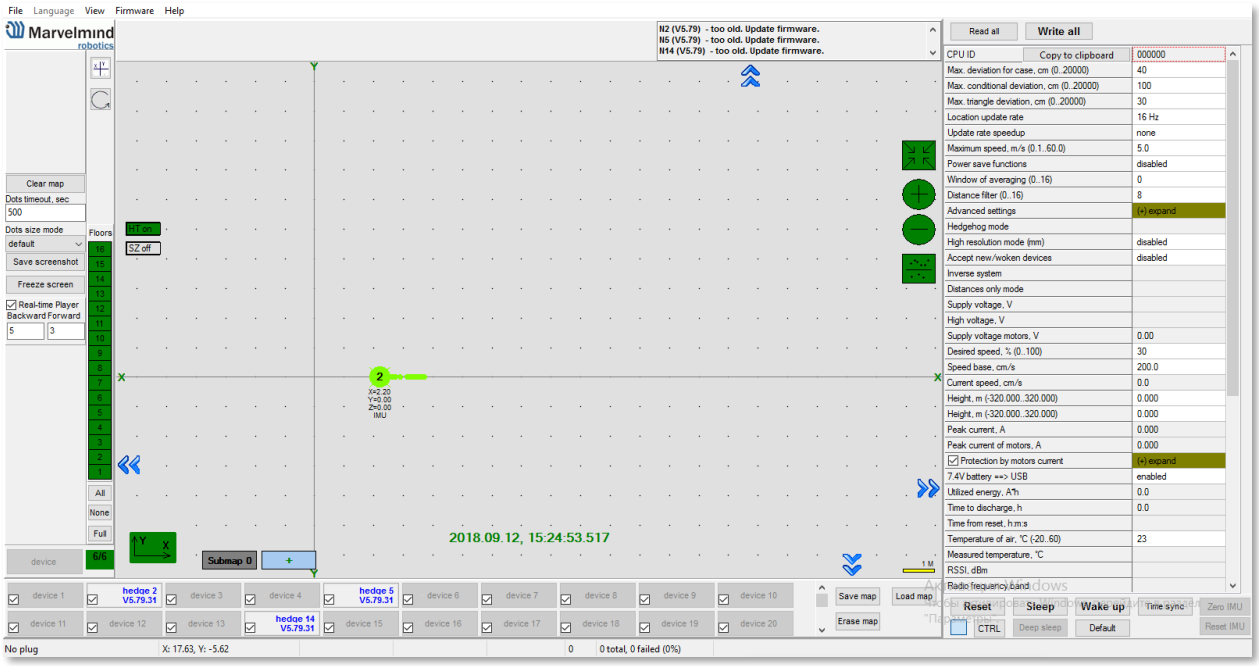



- Color applied. Now, background matches floorplan



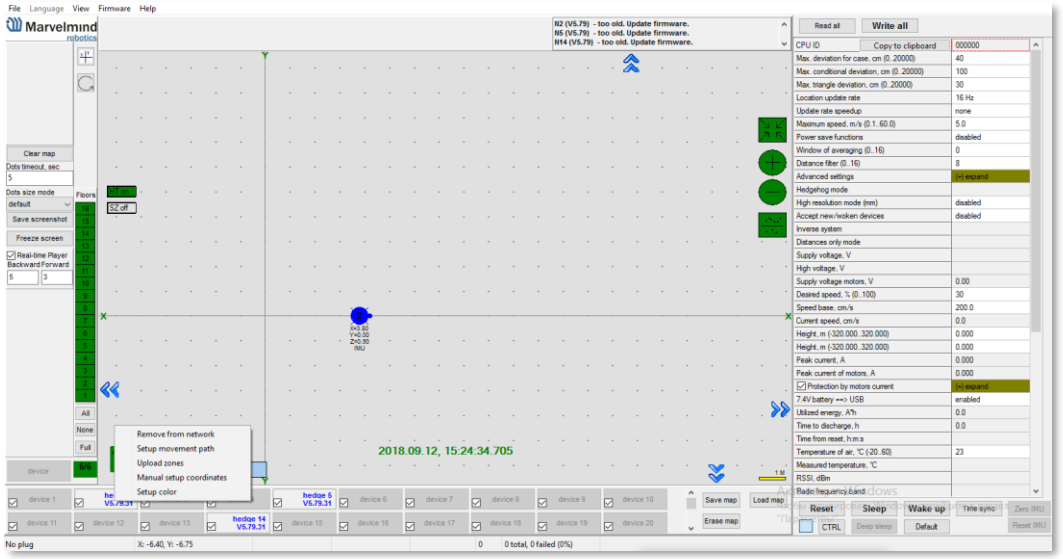
## 7.13 Hedge color change (FN0006)

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

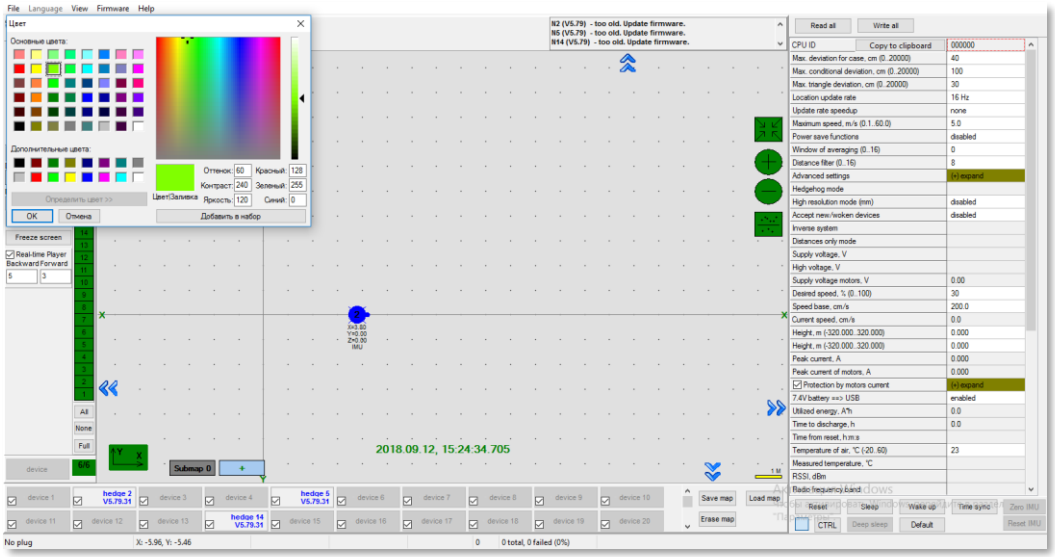



**How to change hedgehog color:**

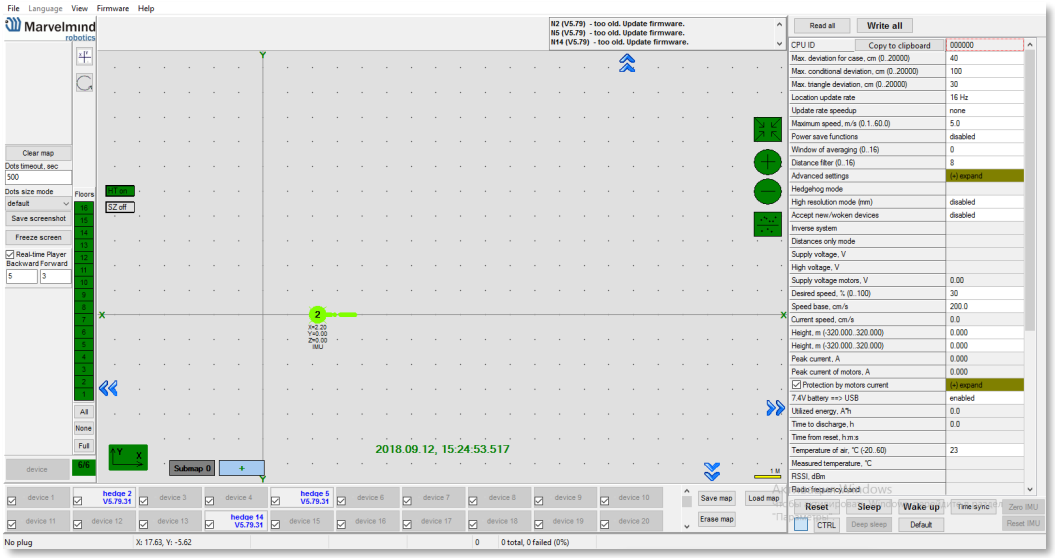
- **Right mouse button** click on the hedge in the list of devices -> **Setup color**



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

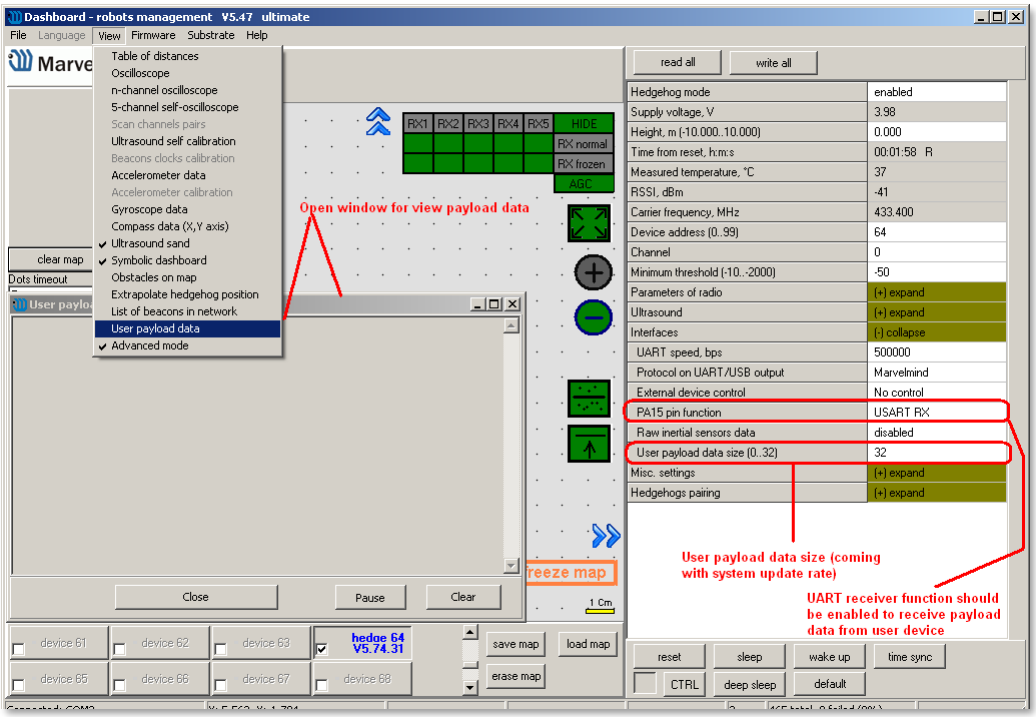



— Now, the hedgehog and its tracking path will be colored



## 7.14 Payload streaming (FN0007)

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




- All measurements were made with update rate setting 16 Hz. Real update rate is limited by distance, radio profile and payload data size.

| 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 |

## 7.15 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).

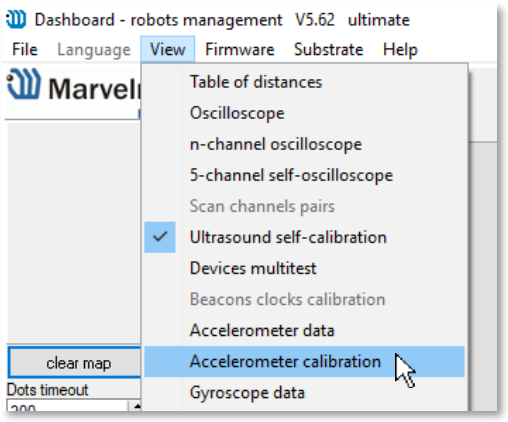
Required:

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

Setup IMU feature:

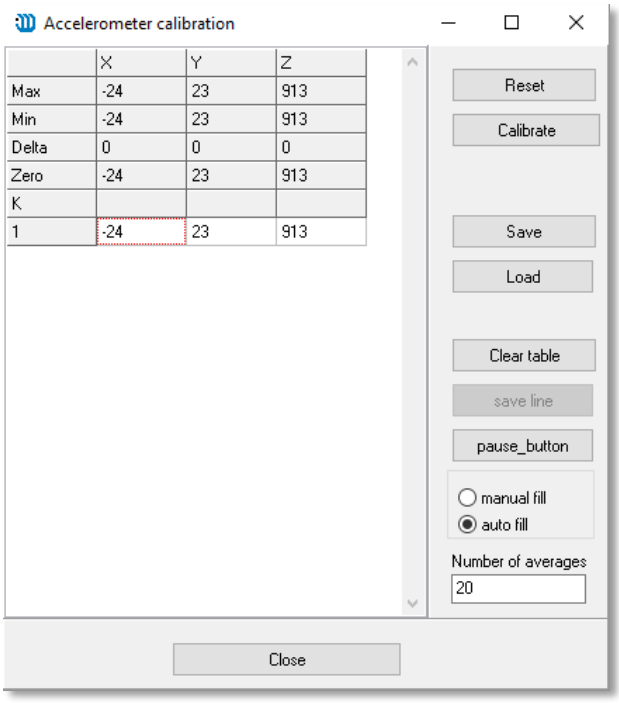
Accelerometer calibration

- Before you start use the feature check whether accelerometer has been calibrated
- Check if hedge was not calibrated before. Was damaged or fall down
- Put hedgehog on a flat surface (antenna directs up) and connect to your PC. Run the Dashboard



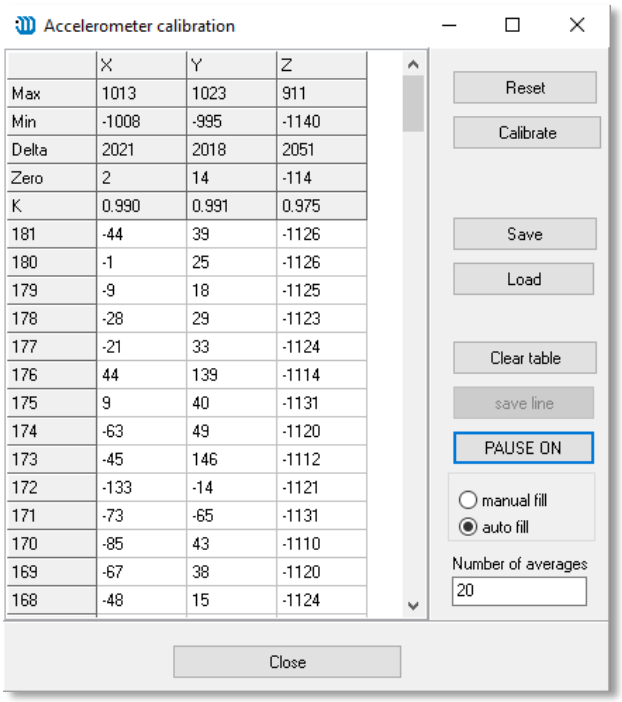

Go to **view => Accelerometer calibration** in open window click **autofill** and **clear table.**

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 10, but 25 is also permissible)
- Every time before calibrating the hedgehog click **Pause**
- Accelerometer calibrator will choose the best value for each axe. At the end click **Calibrate** and close the window
- Calibration is needed to determine **g** value for each accelerometer axe




Start the system:

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

After the ultrasound tracking has started, select the hedgehog in the Dashboard, go to 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.

**Using Data in the Python Library Example:**

Description of the protocol for streaming data: (link)

To work with data, you need to use some ready-made library, or develop your own software tools that can work with the described protocol.

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

- python (link)
- c ++ (link)
- java (link)

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.

## 7.16 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

## 7.17 Player feature (FN0009)

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

1. Go to **File=>player**

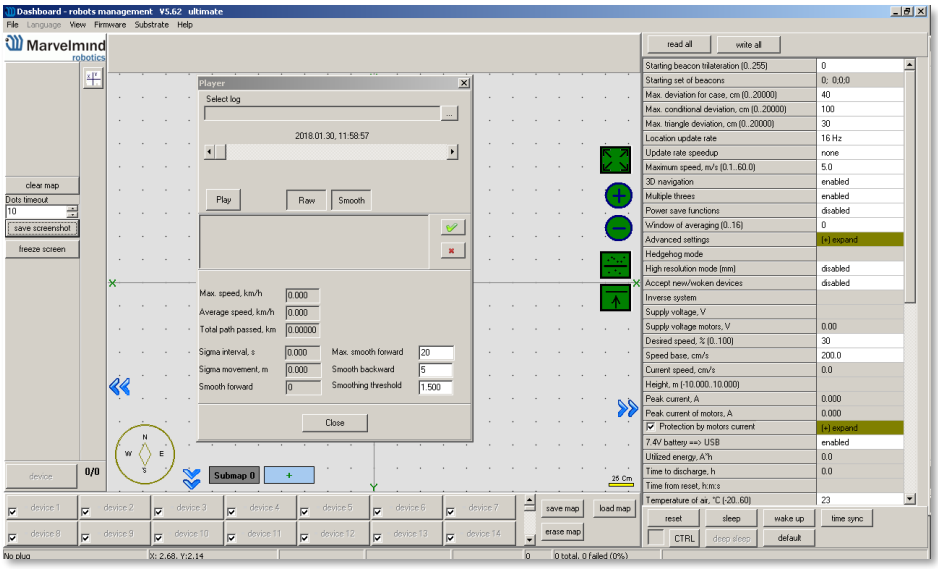

2. This is how the starting player menu looks like

   **Select log** – opens save log file

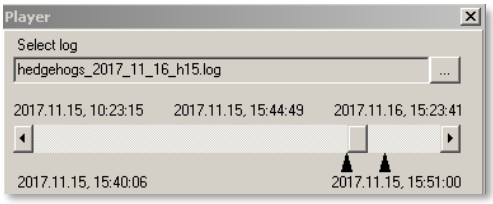
   **Play** – launch the player

   **RAW** – if clicked, player shows raw data

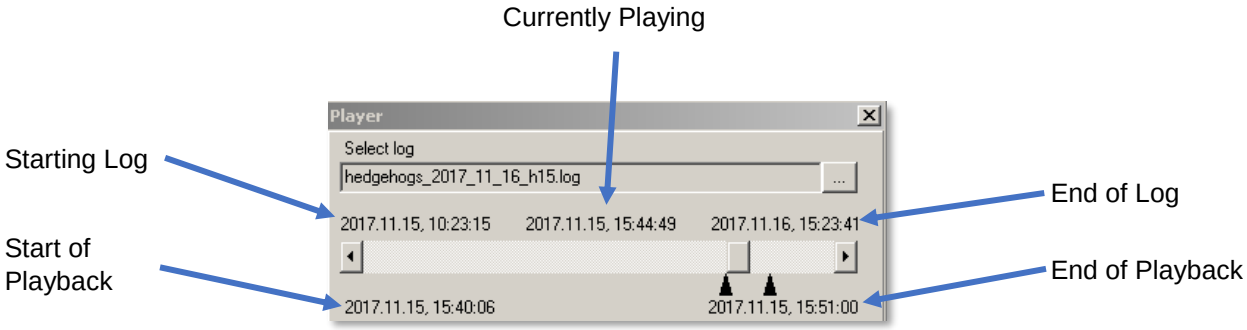
   **Smooth** – if clicked, player shows smooth data



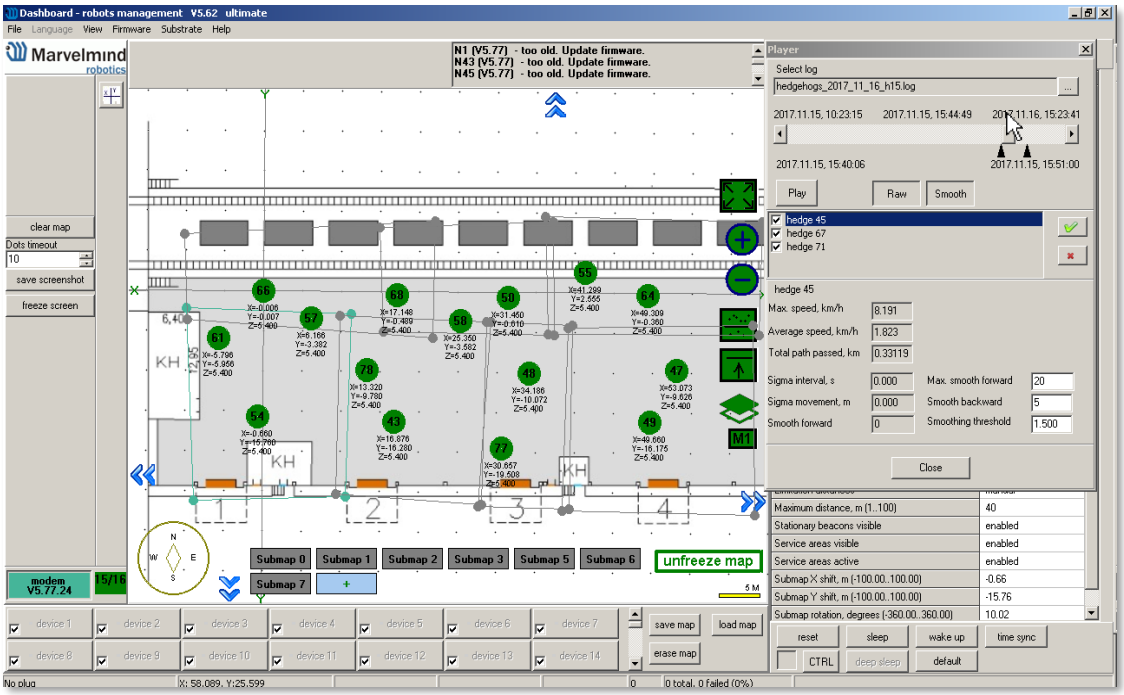
3. Now log is loaded. Important: for recording log file click **Save map** for saving all the beacons locations and attaching all the beacons to the log



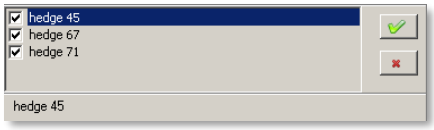

At the top of the player you can see 5 outputs:




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



4. In play mode: grey points – RAW data, blue – Smooth



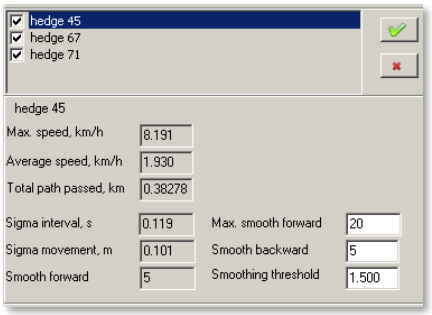

Choose the hedgehog will be displayed

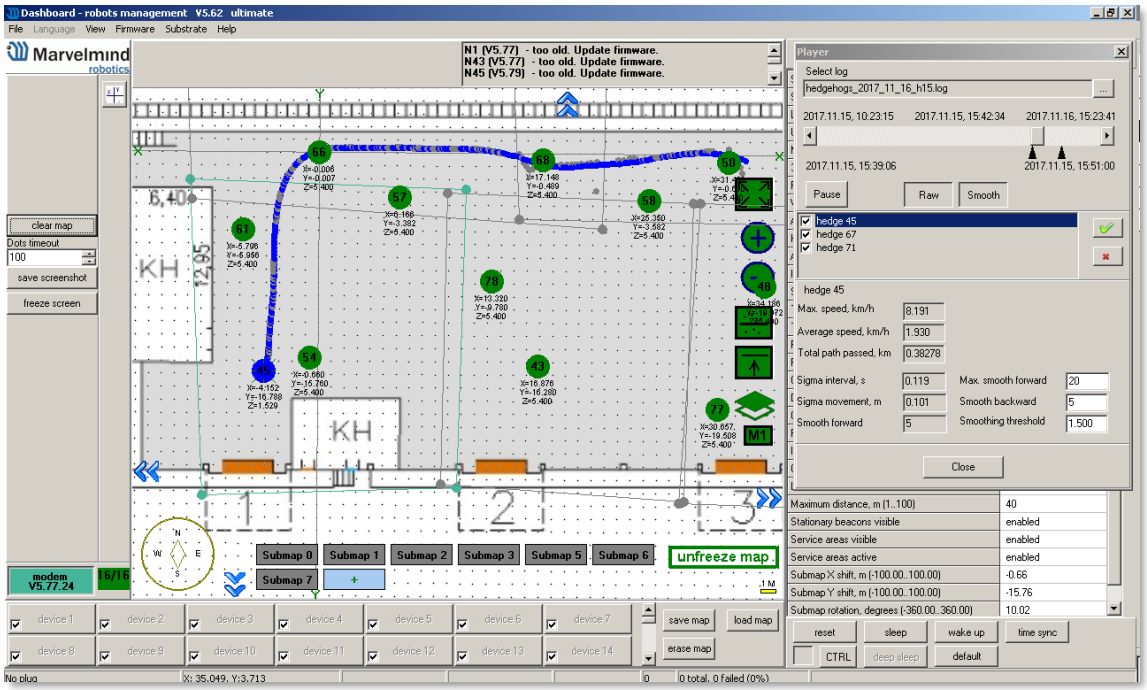
In the main Dashboard window, you can turn off displaying service areas and stationary beacons by clicking **Service areas visible**, **Stationary beacons visible.**


Statistics displayed depends on the chosen hedgehog in the list

**Max smooth forward**, **smooth backward** – depth smoothing

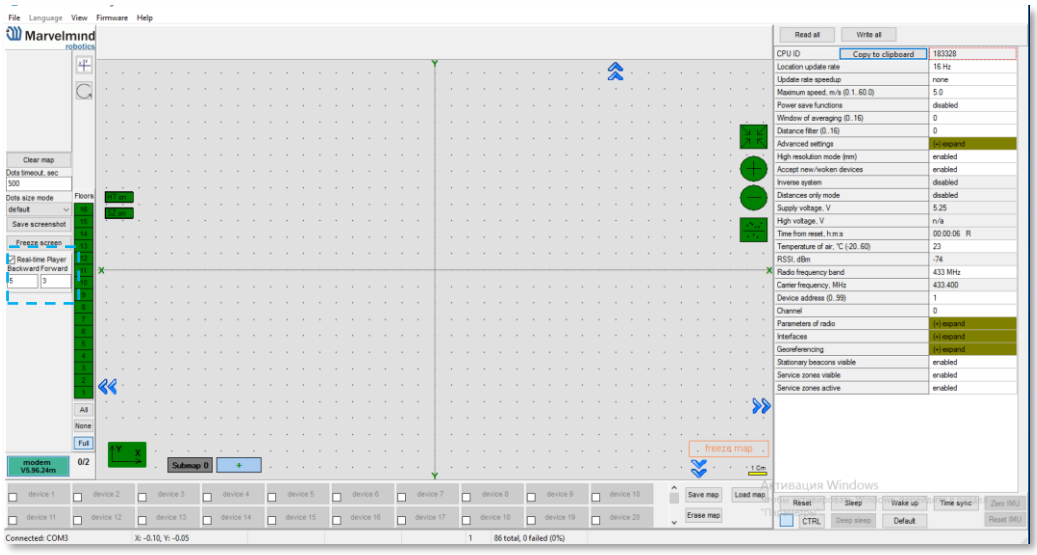
**Smooth threshold** - smoothing ratio.



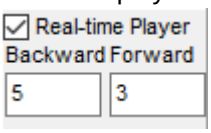



## 7.18 Real-time player feature (FN0010)

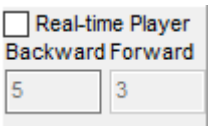
Real-time player is a feature, which makes the tracking path smoother. As far as it looks backward and forward it certain latency based on the selected parameters.



- Real-time player **turned on by default**



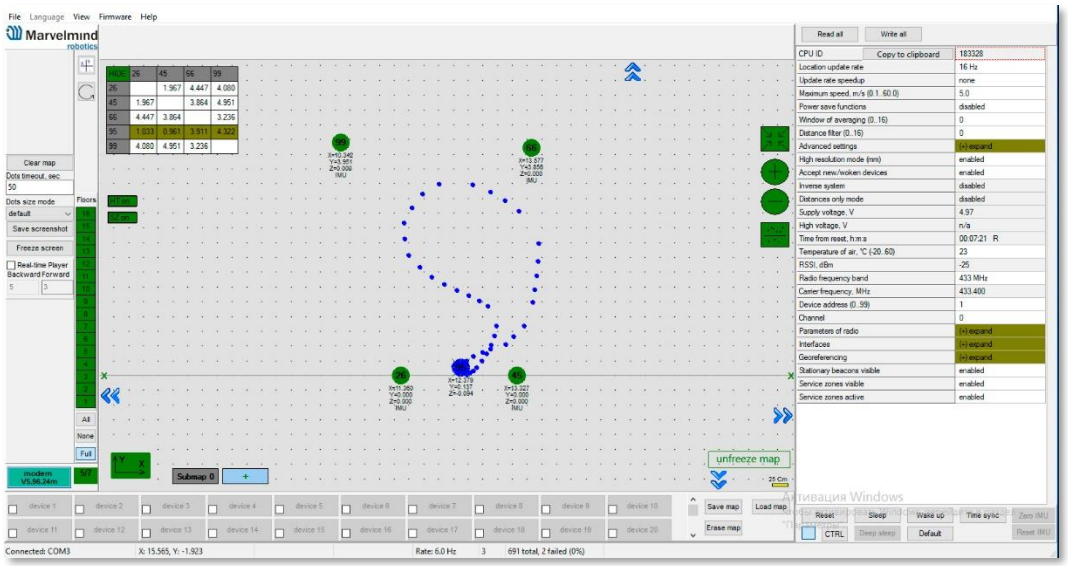

- You can turn it off if you need less delay



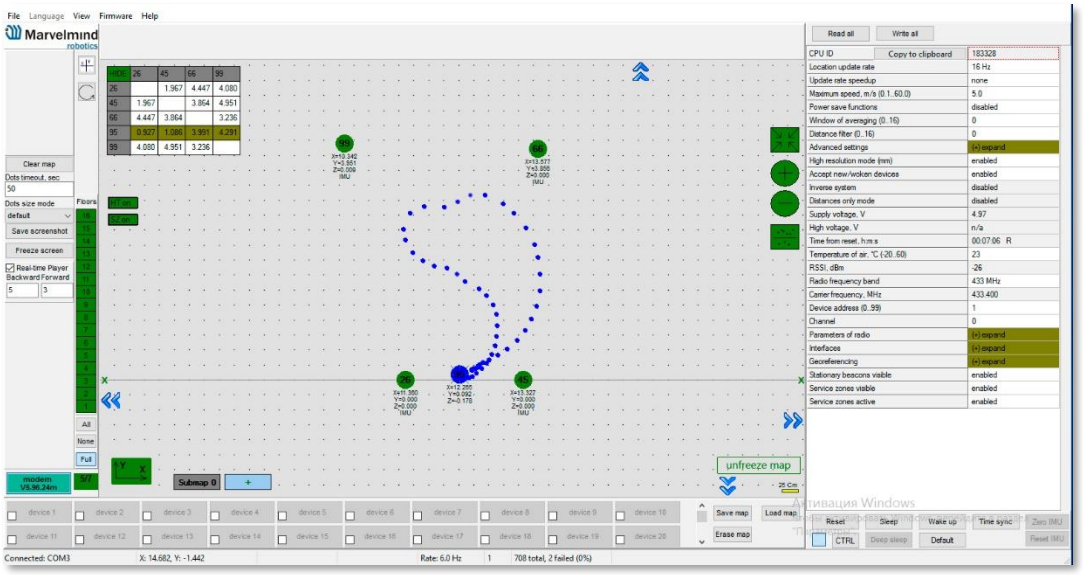

- You can tune it whether you need:
  - **Backward** – amount of dots which player ‘looks’ backward to provide smooth tracking
  - **Forward** – amount of dots which player ‘looks’ forward to provide smooth tracking

Tracking example:

Real-time player **turned off**



Real-time player **turned on**



## 7.19 CSV format

Current Dashboard version supports additional timestamp. See the attached screenshot, the UNIX time in milliseconds is the first value.

In each line comma separated values, CSV:

- UNIX time in milliseconds (time since 1970.01.01)
- time from previous record in milliseconds
- time from running dashboard in milliseconds
- address of hedgehog
- X coordinate of hedgehog, meters
- Y coordinate of hedgehog, meters
- Z coordinate of hedgehog, meters
- address of stationary beacon
- raw distance from hedgehog to stationary beacon, meters

The last pair (beacon address, distance) is repeated n times equal stationary beacons quantity in the system.

```
1494780417562,16,12287484,10,5.643,-0.553,0.453,12,6.343,13,3.169,14,9.814,15,5.841,
1494780417609,47,12287531,10,5.643,-0.553,0.453,12,6.343,13,3.169,14,9.814,15,5.841,
1494780417625,16,12287547,10,5.643,-0.552,0.466,12,6.343,13,3.169,14,9.814,15,5.841,
1494780417687,62,12287609,10,5.643,-0.552,0.466,12,6.343,13,3.169,14,9.814,15,5.841,
1494780417703,16,12287625,10,5.643,-0.552,0.466,12,6.343,13,3.169,14,9.814,15,5.841,
1494780417703,0,12287625,10,5.643,-0.552,0.466,12,6.343,13,3.169,14,9.814,15,5.841,
1494780417750,47,12287672,10,5.646,-0.550,0.466,12,6.343,13,3.169,14,9.814,15,5.841,
1494780417812,62,12287734,10,5.646,-0.550,0.466,12,6.343,13,3.171,14,9.811,15,5.840,
1494780417812,0,12287734,10,5.646,-0.550,0.466,12,6.343,13,3.171,14,9.811,15,5.840,
1494780417843,31,12287765,10,5.646,-0.550,0.466,12,6.343,13,3.171,14,9.811,15,5.840,
1494780417875,32,12287797,10,5.642,-0.553,0.466,12,6.343,13,3.171,14,9.811,15,5.840,
1494780417875,0,12287797,10,5.642,-0.553,0.466,12,6.343,13,3.171,14,9.811,15,5.840,
1494780417937,62,12287859,10,5.642,-0.553,0.466,12,6.347,13,3.172,14,9.813,15,5.837,
1494780417968,31,12287890,10,5.642,-0.553,0.466,12,6.347,13,3.172,14,9.813,15,5.837,
1494780418031,63,12287953,10,5.649,-0.551,0.466,12,6.338,13,3.171,14,9.813,15,5.843,
1494780418078,47,12288000,10,5.649,-0.551,0.466,12,6.338,13,3.171,14,9.813,15,5.843,
1494780418140,62,12288062,10,5.642,-0.553,0.466,12,6.338,13,3.171,14,9.813,15,5.843,
1494780418140,0,12288062,10,5.642,-0.553,0.466,12,6.338,13,3.171,14,9.813,15,5.843,
1494780418171,31,12288093,10,5.642,-0.553,0.466,12,6.463,13,3.169,14,9.813,15,5.837,
1494780418203,32,12288125,10,5.642,-0.553,0.466,12,6.463,13,3.169,14,9.813,15,5.837,
1494780418265,62,12288187,10,5.648,-0.551,0.459,12,6.463,13,3.169,14,9.813,15,5.837,
1494780418312,47,12288234,10,5.648,-0.551,0.459,12,6.345,13,3.172,14,9.813,15,5.844,
1494780418375,63,12288297,10,5.651,-0.549,0.459,12,6.345,13,3.172,14,9.813,15,5.844,
1494780418375,0,12288297,10,5.651,-0.549,0.459,12,6.345,13,3.172,14,9.813,15,5.844,
1494780418390,15,12288312,10,5.651,-0.549,0.459,12,6.346,13,3.171,14,9.812,15,5.846,
1494780418421,31,12288343,10,5.651,-0.549,0.459,12,6.346,13,3.171,14,9.812,15,5.846,
1494780418468,47,12288390,10,5.651,-0.549,0.459,12,6.346,13,3.171,14,9.812,15,5.846,
1494780418468,0,12288390,10,5.651,-0.549,0.459,12,6.346,13,3.171,14,9.812,15,5.846,
1494780418546,78,12288468,10,5.651,-0.552,0.459,12,6.346,13,3.175,14,9.812,15,5.846,
1494780418546,0,12288468,10,5.651,-0.552,0.459,12,6.346,13,3.175,14,9.812,15,5.846,
1494780418593,47,12288515,10,5.651,-0.552,0.459,12,6.346,13,3.175,14,9.812,15,5.846,
```

# 8. Interfaces

Indoor “GPS” system supports many external interfaces that can feed measured location data to an external system (robot, copter, VR, etc.).

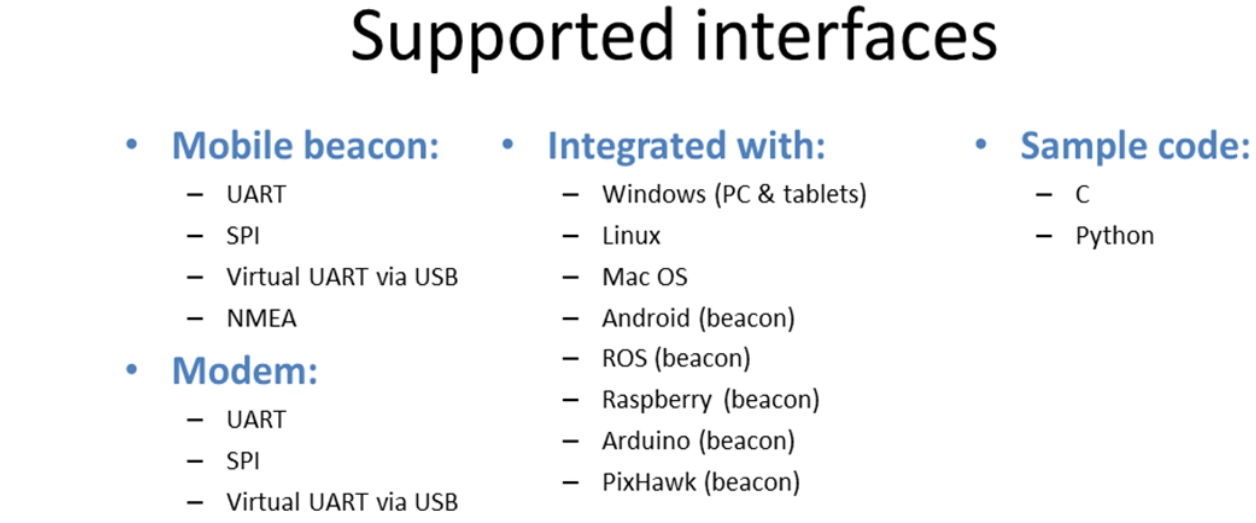
There are two different ways to obtain the mobile beacons’ location data from the system:

1. From the mobile beacons
    - Each mobile beacon knows its own position and does not know the positions of the other mobile beacons
2. From modem/router
    - Knows position of every mobile beacon in the system

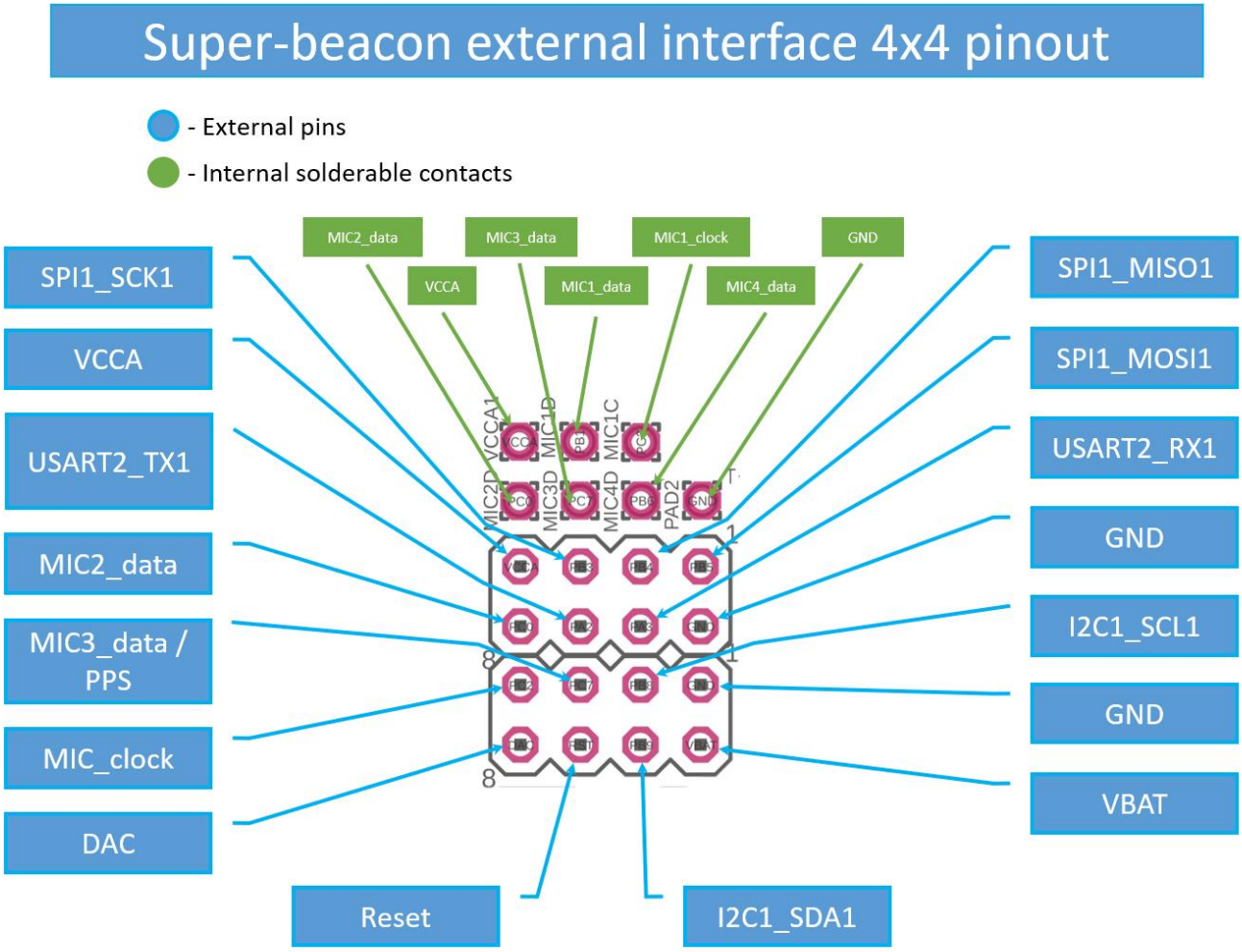
Data from the mobile beacons and from the modem can be obtained at the same time, if necessary

A list of the supported interfaces is shown below.

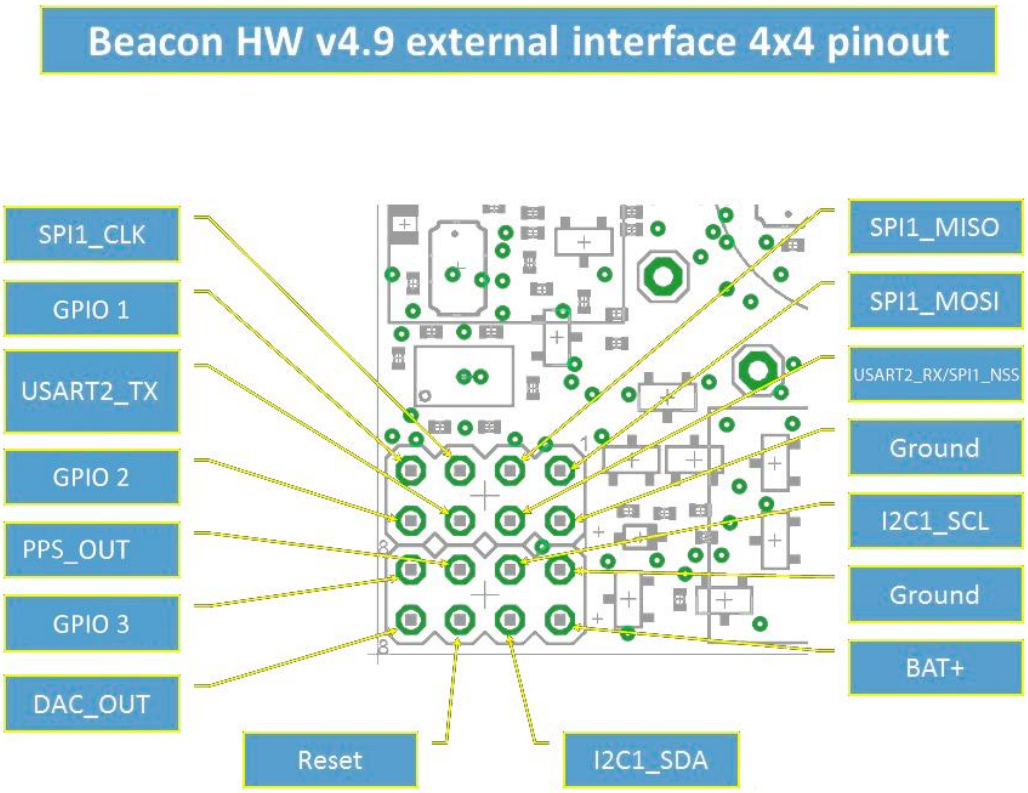
More information on the interfaces can be found here:
http://marvelmind.com/#Interfaces.



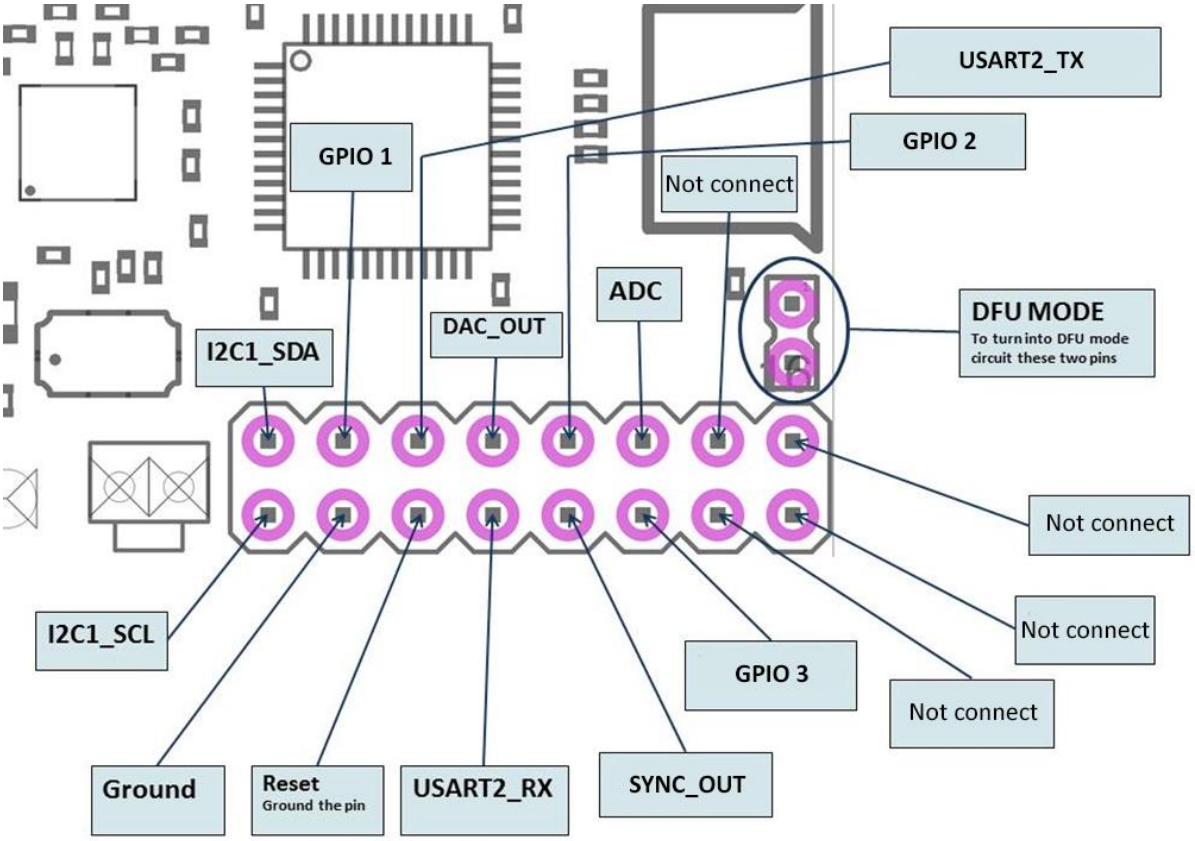
## 8.1 Super-beacon external interface pinout top view



## 8.2 Beacon HW v4.9 external interface 4x4 pinout top view



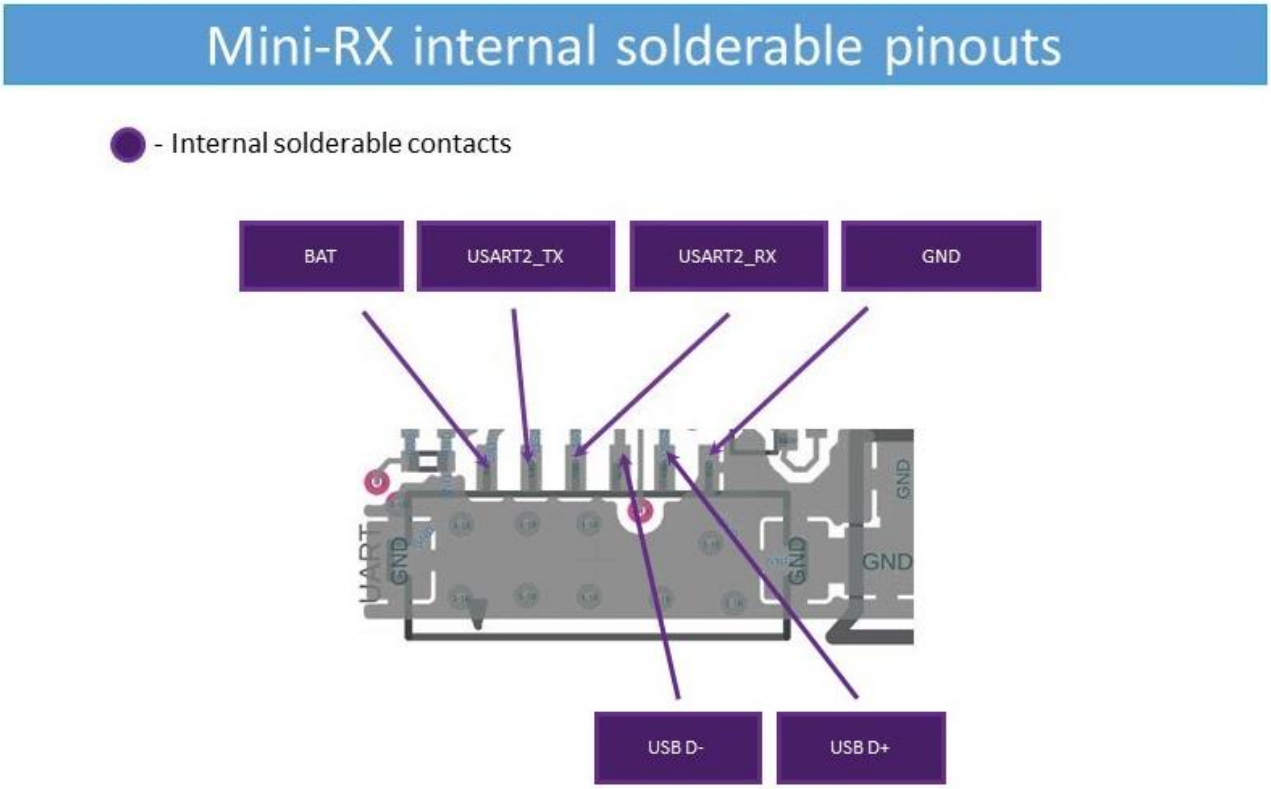
## 8.3 Modem HW v4.9 external interface pinout top view



## 8.4 Mini-RX internal solderable pinouts (for experienced users only)

Use it only if you sure that you can solder it correctly
Do not forget to turn off the beacon with DIP-switches
If you solder bad and kill the beacon, Marvelmind team won't be responsible for it

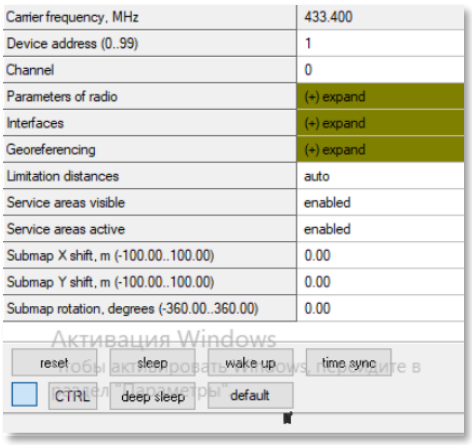
To get UART data streaming from beacon Mini-RX, you must solder to the pins on the board.



# 9. 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.



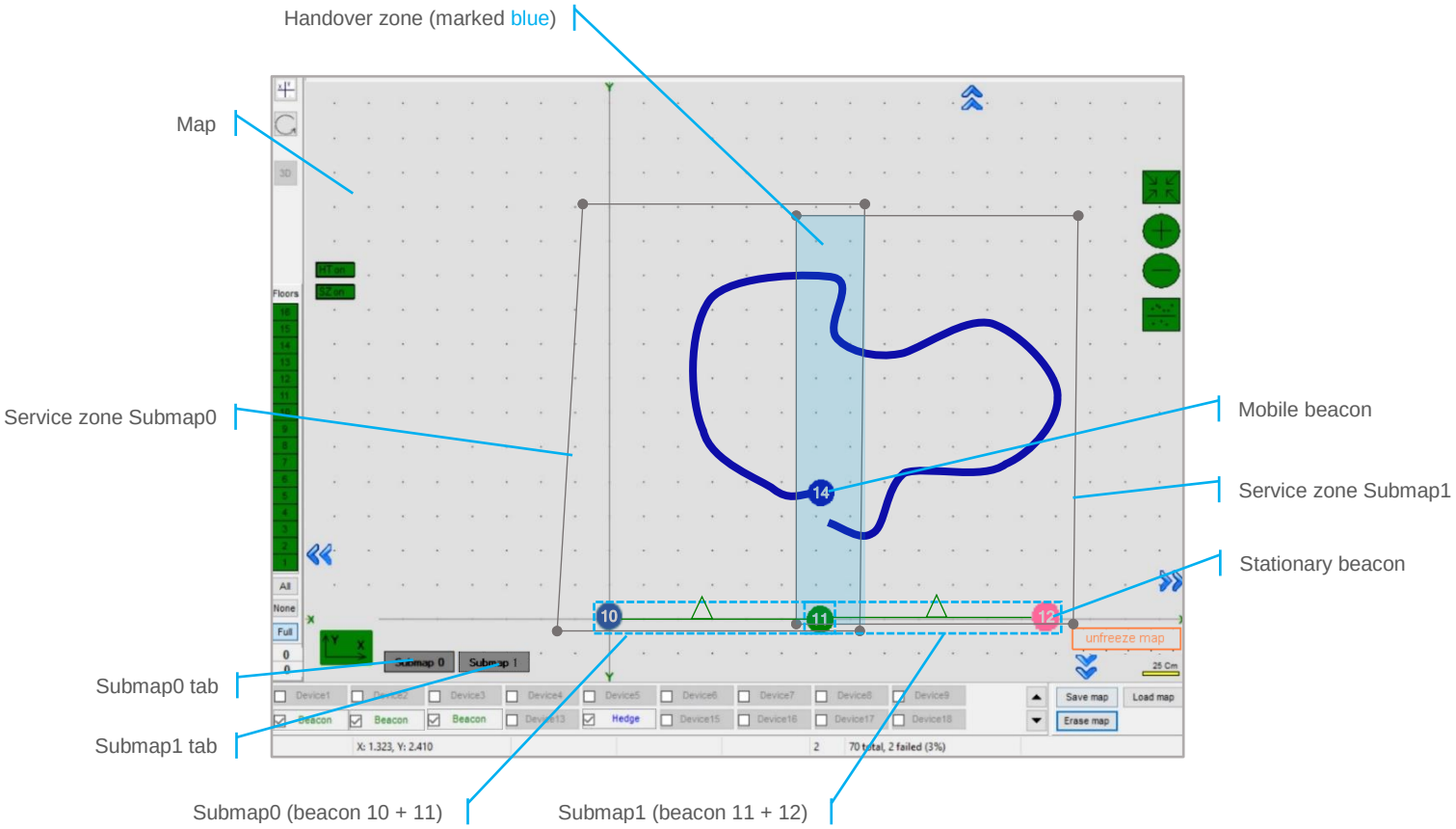
# 9.1 Building big maps in Inverse Architecture (IA)

**This chapter is applicable only for Inverse Architecture**

### 9.1.1. Introduction

In this chapter we described building big maps in **IA**. It has differences from classic NIA map building because we have more than 1 ultrasonic frequency, and we need to make sure that they do not interfere with each other. Please, read carefully.

A **map** is a system unit that includes **submaps, stationary beacons** and **service zones** within which 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, jitter codes** and **TDMA position** of stationary beacons, by which mobile beacons can not only be positioned, but also determine in which submap the mobile beacon is located.

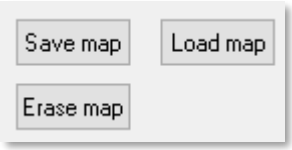
### 9.1.2. Map

Map – the biggest unit in Marvelmind Indoor GPS. It consists of submaps and form full map of all stationary devices you have. After you build and tune all the submaps, waked up mobile beacon, you have to click on Modem icon and Freeze the map. It is the final stage of building the system. After you freeze map, tracking will appear.

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

Map Settings offer some helpful tools, it is situated in the right bottom 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



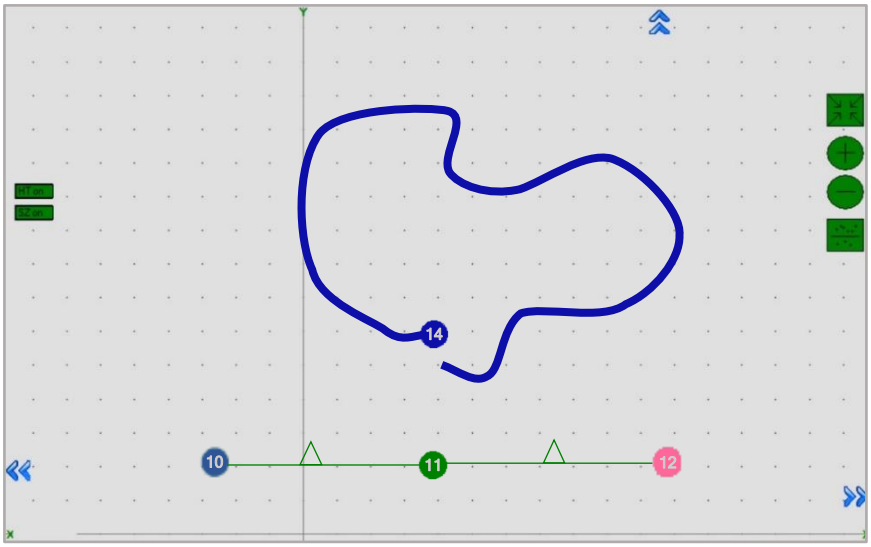
### 9.1.3. Submaps

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

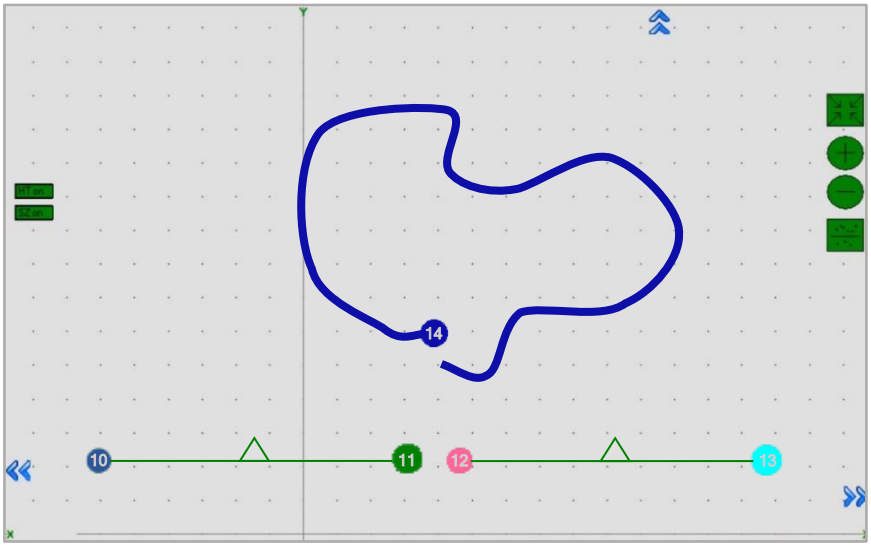
Different types of submaps can be used together. Mix 1D, 2D, 3D as you wish. Map of the office floor, for example, may contain 1D submap for corridor, 2D/3D submaps for office rooms. All that submaps will form a big map with coverage you need.

Submaps can contain the same beacons. It makes possible to use 3 beacons instead 4. It is very helpful in the IA because we are limited with 5 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:



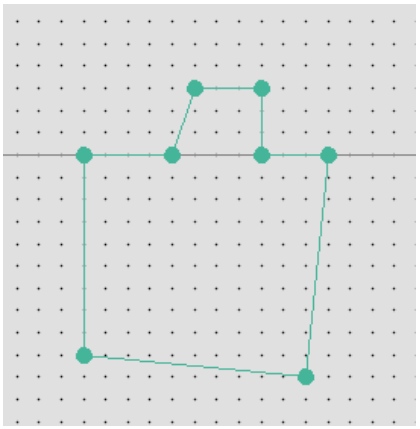

Different configurations suit different cases. You can also have submaps with neighboring beacons and submaps without it on the one map.

### 9.1.4. Submaps' service zones

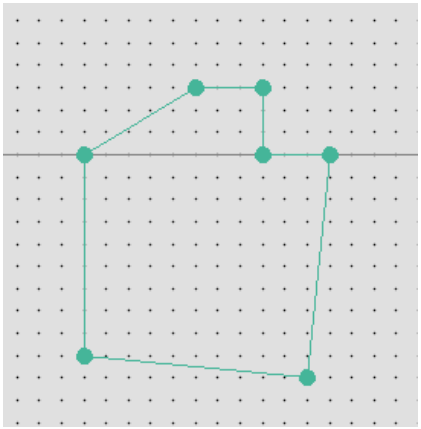
Service zone (or service area) is an area which serve submap. Service zone must be drawn for any submap you build. It helps to divide tracking between different submaps and outline the area of responsibility of every submap.

How to create a service zone:

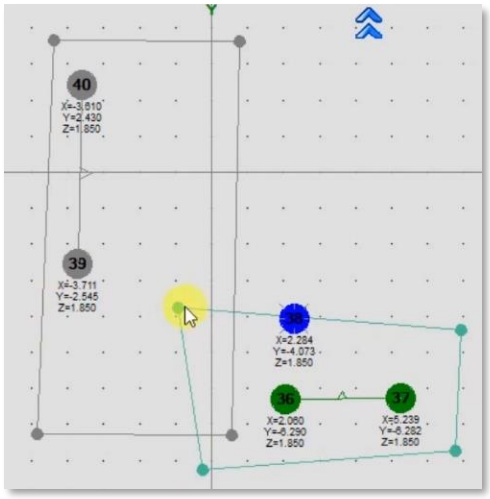
- **Choose submap (click on the submap icon)**
- Use **SHIFT + Left mouse button** on the map to create point.



- Use **SHIFT + Left mouse button** on the point to delete it.

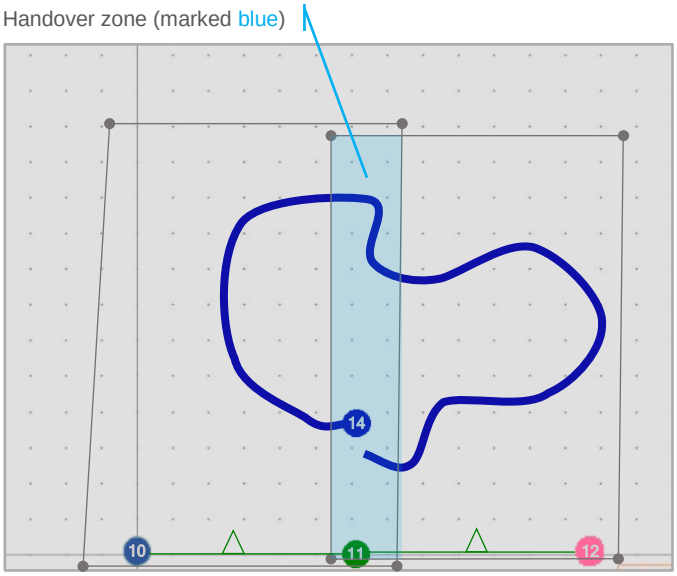


- Put points around submap, move them to provide service area for current submap. Service areas will cross each other. If hedgehogs get lost between two submaps expand the service area



### 9.1.5. Handover zones

Handover zone is an area which creates when service zones cross. It serves to make a smooth transfer of mobile beacon from service zone of one submap to another

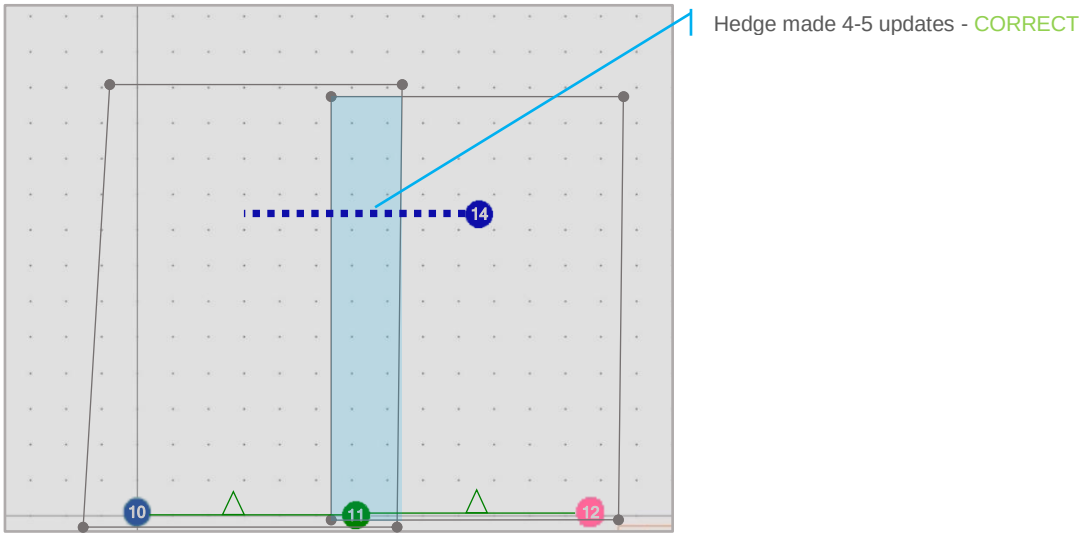



**How to create Handover zone correctly**

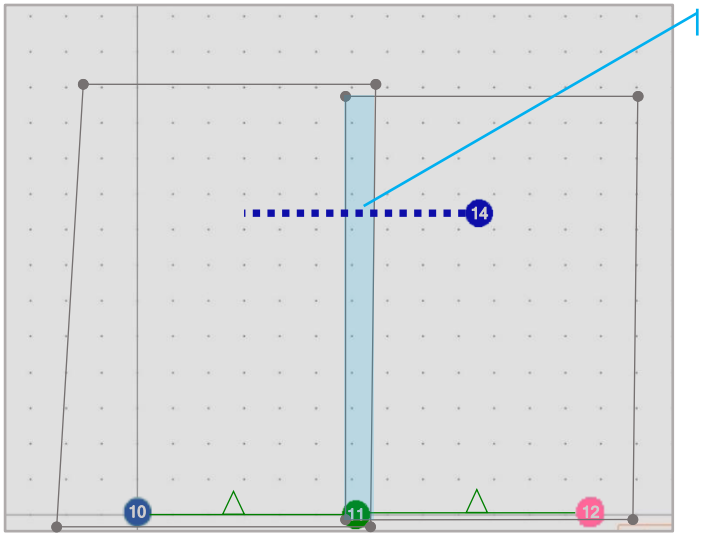
Size of a Handover zone may be different and depends on the mobile beacon's speed and system's update rate. We recommend testing it with the speed of your mobile beacon mounted on a person/robot/copter. General recommendation is – to make handover smooth and correct, make sure that your mobile beacon makes at least 4 refreshes in a handover zone.

Look at the following examples:

**Example 1**: Normal handover zone:

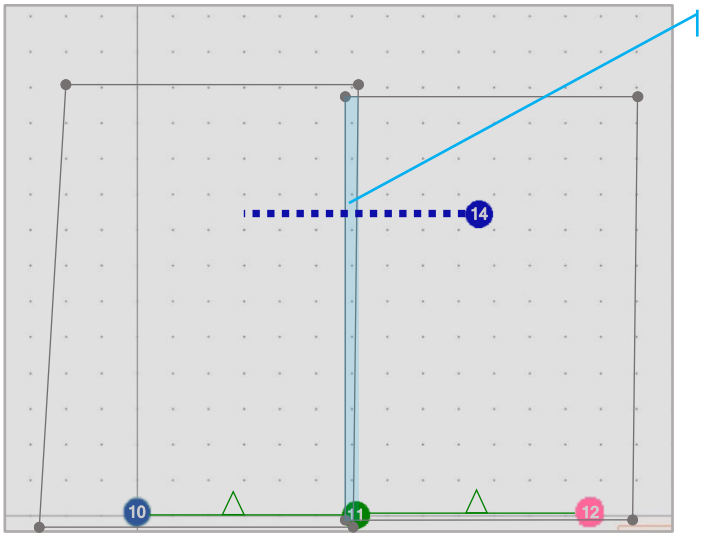


**Example 2**: Small handover zone:



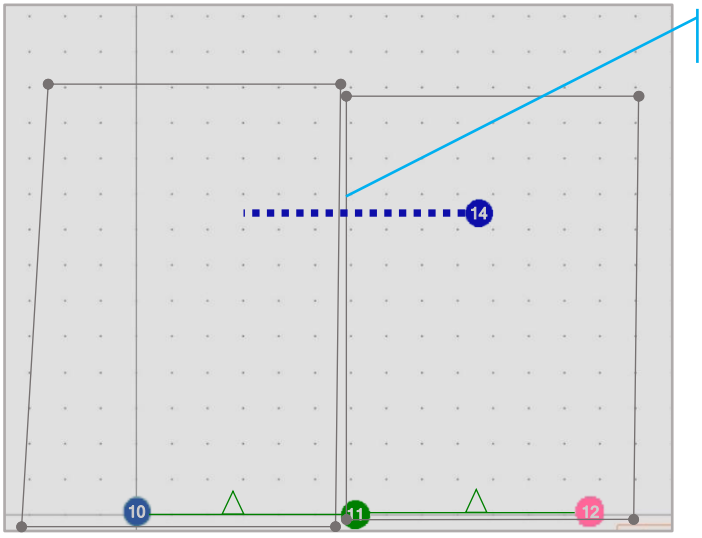

Hedge made 2-3 updates – MAY BE NOT ENOUGH

**Example 3**: Very small handover zone:




Hedge made 1-2 updates – NOT ENOUGH

**Example 4**: No handover zone:




Service zones not cross – NO HANDOVER ZONE CREATED, NO HANDOVER BETWEEN SUBMAPS

### 9.1.6. Beacons' ultrasonic frequencies

Beacons must have different ultrasonic frequencies in IA. It can be used for different aims and different cases.

Please notice that 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 NIA (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 colored in different colors:

- 19KHz beacon
- 25KHz beacon
- 31KHz beacon
- 37KHz beacon
- 45KHz beacon

### 9.1.7. Beacons' jitter codes

In order for the beacon to be able to move between submaps, the **service zones** of these submaps **must intersect**, the intersection area of the service zones of neighboring submaps forms a **handover zone**, when the beacon enters the handover, it becomes possible for it to go to the neighboring submap. This ensures the positioning of the beacon on the entire area of the map.

Jitter is a code corresponding to a stationary beacon, depending on the code, a stationary beacon introduces a delay before emission and, accordingly, the received signal will be delayed by this value, the mobile beacon knows this delay by the emission cycle number and makes the appropriate distance adjustment.

**Jitter codes**, **sets of ultrasonic frequencies** and **TDMA** makes every submap unique and let mobile beacon displays in correct submap.

### 9.1.8. Examples of map building and beacons' placement

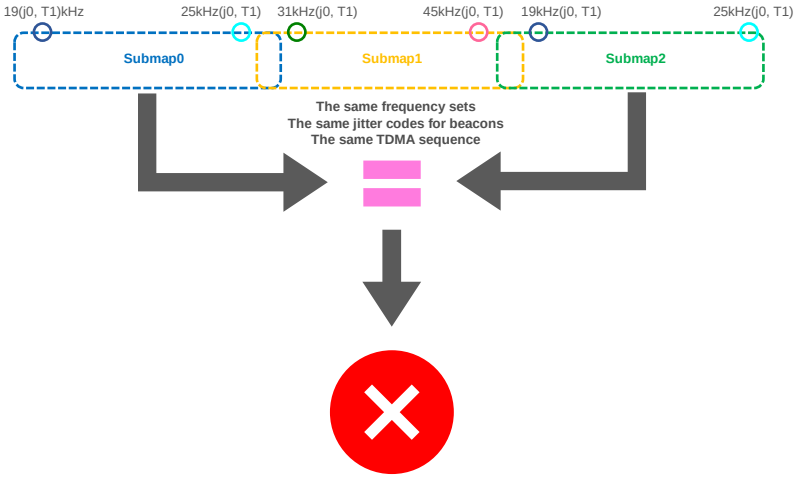
To make it possible for beacon to switch from the current submap to the neighboring one, the uniqueness condition for the frequencies of neighboring submaps is required, i.e. for any submap, all adjacent submaps must not have repeating **sets of frequencies + jitter codes + TDMA sequence**, it should be unique set for every submap.

How to decipher the notation below:

| | | |
|---|---|---|
| 19kHz(j0, T1) | = | 19kHz beacon, jitter=0, TDMA 1 |

**Sets of frequencies:**

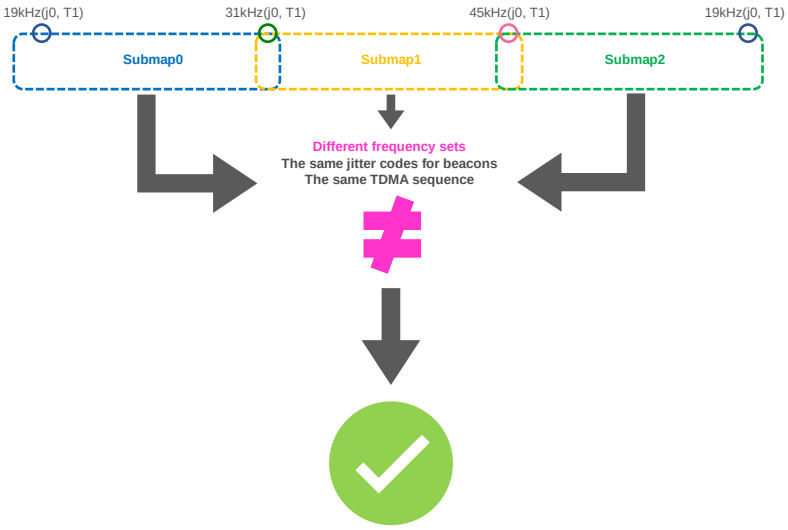
**Example 1:**




**Submaps the same - INCORRECT**

In this example, **submap1** has two adjacent submaps with the same frequencies (19-25kHz) – It is INCORRECT.

**Example 2:**




**Submaps differ - CORRECT**

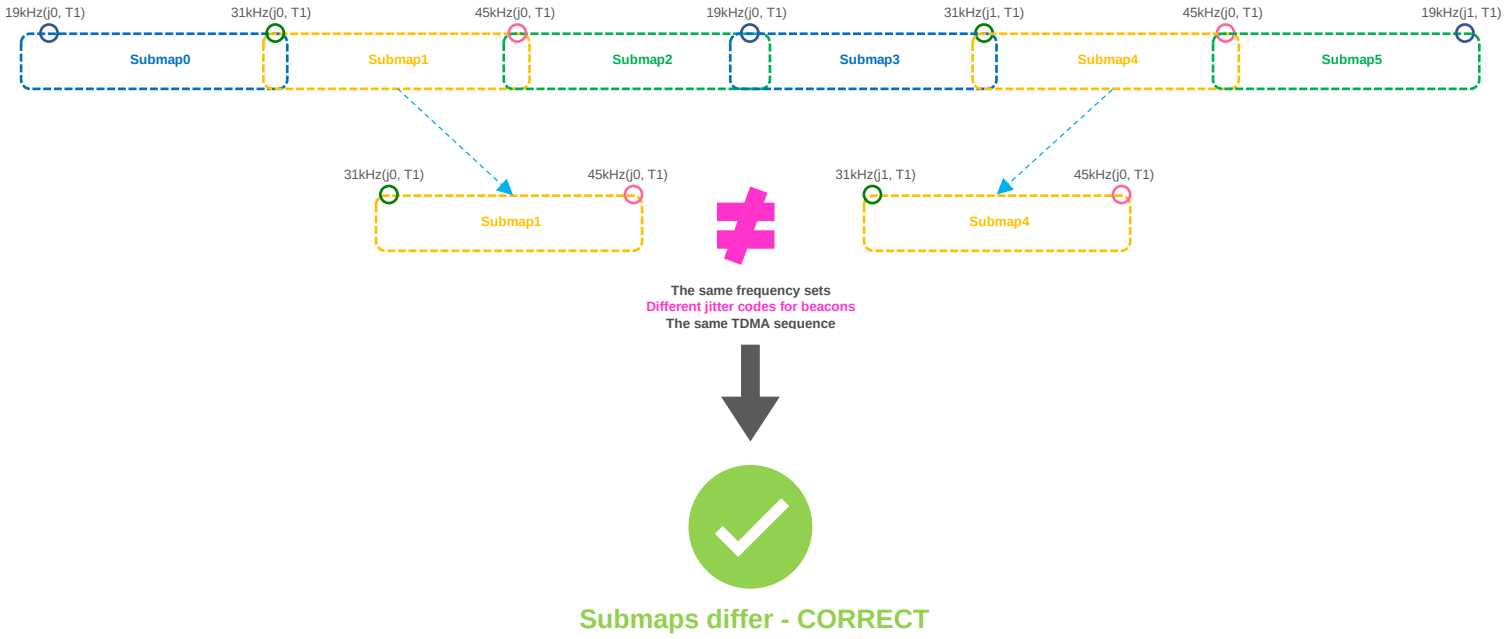
In this example, sets of frequencies are: 19-31kHz, 31-45kHz and 45-19kHz, while there are no repetitions in adjacent submaps, while further construction of submaps using the same frequencies is allowed, i.e. 19-31kHz, 31-45kHz, 45-19kHz, 19-31kHz, 31-45kHz, 45-19kHz, because in this case, repetition does not occur – It is CORRECT.

**Jitter codes:**

To make it possible for beacon to determine which submap it is located, it is necessary to fulfill the uniqueness condition for the set of frequencies and jitter in the submap with respect to the entire map. It allows to use the same sets of frequencies.

For instance:

**Example 1:**




In this example, frequency sets are: 19kHz(j0, T1)-31kHz(j0, T1), 31kHz(j0, T1)-45kHz(j0, T1), 45kHz(j0, T1)-19kHz(j0, T1), 19kHz(j0, T1)-31kHz(j1, T1), 31kHz(j1, T1)-45kHz(j0, T1), 45kHz(j0, T1)-19kHz(j1, T1), while there are no repetitions within the entire map – It is CORRECT map building

The following particular qualities must apply to handovers, within one submaps, the handover zones of other submaps cannot overlap, switching to a neighboring submap is possible only from a handover between these submaps.

**TDMA sequence:**

As far as we have only 5 ultrasonic frequencies, when we build big maps and when ultrasonic signals may interrupt each other, we must use TDMA. In this case submaps that cannot be used together will work alternately. Please notice that update rate falls by a multiple of TDMA sequence. If you have 8Hz basic update rate without using TDMA, 3 TDMA sequences will make it 8/3Hz.

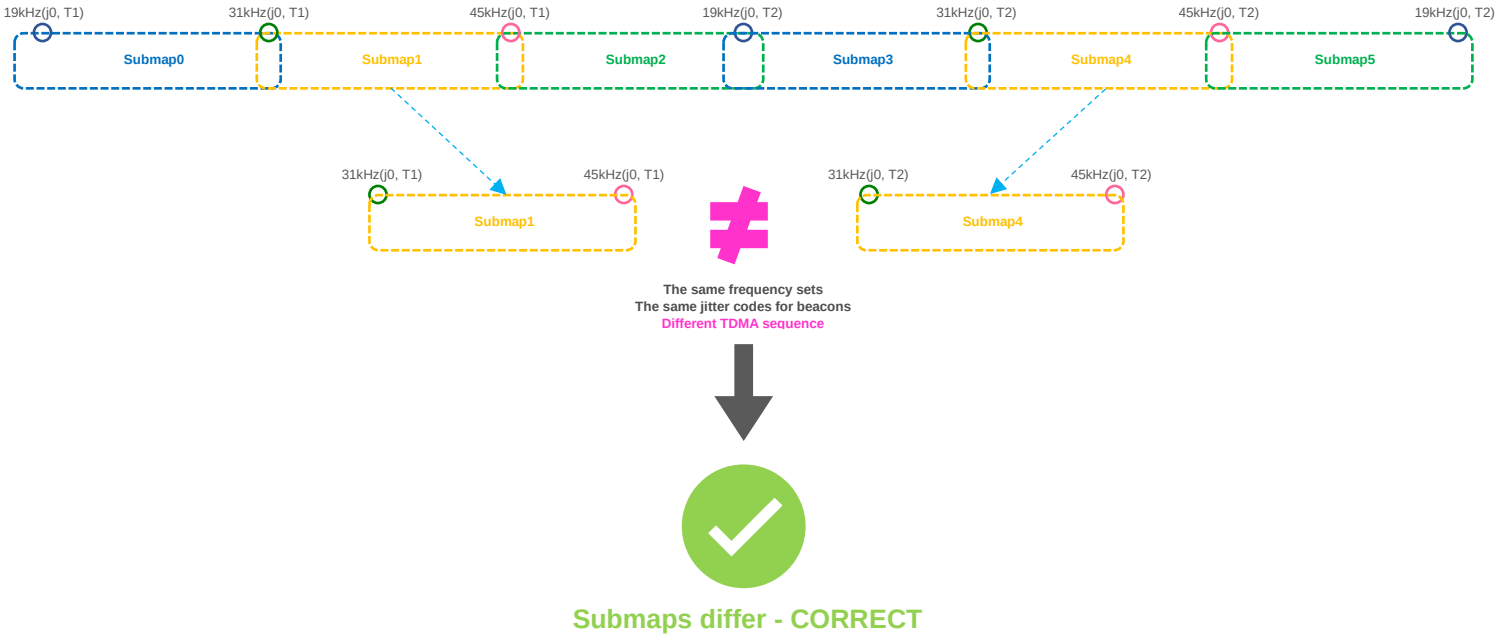
*TDMA is the mode of sequential radiation, when for each stationary beacon the number of the cycle in which it should emit and the number of cycles of radiation after which these numbers are repeated is set*

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 on TDMA chapter
- **Type 3** - TDMA for huge IA maps building (described below)

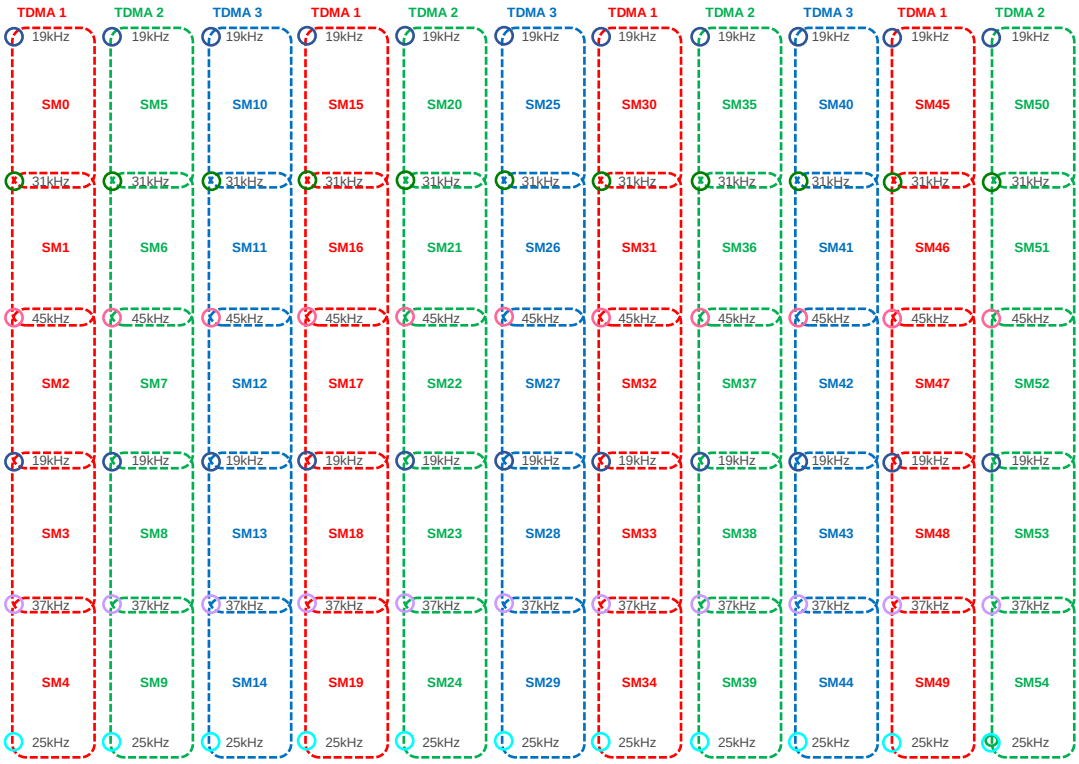
For building huge maps in IA, we need **TDMA Type 3.**

**Example 1:**



**Example 2:**

For example, a **100x100 meter map in 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 of the frequencies combined into submaps: 19-31kHz, 31-45kHz, 45-19kHz, 19-37kHz, 37-25kHz.

### 9.1.9. Map building

Before building a map, you need to determine the need to use jitter and if it is necessary to select a mode, the modes differ in information capacity and transmission speed, i.e. for how many cycles the jitter code is transmitted:

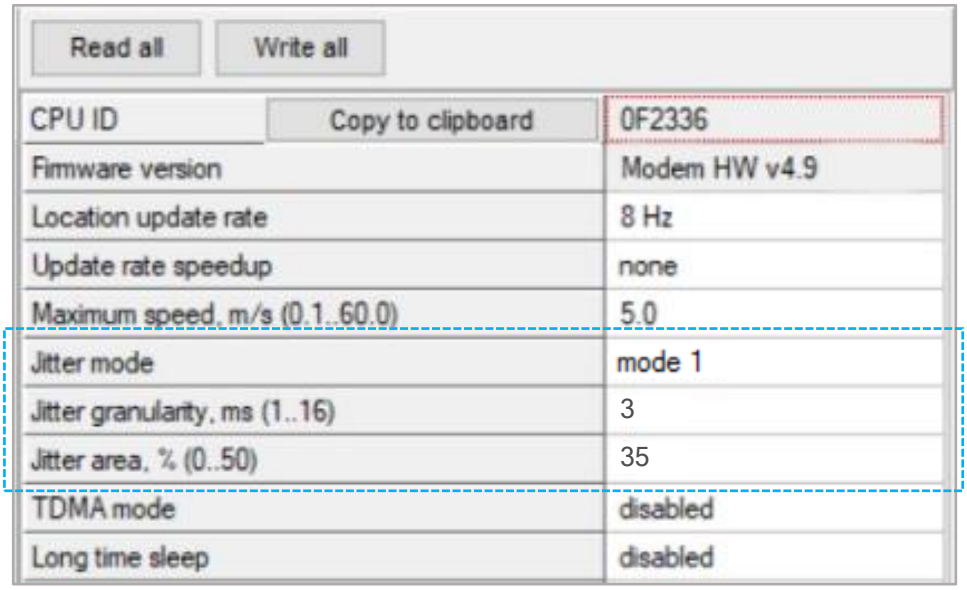
- **Jitter Mode1** - information capacity = 6 bits, and transmitted in 2 cycles.
- **Jitter Mode2** - 8 bits, 4 cycles.
- **Jitter Mode3** - 4 bits, 8 cycles.

The beacon movement introduces distortions in the definition of jitter code, therefore for objects moving fast, the most suitable mode is 1. So using 5 frequencies you can build 10 unique sub-maps in a set of frequencies, without using jitter, if this number is insufficient or not in the presence of a complete set of frequencies or you cannot use them because of the requirement of uniqueness of neighboring sub-maps, use jitter.

For example, when using **Jitter Mode1** and only two codes 0 and 1 for each stationary beacon, from 10 initial combinations, you can get 40 submaps, because each submap contains two beacons and, accordingly, 4 combinations, however this number may turn out to be slightly less when one stationary beacon enters into more than one submap, because the number of combinations is reduced. You can select a mode in the Dashboard menu.

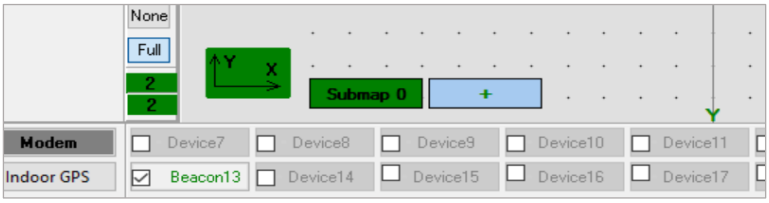
You also need to select **Jitter granularity**, each ms is 0.343m i.e. 3ms corresponds to 1.03m, which is enough for most cases.

You also need to select the **Jitter area**, this parameter indicates the neighborhood around the jitter value, which is considered a valid deviation of the jitter value, if this deviation is exceeded, the accepted jitter value is considered incorrect and does not take part in determining the submap.

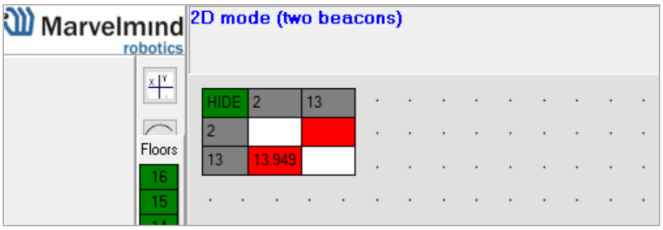



Select and set the **Code of jitter** in the menu of the emitting beacon

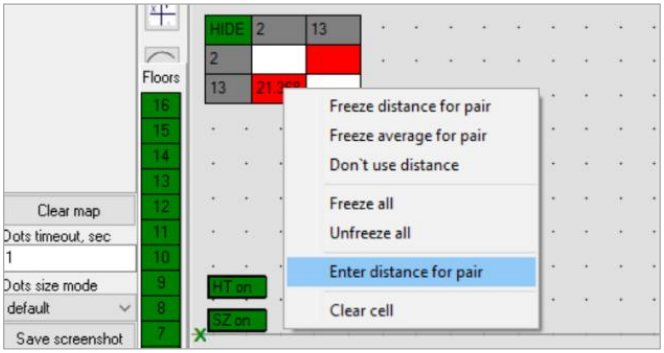
Next, you need to choose submap 0, add the beacons included in submap 0, and set the jitter code for them.



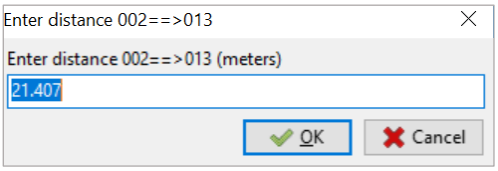

If the distance is determined correctly in the automatic measurement mode, you can leave it in the distance table unchanged.




If you need to change it, you can do this through the context menu. See detailed description of manual map building in the **Operating Manual – Table of Distances chapter**




And set the required distance manually.




Then you need to move the submap to the desired coordinates, using the settings of the submap (click on the submap's tab icon and settings tab will appear in the right side of the Dashboard), to specify its displacement and rotation

| | |
|---|---|
| Submap X shift, m (-320.00..320.00) | 0.00 |
| Submap Y shift, m (-320.00..320.00) | 0.00 |
| Submap Z shift, m (-320.00..320.00) | 0.00 |
| Submap rotation, degrees (-360.00..360.00) | 0.00 |
| Plane rotation X, degrees (-360.00..360.00) | 0.00 |
| Plane rotation Y, degrees (-360.00..360.00) | 0.00 |
| Plane rotation Z, degrees (-360.00..360.00) | 0.00 |
| Service zone thickness, m (-320.00..320.00) | 0.00 |
| Hedges height in 2D mode, m (-320.00..320.00) | 0.00 |

After that, you need to freeze the selected submap, create the next one by pressing the “+” button, make it active and repeat the operations starting from adding beacons to the new submap.


When all the submaps are installed and frozen, you need to turn on all mobile beacons, add them to the card and freeze the map.


After freezing, the parameters of stationary beacons and submaps are transferred to the beacons and stored in flash. Further, to change the parameters of the map, you will need to unfreeze it and freeze it again in order to repeat the transfer of parameters to the beacons.

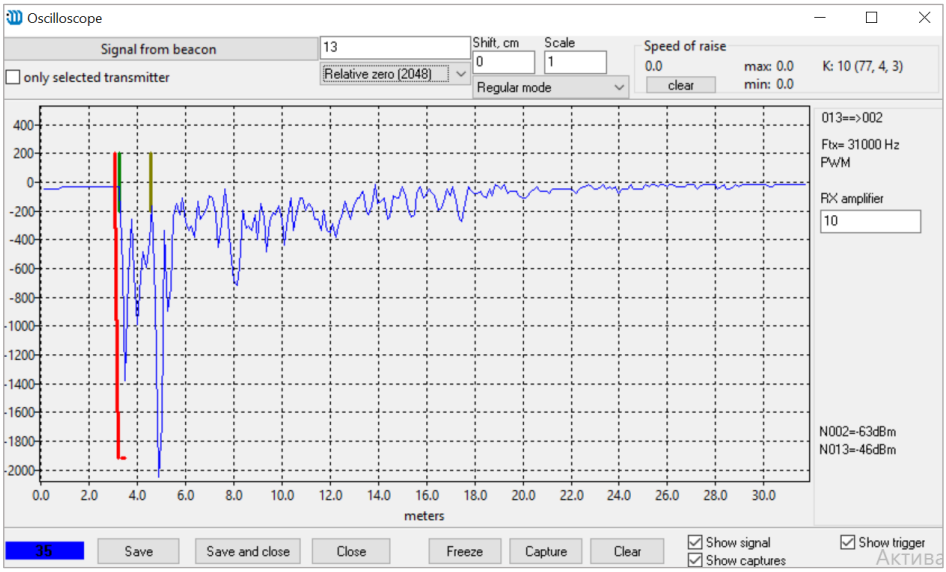
### 9.1.10. Testing

The ability of a beacon to correctly position itself and determine the submap in which it is located completely depends on the correct measurement of the distance to each stationary beacon

Stationary beacons in a submap emit at different frequencies. It is important to ensure the same reception conditions from different stationary beacons and frequencies, respectively, because the emission spectrum at one frequency has limited suppression at a neighboring frequency.

The signals can flow into adjacent frequency channels, this is reflected in the appearance of false triggers and incorrect determination of the distance, as a result of incorrect positioning, incorrect jitter detection and, accordingly, incorrect determination of the submap.

To find the causes of such problems, the dashboard has a digital oscilloscope mode, it displays the envelope of the received signal and trigger triggers. It is necessary to verify that the main candidate corresponds to the actual distance and that there are no other candidates that could interfere with the correct measurement.




As a rule, false candidates preceding the correct one are a consequence of the penetration of a different frequency, you can check this by turning on the “only selected transmitter” option, and only the selected beacon on one frequency will emit, if the false candidate disappears, then this is penetration of a different frequency and you need to check whether the restrictions are met described above.

Another case is re-reflection, when the signal reflected from neighboring objects and turns out to be higher than the main candidate. As a rule, in this case the false candidate is further than the main candidate, but it cannot be much further due to attenuation. In this case, you can use the **“Min. over raise for new front”** beacon’s setting.

| | |
|---|---|
| Min. over raise for new front (0..200) | 30 |

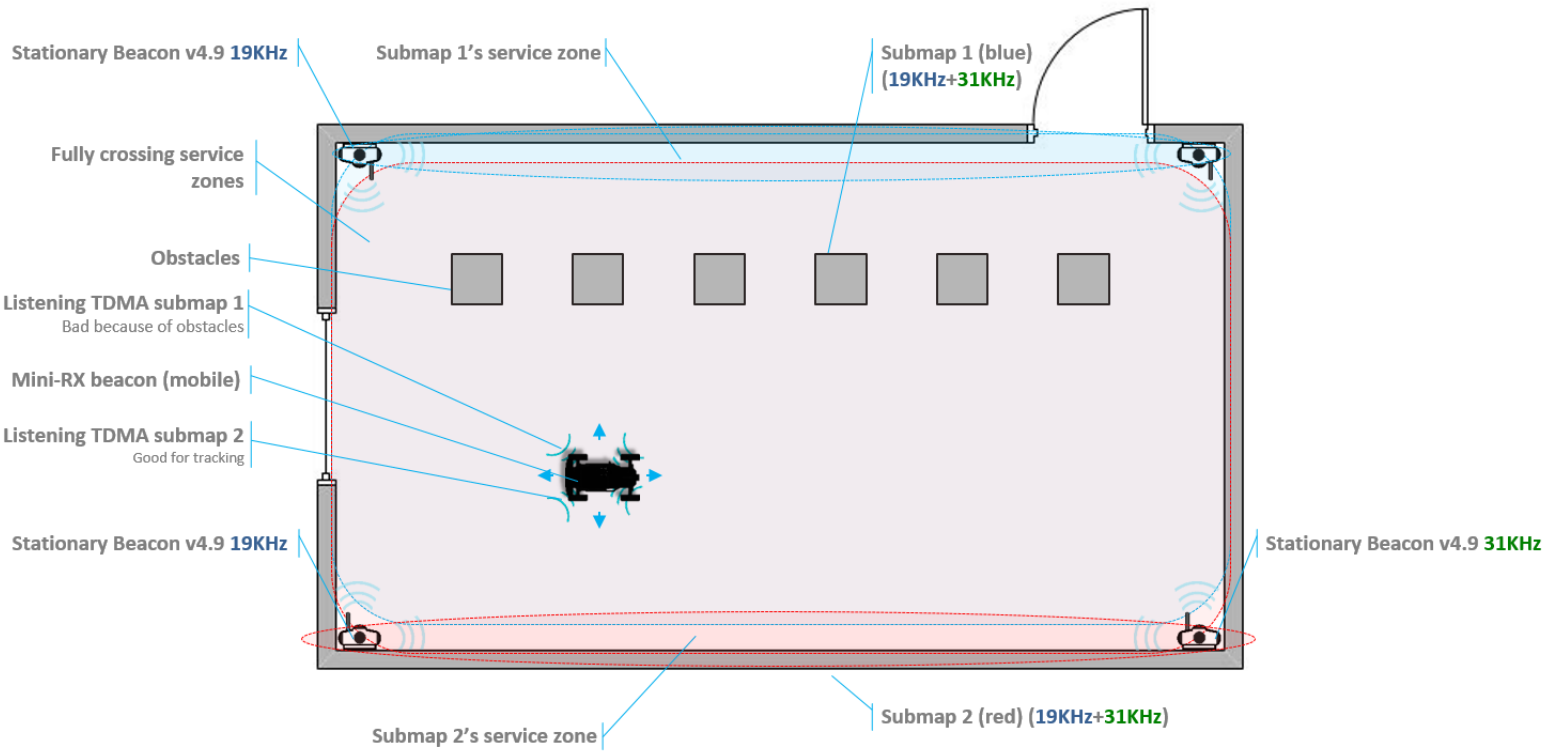
This parameter prefers the candidate who is closer.

When positioning is done correctly, you need to make sure that the given jitter is correctly estimated, the stationary beacon emits a signal without delay and with a delay equal to the jitter code multiplied by granularity, in an oscilloscope this looks like a shift of the main candidate by jitter.

Map built, tested and ready to use.

## 9.2 TDMA Type 2 - Full-overlapping TDMA

The steps below describe how to run IA with TDMA feature, which helps to improve the tracking quality in complex situations.




**Suitable for IA only. Use IA Software**

**Beacons HW v4.9 should have different frequencies**

**When you work with two TDMA submaps, update rate reduces twice.**

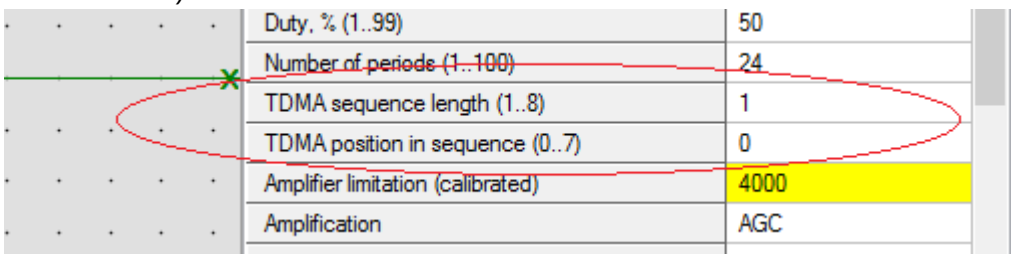
10.1.1. Mount stationary beacons in according to the TDMA chapters in Placement manual.

10.1.2. Wake up beacons included in Submap0. Enter the values in the table "distance between beacons", Freeze it. If necessary, set the shift, rotation, height, etc. Draw a service zone (More info: Submaps feature description).

10.1.3. 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.

10.1.4. 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 19kHz+31kHz submap, then 31kHz+45kHz submap. You can also use absolutely the same set of frequencies in submaps (Submap0 = 19kHz+31kHz, Submap1 =

19KHz+31KHz)



| | |
|---|---|
| Duty, % (1..99) | 50 |
| Number of periods (1..100) | 24 |
| TDMA sequence length (1..8) | 1 |
| TDMA position in sequence (0..7) | 0 |
| Amplifier limitation (calibrated) | 4000 |
| Amplification | AGC |

10.1.5. Activate mobile beacons.

10.1.6. Freeze the entire map. Now, you can work with it.

10.1.7. If you have any jumps, that can mean that you have wrong submaps' positions. Unfreeze all and try to move it until you get their correct positions.

**TDMA modes:**

System supports two modes of TDMA:

- **Mode 1 (Adaptive)**: 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 suiting for your case.

**How to change modes:**

- Choose hedge
- Go to **Ultrasound -> TDMA mode**
- **Left mouse button 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 |

## 9.3 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 is able to 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 device in the system (including modem), change the Radio profile parameter to **500kbps** (or any you need). It is situated in the Dashboard, on the right side of the Dashboard screen.

*Tip: Change the beacons' profile before modem's, in order not to lose your beacons. It allows you to do it remotely*

2) Room dimensions (tracking areas)

Update rate is also having linear dependence with tracking distance (distance between stationary and mobile beacon):

**Longer** distance – **lower** update rate
**Smaller** distance – **higher** update rate

If you have room 10x10m, change 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 very small value, use 1-2 meter's margin. Also, do not use 20 meters if you have small tracking area. Tune carefully*

.

## 9.4 Reducing location update latency

Exact latency depends on many factors:

- IA or NIA
- From modem or from the beacon
- IMU sensor fusion or regular ultrasonic only
- Radio profile
- Realized update rate
- Any sort averaging or Real-time player enabled or not

The range is:

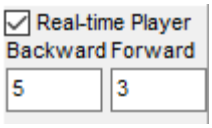
~ 12ms for data from a mobile beacon via USB with IMU fusion enabled and not averaging at all

~ 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

### 9.4.1. What affects delay:

9.4.1.1. *Real Time Player in the Dashboard* (For **NIA**)




9.4.1.2. *Real Time Player in hedge* (For **IA**)

| | |
|---|---|
| Real-time player | disabled |
| Real-time player backward (0..127) | 3 |
| Real-time player forward (0..127) | 5 |

9.4.1.3. *Window of averaging and Distance filter settings in modem* (For **NIA**)

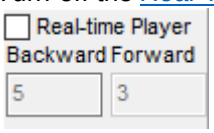
| | |
|---|---|
| Window of averaging (0..16) | 4 |
| Distance filter (0..16) | 3 |

9.4.1.4. *Prefiltration coefficient and Ultrasonic filtering settings in hedge* (For **IA**)

| | |
|---|---|
| Prefiltration coefficient (0..127) | 0 |
| Ultrasonic filtering (0..255) | 40 |

### 9.4.2. How to decrease latency:

9.4.2.1. *Turn* off the *Real-Time Player* (works for **IA** and **NIA)**




9.4.2.2. 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**

9.4.2.3. 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**

9.4.2.4. Complete. Latency reduced

## 9.5 How to Place Beacons

**Avoid placing beacons on long sound-conducting objects**

This is very rare but may happen under some special 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 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 real 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. It must be one beacon in the line of sight of minimum 2 beacons. Try to locate them under ceilings to avoid shadows, walls etc.**

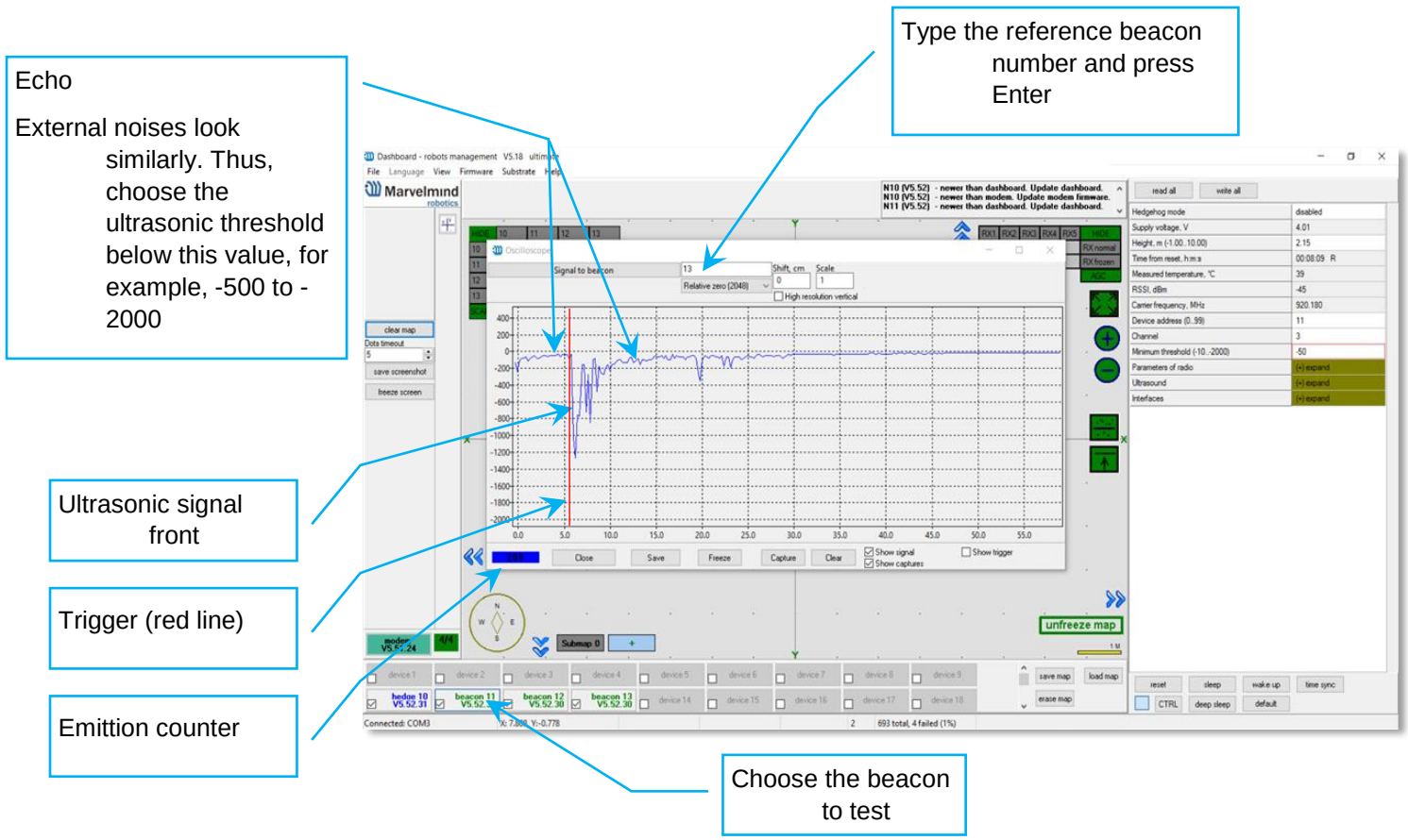
- Optimal settings for stationary beacons in small and big rooms.
- Use 30–50 ultrasonic pulses for larger places and the default 5 pulses for smaller places.
- Optimal settings for noisy environment.

There are several ways to reduce impact:

- Mobile beacons can be placed very close to the source of noise without harm, but stationary beacons should be placed further from the noise because they are receiving the ultrasound, whereas the mobile beacon is emitting the ultrasound.

## 9.6 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 very powerful tool, because it also gives information on the background noise, level of the signal, echo, etc. With this tool, it is easy to set up the proper ultrasonic threshold on the Dashboard.



## 9.7 Proper Ultrasonic Signal Detection

This chapter 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 do you use

These recommendations suitable only for NIA

Marvelmind Indoor Navigation System uses proprietary multi-frequency for ultrasonic signal and employs additional filtering to combat external noise. This also makes the system rather immune against the “usual suspects.” However, if the external noise is too strong, its source is too close, or it’s emitting a strong 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 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 at 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 is emitting, whereas stationary beacons are 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.

## 9.8 Using hedgehog.log file

- The system automatically records all measured positions in the hedgehog.log file that is stored in the same folder as the Dashboard.exe file
- The data is written in csv format; each line describes the position of one of the hedgehogs at a certain moment



- The line format is described here.

## 9.9 System Accuracy Evaluation

Accuracy of distance measurement.

- Marvelmind navigation system can measure distances between beacons with accuracy of +/- 2cm if correct ultrasound speed is used.
- The ultrasound speed depends on several factors: temperature, pressure, and humidity. Other factors have an insignificant effect.
- The main factor is temperature. In temperature range of -20…+50 °C the speed of ultrasound changes on about 0.6 m/ (s* °C). It gives distance error about (0.6 / 340) *100% ~ 0.17%/ °C. So caused by incorrect temperature setting absolute error of distance measurement is 0.17% of real distance between beacons. For example, with distance 30 meters and 5 °C error, this gives 0.85%*30 ~ 0.25 meters' error. Marvelmind system allows to setup temperature of air in the system settings.

Accuracy of position measurement.

- Marvelmind system uses trilateration algorithm to calculate position by distances. The inaccuracy of position calculation is related to inaccuracy of distances measurement and to geometry of 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**, **Z** is calculated from positions of 3 stationary beacons which are set by values of **d**, **i**, **j**. One of the beacons was shifted to (0,0) position to simplify formulas in the article. In formulas for **X**, **Y** we see **d** and **j** in denominators. This means that with low values of **d** and **j** small error of this value can cause significant position error
- Please see the picture of the beacons in the article - in more simple words, in means that if one of three beacons is close to line connecting 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 very large Y error
- Another example for Z. Assume mobile beacon is relative close to 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, low change of distances causes large change of Z value near the plane.

## 9.10 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 ***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***

- 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"

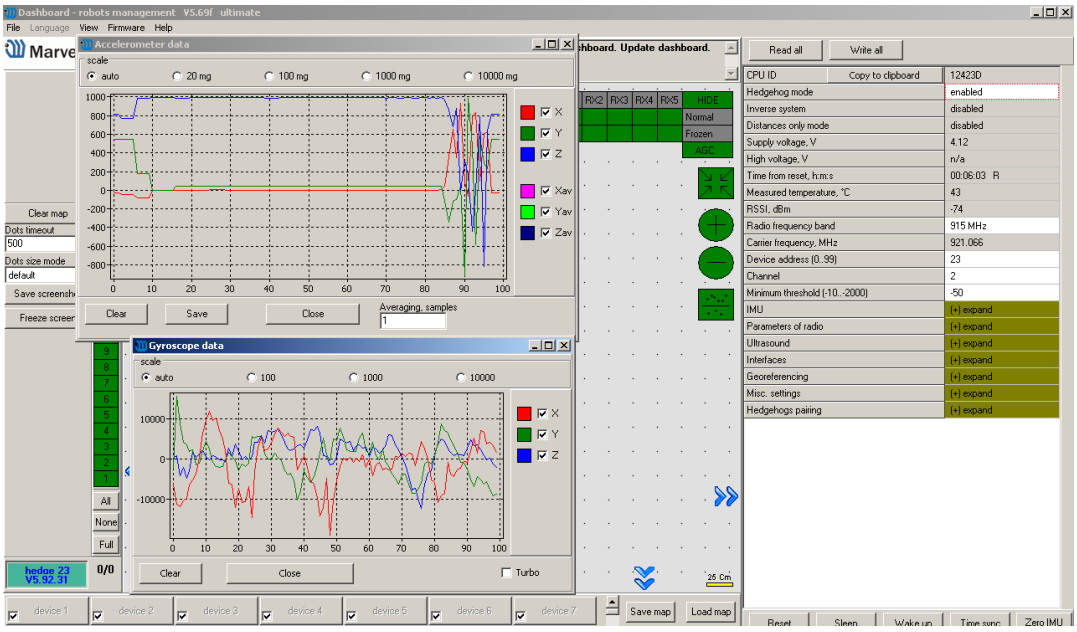
- The switch at the right bottom of the window should be in the **AutoFill** position

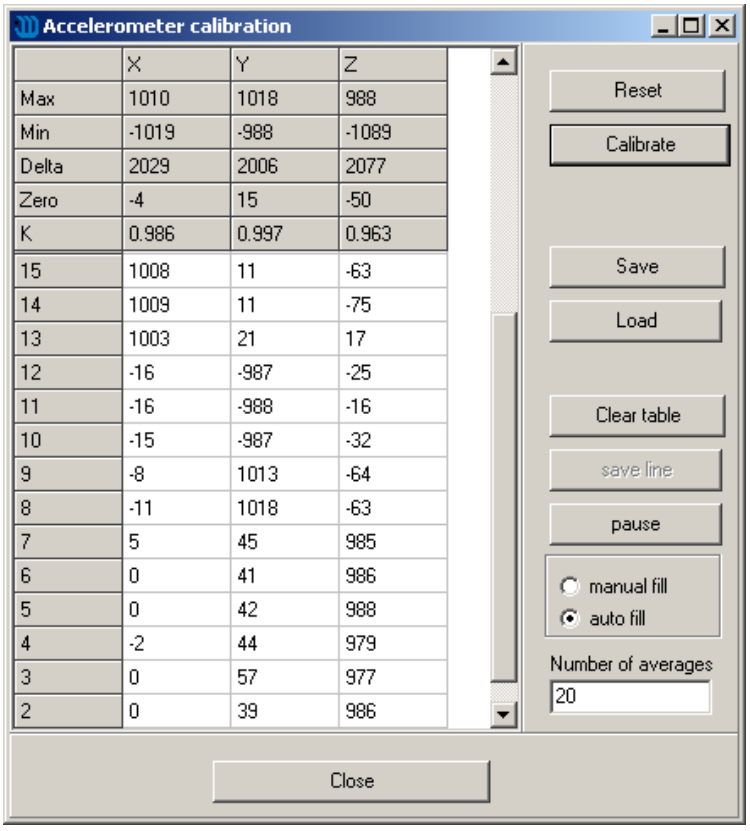
- Before starting the calibration, click the **Reset** button at the top of the window - zeroing the current calibration results

- 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, 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, the RX5 sensor points toward the table (calibration X-)

- In each measurement, the readings of the accelerometer 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**.




| | 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 |

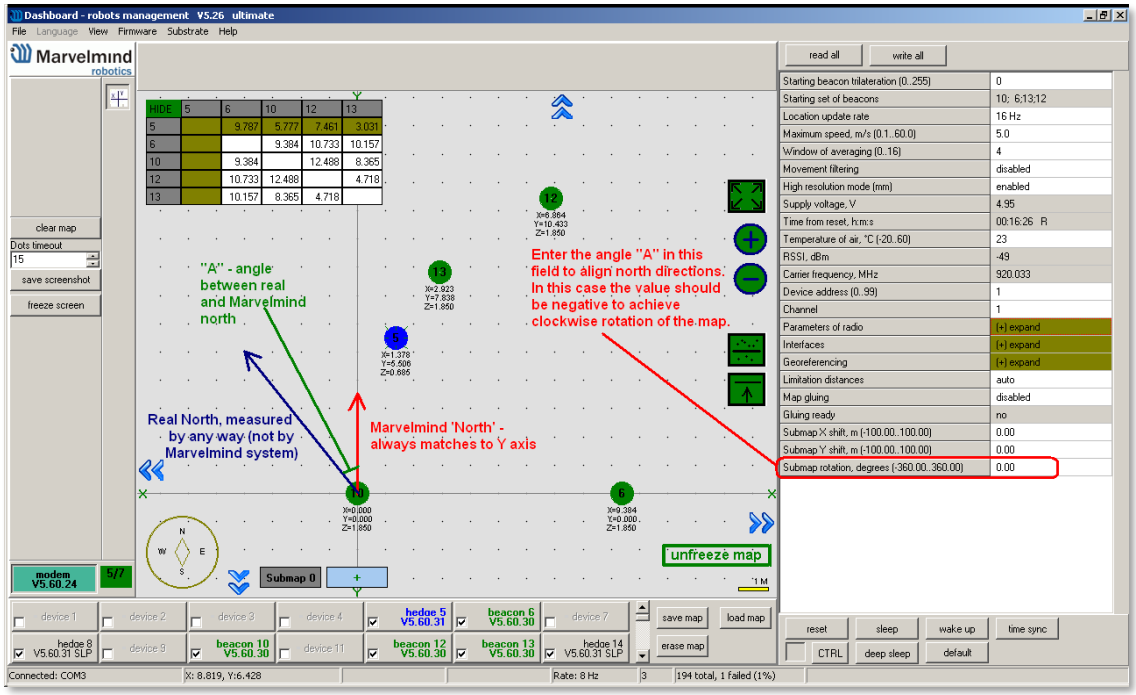
## 9.11 Settings to obtain correct north direction

- In some cases, it is necessary to obtain a correct north orientation of the map for NMEA output from Marvelmind system. For example, when using a Marvelmind mobile beacon as the navigation data source for Pixhawk installed on a copter, 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:

    1. Rotate the Marvelmind map using the dashboard, as shown on the attached screenshot
    2. You can also view the video: https://www.youtube.com/watch?v=AsYXrtg7aVU&feature=youtu.be

- Enter the angle correction (the angle shown on screenshot) on the Pixhawk side from the Mission Planner of APM Planner

- Refer to the parameter "BCN_ORIENT_YAW": http://ardupilot.org/copter/docs/parameters.html?highlight=bcn_orient_yaw




- Beacons may issue raw sensor data. To learn how to obtain this data, please check this protocol: https://marvelmind.com/pics/marvelmind_beacon_interfaces.pdf

- You can receive the data byte-by-byte and check for the required packet header

- See an example here: http://www.marvelmind.com/downloads/2017_02_08_C_example.zip.

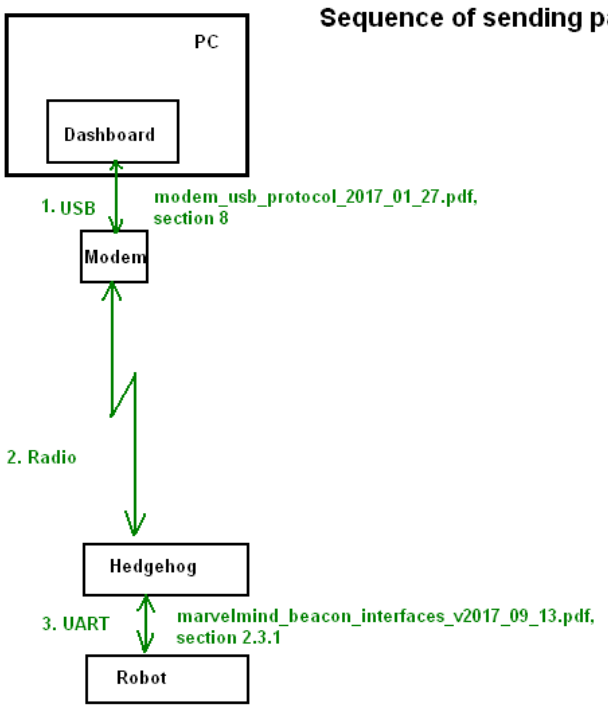
## 9.12 Communication of Pixhawk with Marvelmind mobile beacon



The Marvelmind mobile beacon can be connected to Pixhawk (and to any other hardware or software that inputs GPS according to the NMEA0183 protocol). The mobile beacon can send GPS data via UART and USB (virtual UART) interfaces. For further explanation, please check out this document.

## 9.13 Sending path to robot

1. The dashboard sends request to modem via USB.
   Procedure of sending these requests in dashboard is shown on second screenshot.
   This format of request is described in section 8 of modem protocol:
   https://marvelmind.com/pics/modem_usb_protocol.pdf

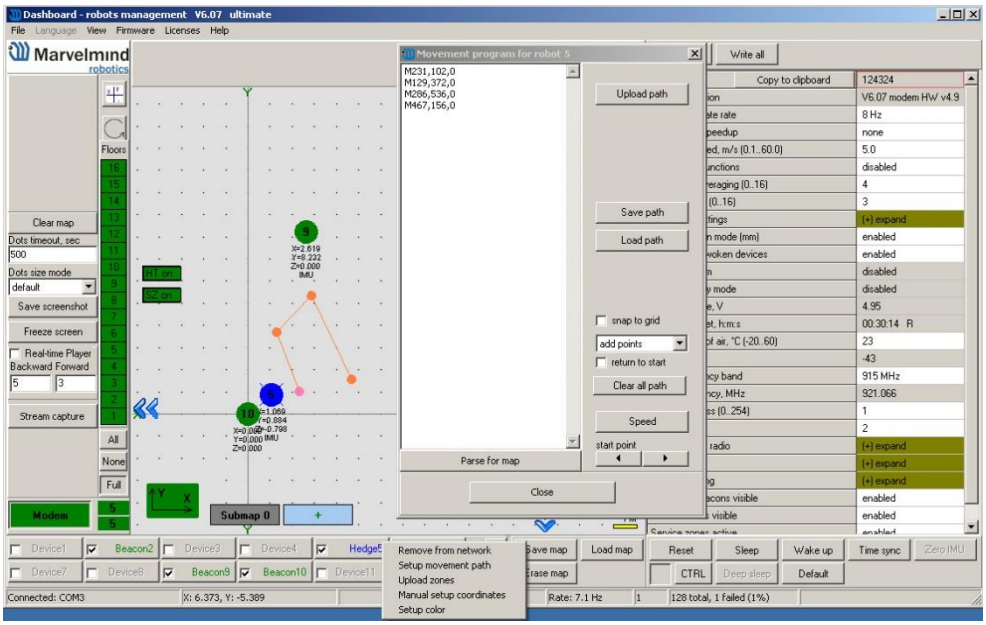



Modem transmits data to the hedgehog via radio, using our proprietary protocol

2. the hedgehog communicates with robot via UART. Hedgehog sends data according to section 2.3.1 of this protocol:
   https://marvelmind.com/pics/marvelmind_beacon_interfaces.pdf

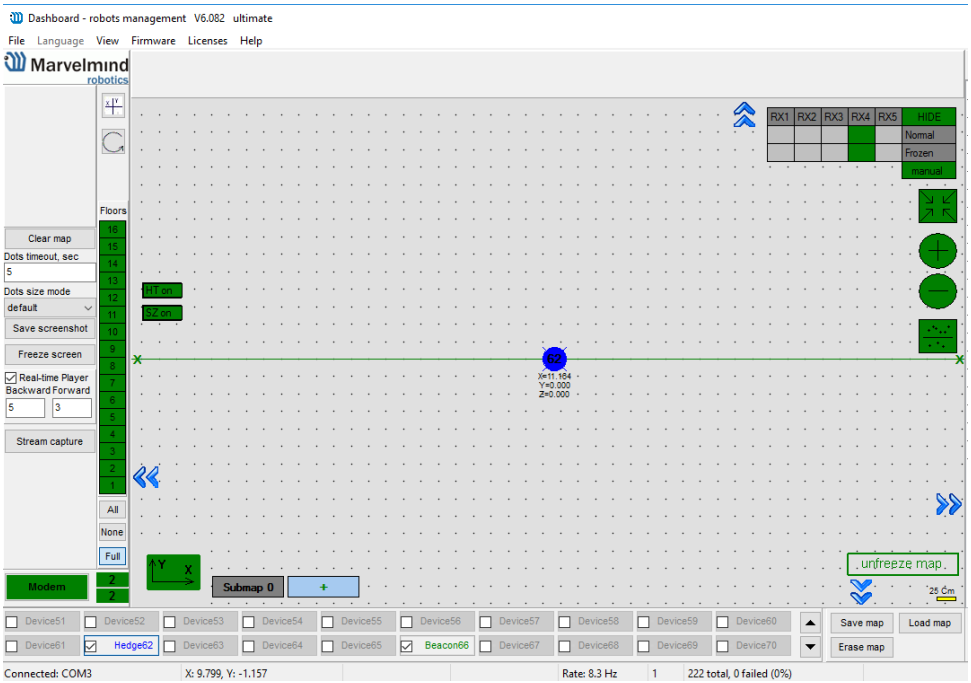
   The robot should confirm receiving data by response packet shown in section 2.3

   This communication on the robot side is implemented in the Arduino example on our site. As you can see in the protocol, robot should not request the waypoints, the hedgehog will send the waypoints when they will be transmitted from dashboard. But robot should confirm receiving each waypoint by this packet:
   [0x03,0x47,0x01,0x02,0x00, <2 bytes of checksum>]

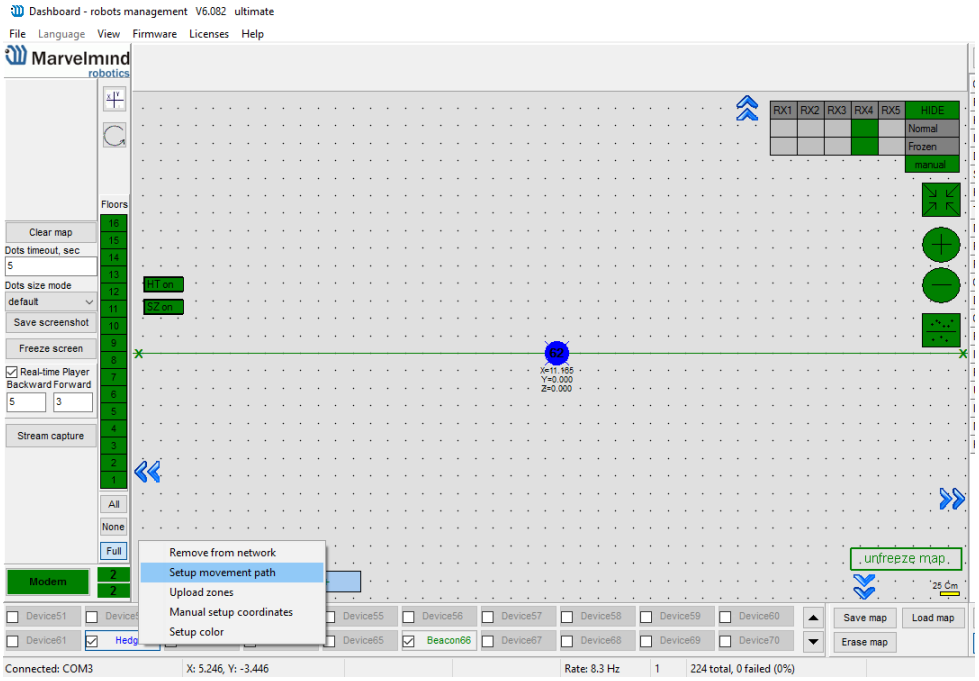



**How to send a path:**

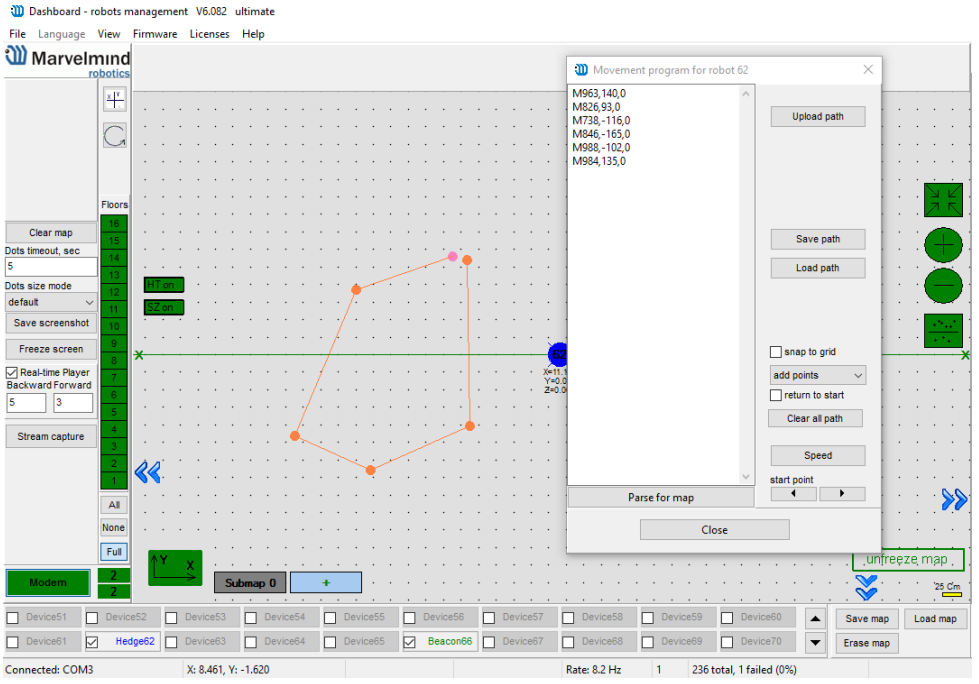
– Choose mobile beacon in the dashboard



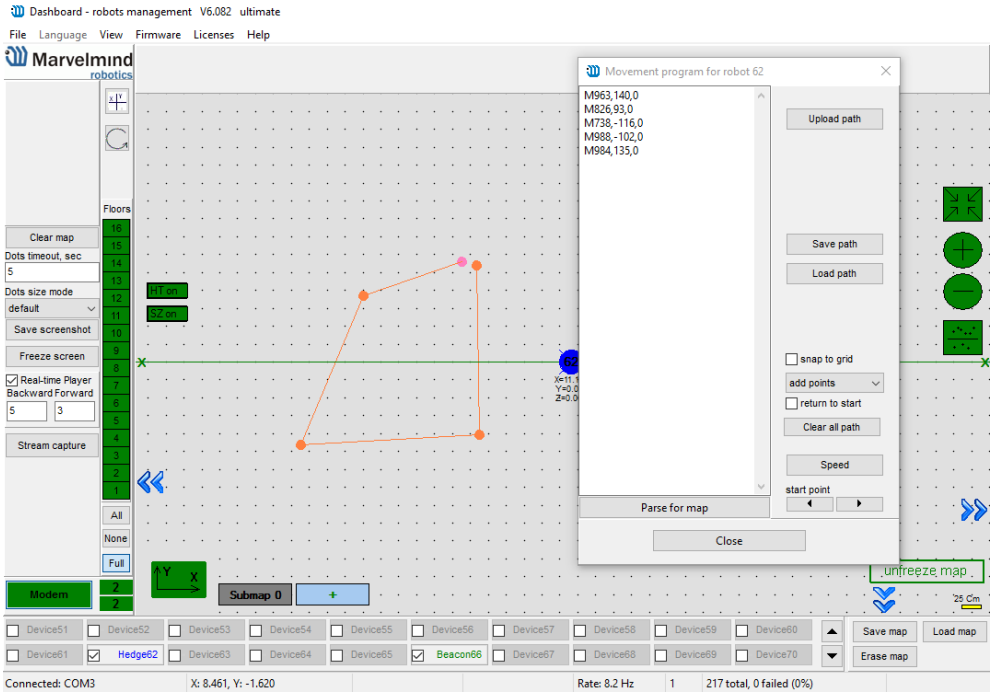
– **Right mouse button on it -> Set movement path**



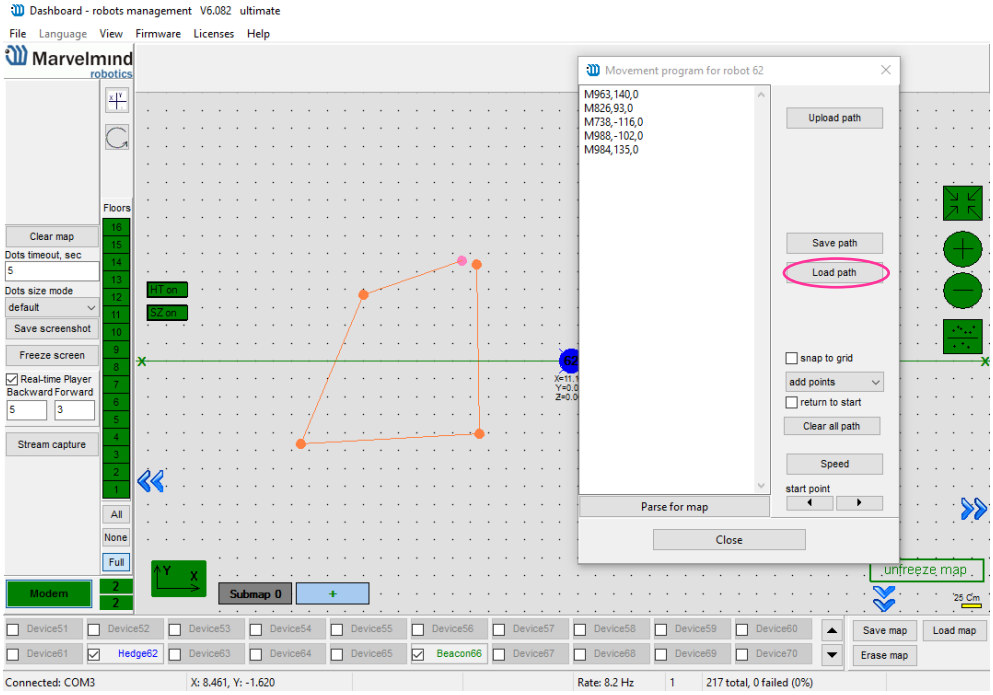

– **Shift+Left mouse click** to add point



– **Shift+Left mouse click on point**, to remove that point




– Click on **Upload path** to send it to robot



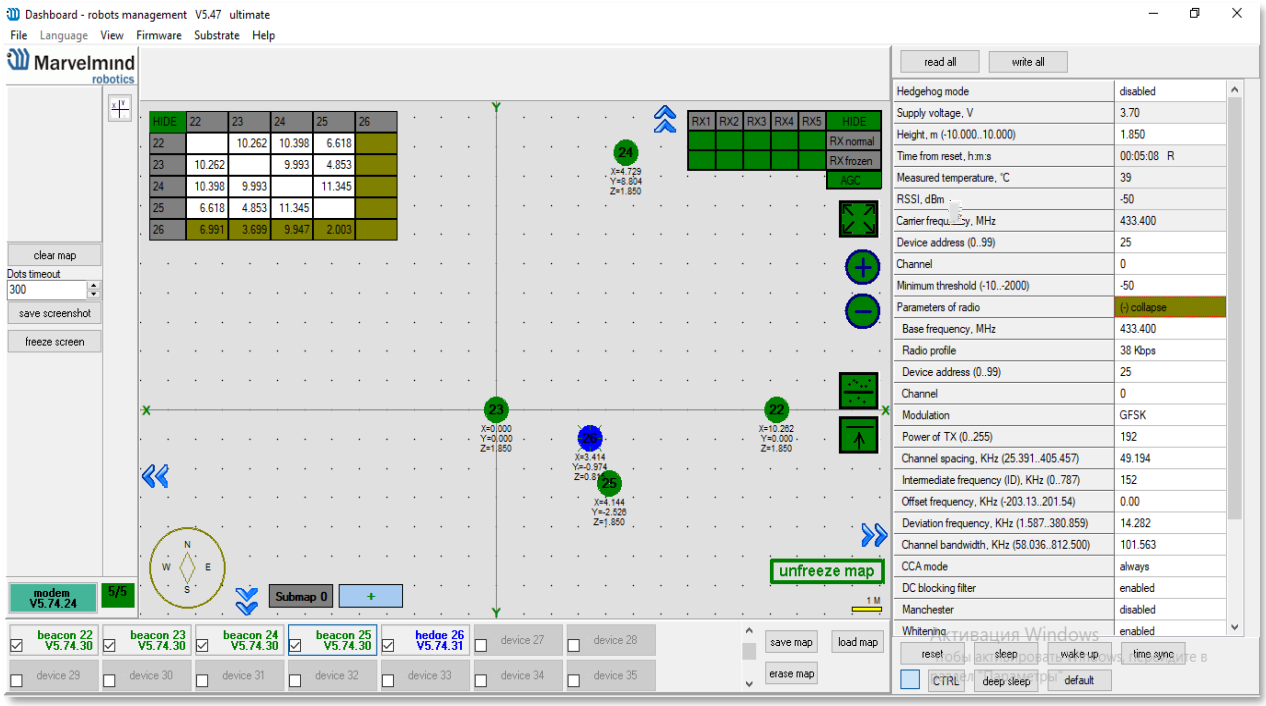

– Path loaded

## 9.14 Proper ultrasonic coverage

**The single most important 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 drops quite rapidly. From the left, right, or back of the ultrasonic sensor, the signal is highly attenuated. 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
- It is advised that the mobile beacon be placed as high as possible on the robot if the stationary beacons are above the mobile beacon. This minimizes shadows from other objects, people, etc.

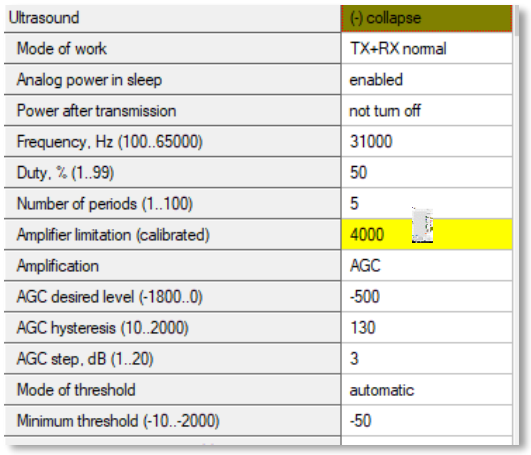


- Example of proper positioning of the mobile beacon can be found here: https://youtu.be/PFgNPkLGCDk
- The beacon is placed horizontally and above other objects that can cast a shadow on the stationary beacons
- **Keep the radio signal's strength under control**
- The RSSI (Dashboard => right menu) of 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 extremely 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 work too, but packet losses may start occurring. The quality of the radio connection very much depends on external interference as well 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**

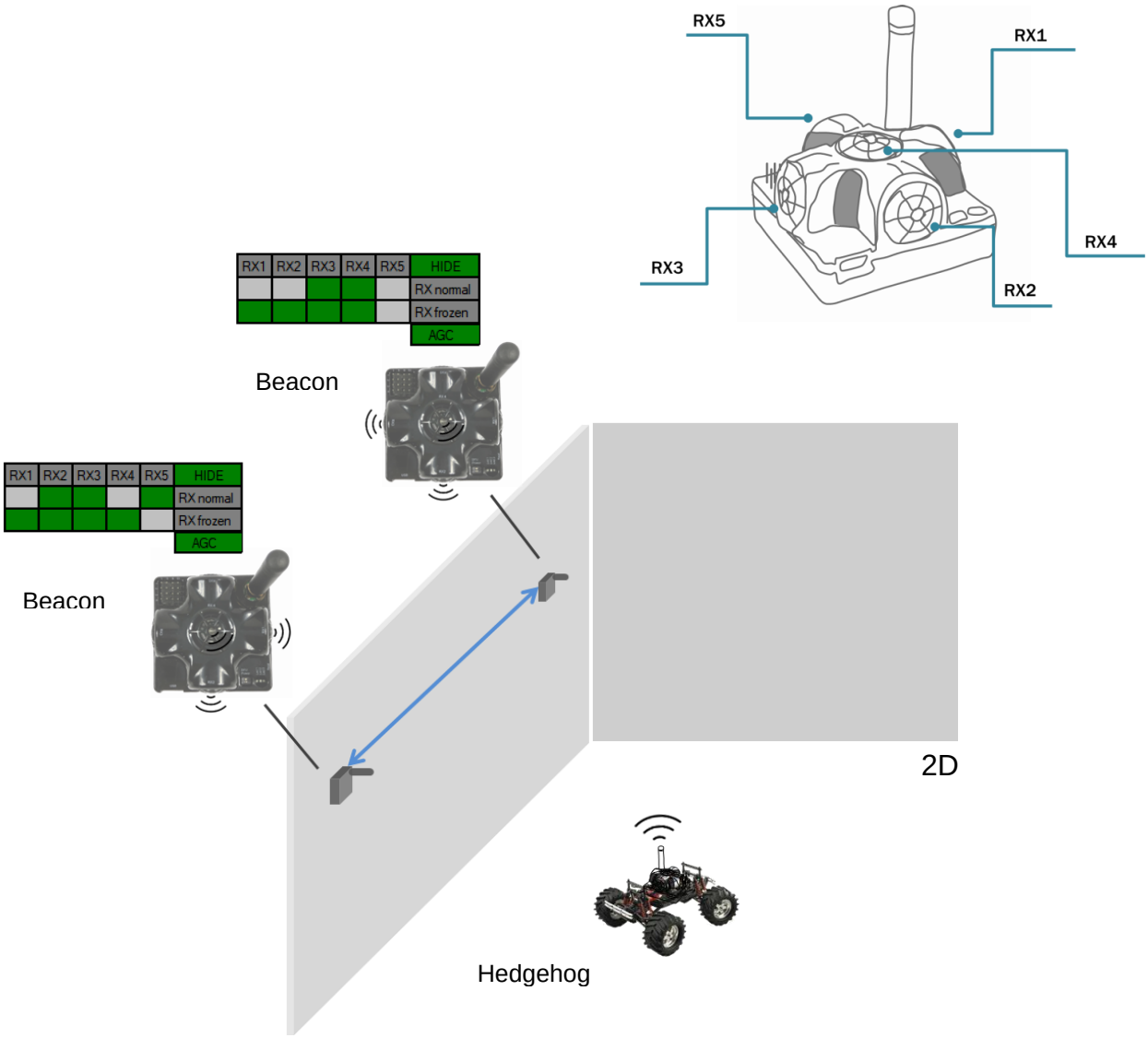


| Ultrasound | (-) collapse |
|---|---|
| Mode of work | TX+RX normal |
| Analog power in sleep | enabled |
| Power after transmission | not turn off |
| Frequency, Hz (100..65000) | 31000 |
| Duty, % (1..99) | 50 |
| Number of periods (1..100) | 5 |
| Amplifier limitation (calibrated) | 4000 |
| Amplification | 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

## 9.15 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

## 9.16 Powering beacons

Depending on the type of beacon, may be internal battery, or external USB power supply, for more details check comparison table

Battery lifetime totally depends on the mode of operation and can be varied between several days to several months (or more for special applications)

# 10. Frequently Asked Questions

Please check this forum for more information. 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 minimum two others

## 2 How far can beacons be located from modem?

- In the open space the distance from the modem to the beacon can reach several hundred meters

## 3 What if hedgehog shown as **orange** circle or transparent inside in 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 real obstacles for ultrasound are walls (concrete), glass, 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 beacon (outdoor, explosion safe, etc.) in the comparison table
- We also possible to produce some special versions, which will suit your case. Please write to info@marvelmind.com

## 6 Are beacons resistant to explosions, dust, dirt, water, 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 beacon (outdoor, explosion safe, etc.) in the comparison table

## 7 What is the time of delay between positioning the object and respond?

- The delay is directly proportional to the update rate. For example, if update rate is 16 Hz delay is 1.2:1.5x60ms
- The limit is 1.5x times the maximum distance between the stationary beacons. To expand the service area, please follow the instructions shown in the attached screenshot. Notice that positioning the mobile

beacon far from stationary beacons and close to their plane may result in increased positioning error because of bad geometry of measurement

## 8 How to define IMU or not IMU beacon?

- Check white sticker on the box and on the beacon's bottom /IMU - with IMU
- Connect beacon via USB: Dashboard => View => Accelerometer data

## 9 Can we use none-IMU beacon as 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 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 Device do not connect via USB?

- Use USB cable with long metal part. If you have any problems with 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)

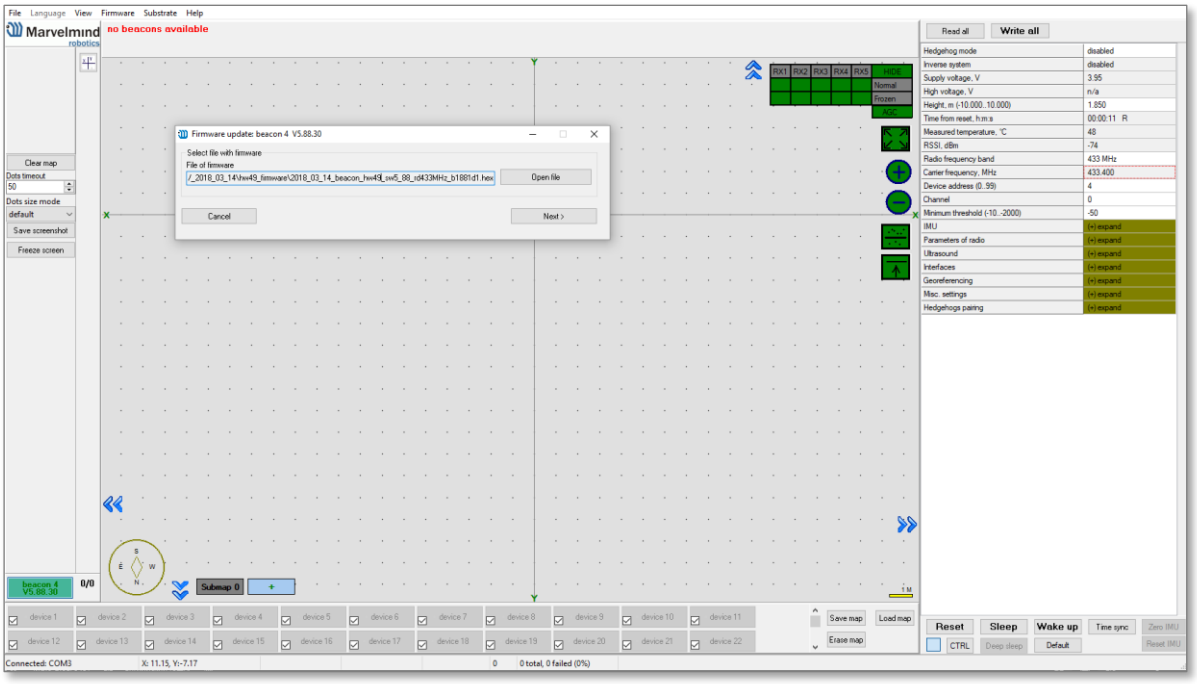
## 13 Why Dashboard do not see more than 4 beacons

- System has a limitation of 4 beacons per submap. If you have more than 4 beacons, just create another submap, and beacons will appear

# 11. Troubleshooting checklist

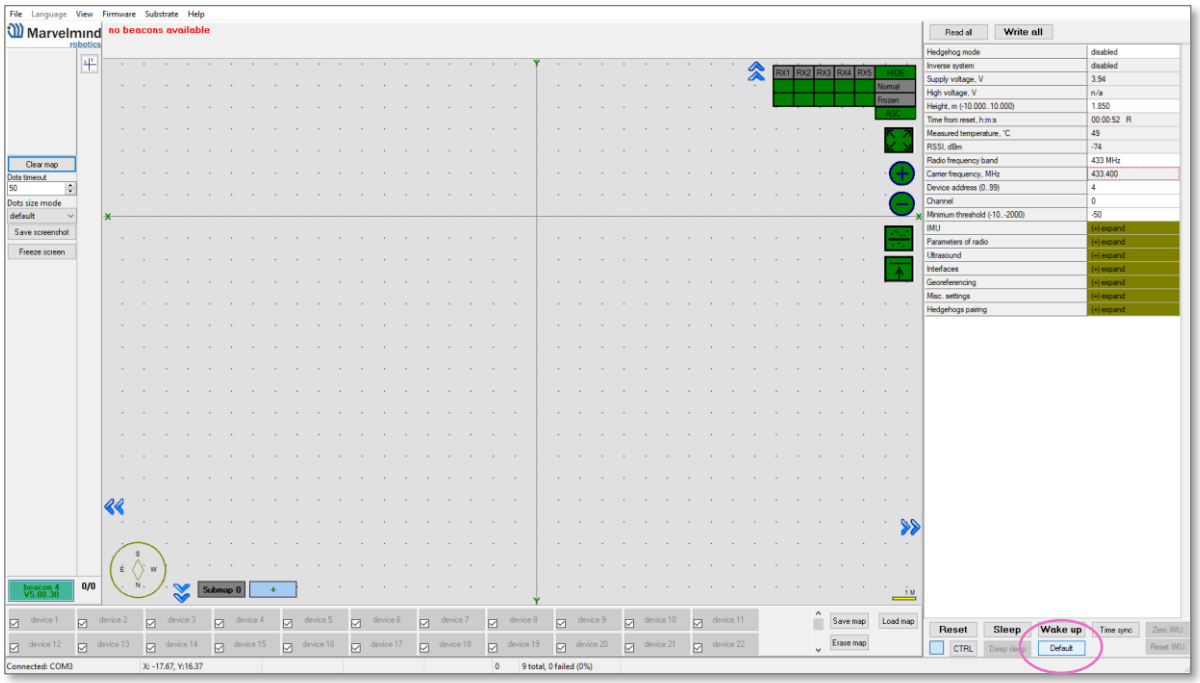
If you have any problems with the system, follow these simple steps:

- **Update SW** on modem and beacons




- Now, connect all beacons and modem one by one and press **Default** button in the Dashboard (When updating the SW, please, press **Default** button to make sure that beacons really have default settings. Otherwise, modem may be calling on a wrong channel or something)

- Press **Erase map**



**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 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. If not, charge it for 2-3 hours.
- Keep modem 1-2m away from beacons. if closer, the beacons 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 USB cable with long metal part. If you have any problems with USB connection, change the cable first. One cable can work for one beacon and do not work for other
- Be sure that you use SW from the same pack
- When updating the SW, please, press Default button to make sure that beacons really have default settings. Otherwise, modem may be calling on a wrong channel or something
- Start with simple configuration (10x10m square, 4 stationary beacons)
- Do not obstruct line of sight between beacons
- Build the map first, freeze it, then wake up the "hedge"
- Number of periods. By default – 5; For longer distances, you shall put it 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

# 12. Contacts

For additional support, please send your questions to info@marvelmind.com