

Modem 915MHz v4.95

915 MHz Operating Manual

v2017_07_25a

www.marvelmind.com

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2 Executive summary

Marvelmind Indoor Navigation System is off-the-shelf indoor navigation system designed for providing precise ($\pm 2\text{cm}$) location data to autonomous robots, vehicles (AGV) and copters. It can also be used for tracking other objects, where the mobile beacon can be installed, for example, in virtual reality (VR) systems, helmets for construction workers or miners, etc.

The navigation system is based on stationary ultrasonic beacons united by radio interface in license-free band and modem. Location of a mobile beacon installed on a robot (vehicle, copter, human, VR) is calculated based on the propagation delay of ultrasonic signal (Time-Of-Flight or TOF) to a set of stationary ultrasonic beacons using trilateration.



modem v4.9, 915 MHz
controller of the system

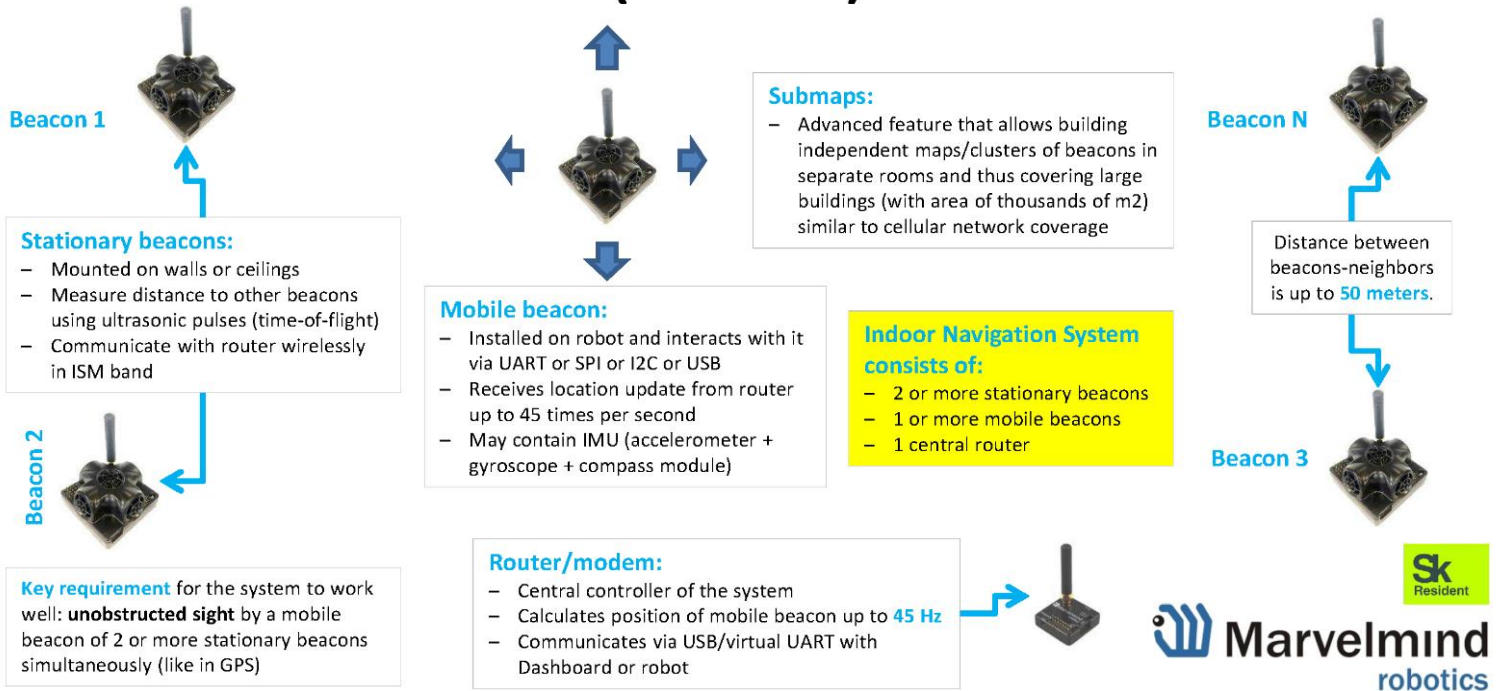
Key capabilities:

Parameter	Technical Specifications
Radio coverage to beacons	Up to 400 with full size 165 mm antenna
Location update rate	<ul style="list-style-type: none"> - 0.5-45Hz - Can be set manually - Depends on the distance between mobile and stationary beacons (shorter distance – higher update rate) - Depends on the number of mobile beacons (update rate for 25Hz for 1 mobile beacon => 25Hz/2 for 2 mobile beacons and 25Hz/3 for 3 mobile beacons) - Depends on the radio interface profile (500kbps vs. 38kbps) - Slightly depends on the number of stationary beacons – not like for mobile beacons
Power supply	<ul style="list-style-type: none"> - External power supply only microUSB
Weight	Modem from Starter set: <ul style="list-style-type: none"> - 16,32 grams (with housing)
Modem size	Size: 35x35x10 mm (with 50mm antenna: 55x55x65mm)

3.1 Indoor GPS architecture

Marvelmind Indoor Navigation System provides high-precision ($\pm 2\text{ cm}$) indoor coordinates for autonomous robots and systems (“indoor GPS”). Brief description of the key elements of the system is given on scheme below:

Indoor “GPS” ($\pm 2\text{cm}$) – architecture



3.2 Modem description

- The central controller of the system. It must be powered all the time, when the Navigation System works. It is recommended to use active USB hub for that purpose or even a regular USB power supply for cellular phones. A USB power bank can be used too
- Modem is also used to setup the system, monitor it, interact with the Dashboard
- It can be placed anywhere within radio coverage to have permanent radio connection with all beacons – usually in the radius of up to 100 meters with antennas from Starter Set
- The radio coverage can be further extended to a few hundred meters by using lower bitrate of 38kbps and full-size antennas (tested up to 400 m in ideal conditions)
- Proprietary radio protocol is used for communication and synchronization
- You can also check our video describes the modem <https://www.youtube.com/watch?v=WkvhLGbDhEg>

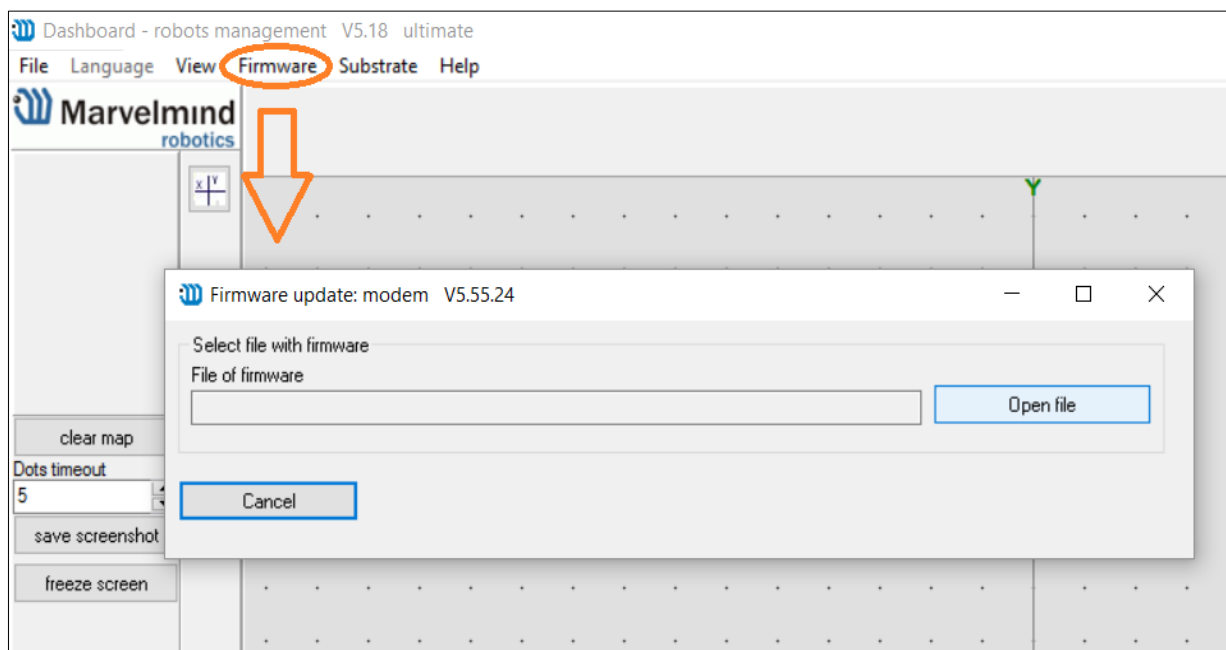


3.3 Modem - close-up and internal view



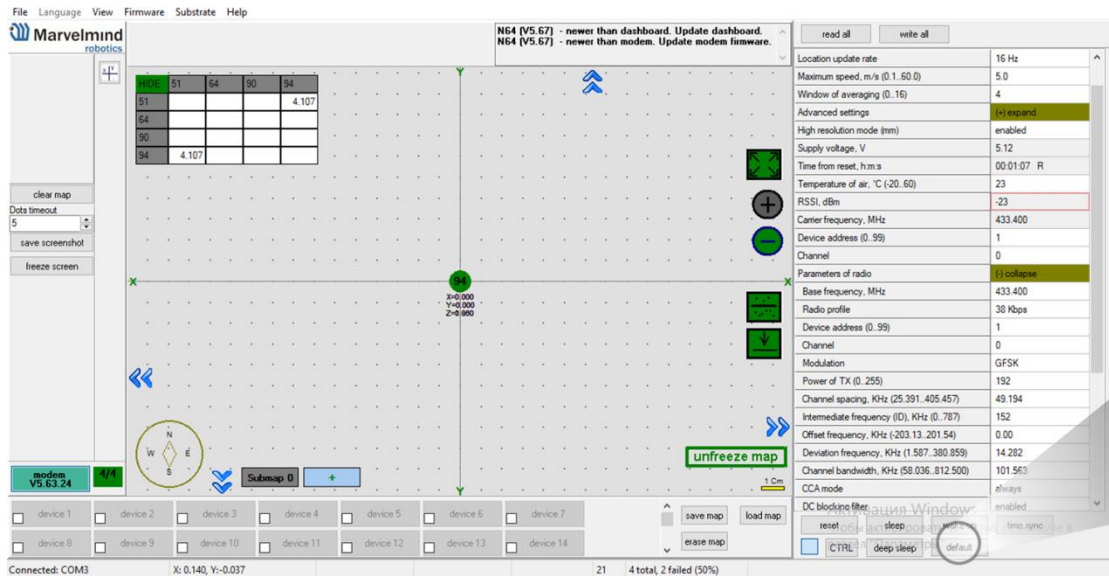
4 Setup software (Dashboard)

- 4.0.1 After charging all the boards download the **latest stable software package** from <http://www.marvelmind.com/#Download>
- 4.0.2 Select the SW version of the portable or distribution and unzip
- 4.0.3 Run the **Dashboard** and update the SW for modem using **Dashboard => Firmware => Choose the file => Program**



- 4.0.4 If you see message in the Dashboard “**Not found modem connection to computer through USB**”, usually, it means that the driver is not installed. To install the driver, download it with link at top and run installation file” click on the link under, install the driver
- 4.0.5 Ensure that
 - (a) You are programming modem’s SW to modem and
 - (b) You are using SW for 4.9, if you have HW v4.9
 - (c) You have the SW from the same SW pack, i.e. the Dashboard SW and modem SW must be from the same SW pack. Don’t mix SW releases

4.0.6 While modem is connected to the Dashboard, press **DEFAULT** button in the Dashboard to upload the default settings. See the print screen below:



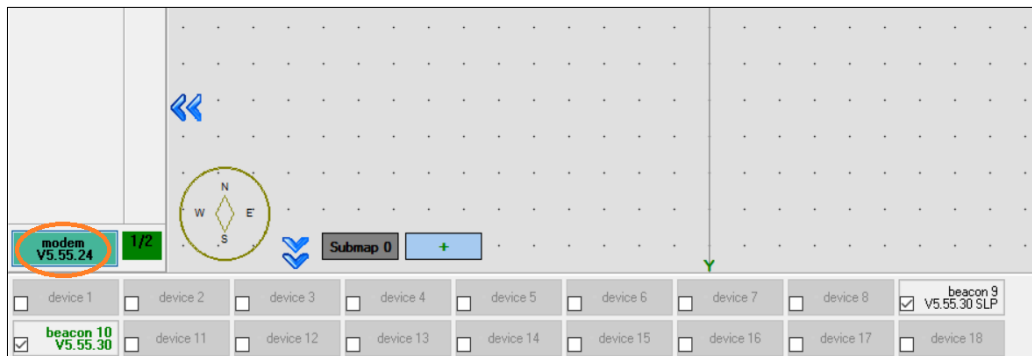
4.0.7 Press **RESET** button on your modem after programming

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

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

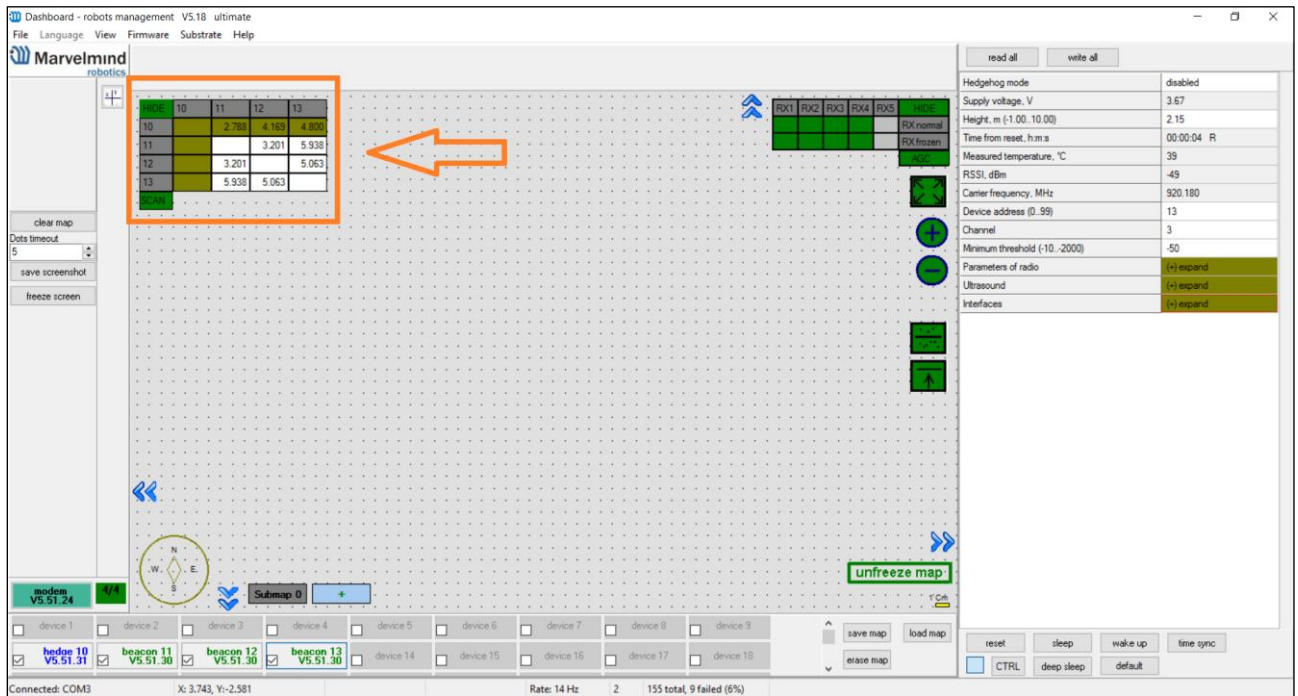
4.0.10 Run the Dashboard

4.0.11 In the left corner of the Dashboard Modem shall appear connected



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

4.0.13 If modem is not active and is not powered, the beacons will go asleep automatically after 1 minute. The system may run for the frequency search, if it is you're the very first waking up the beacons. If doesn't succeed with this step, disconnect the modem and connect that beacon again via USB. Press the **DEFAULT** button in the Dashboard and Read all button to make sure that the radio settings are really the default ones. You may compare the radio settings on the modem and the radio settings on the beacon. They must be the same



4.0.14 Freeze the map by clicking the button.

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

4.0.16 By now, the system must be fully operational

4.1 Dashboard menu and parameters

4.1.1 The main parameters of the connected band are shown on the right long panel of the Dashboard.

Check our [help video](#) for deep understanding the Dashboard menu.

4.1.2 **CEILING** and **MIRRORING** buttons in the Dashboard

File Language View Firmware Substrate Help

Marvelmind robotics

N64 [V5.67] - newer than dashboard. Update dashboard.
N64 [V5.67] - newer than modem. Update modem firmware.

MODE	51	64	90	94
51				4.107
64				
90				
94	4.107			

clear map
Dots timeout: 5
save screenshot
freeze screen

modem V5.63.24

Submap 0

unfreeze map

save map load map
erase map



Connected: COM3 X: 0.140, Y: -0.037 21 4 total, 2 failed (50%)


read all write all


Location update rate
Maximum speed, m/s (0.1-60.0)
Window of averaging (0.16)
Advanced settings
High resolution mode (mm)
Supply voltage, V: 5.12
Time from reset, h:m:s: 00:01:07 R
Temperature of air, °C (-20.60): 23
RSSI, dBm: -23
Carrier frequency, MHz: 433.400
Device address (0..99): 1
Channel: 0
Parameters of radio (collapse)
Base frequency, MHz: 433.400
Radio profile: 38 Kbps
Device address (0..99): 1
Channel: 0
Modulation: GFSK
Power of TX (0..255): 192
Channel spacing, KHz (25.391..405.457): 49.194
Intermediate frequency (ID), KHz (0..787): 152
Offset frequency, KHz (-203.13..201.54): 0.00
Deviation frequency, KHz (1.587..380.859): 14.282
Channel bandwidth, KHz (58.036..812.500): 101.563
CCA mode: always
DC blocking filter: enabled

reset sleep wake up time sync
CTRL deep sleep default

The **MIRRORING** button   allows to display the map in mirror reflection

The **CEILING** button   shows where the mobile beacon is located in respect for stationary beacons

When the arrow points upwards  it means that the mobile beacon is below the stationary beacons

When the arrow points down  it means that the mobile lighthouse is above the stationary beacons

4.2 Using the system after the very first setup

- 4.2.1 If you had setup the drivers, built and froze the map and hadn't moved stationary beacons, in order to start using the system again, you simply have to power up the modem. The map is stored inside the modem and the system will be ready to handle your mobile beacons in 5 seconds after that

More help you can find here: https://www.youtube.com/channel/UC4O_kJBQrKC-NCgidS_4N7g/videos

4.3 DFU programming

DFU programming or SW uploading is used when HEX SW uploading in the Dashboard cannot be used, for example, when you update from a very old SW version or when the SW brings so much change to the system that it is possible to update the SW only via DFU programming

- 4.3.1 Download the latest SW package, unpack it and select the proper version of the SW – for your HW and for your frequency variant. Remember, that for DFU programming you shall use DFU SW – not HEX SW
- 4.3.2 Download <http://www.marvelmind.com/downloads/Software.zip> - here you can find different versions of DfuSe. Install DfuSe v3.04 (or v3.0.3 or v3.0.5) – whatever works the best for your Windows.

http://www.marvelmind.com/downloads/DFU/DfuSe_Demo_V3.0.5_Setup.exe - v3.0.5

- 4.3.3 Download the DFU driver (file) for the **modem**
http://marvelmind.com/downloads/2017_03_14_modem_hw45_sw5_48_r433MHz_8212d40.dfu
- 4.3.4 After uploading DFU driver by DfuSe short circuit holes temporarily as shown on the picture below
- 4.3.5 Press "Upgrade" button in the DfuSe program
- 4.3.6 After a couple of seconds, the DFU will be uploaded to the modem. Make sure it actually take 1-3 seconds, but not immediate. Otherwise, it is not really uploading the SW. If immediate, check with CHOOSE button you use or even change the version of DfuSe SW to another one
- 4.3.7 Disconnect the short circuit
- 4.3.8 Start the Dashboard and press **RESET** button



If you have experienced difficulties in DFU programming, please check and do the following:

- Change your operation system (from Windows10 to Windows7 and vice versa)
- Reinstall other DfuSe version (Install DfuSe SW 3.04 (or 3.0.3 or 3.0.5) - whatever works the best for your Windows)

5 Interfaces

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

The way to get location data from the system:

From modem/router

- Knows position of every mobile beacon in the system

One can get data from mobile beacons and from the modem at the same time, if need to do so.

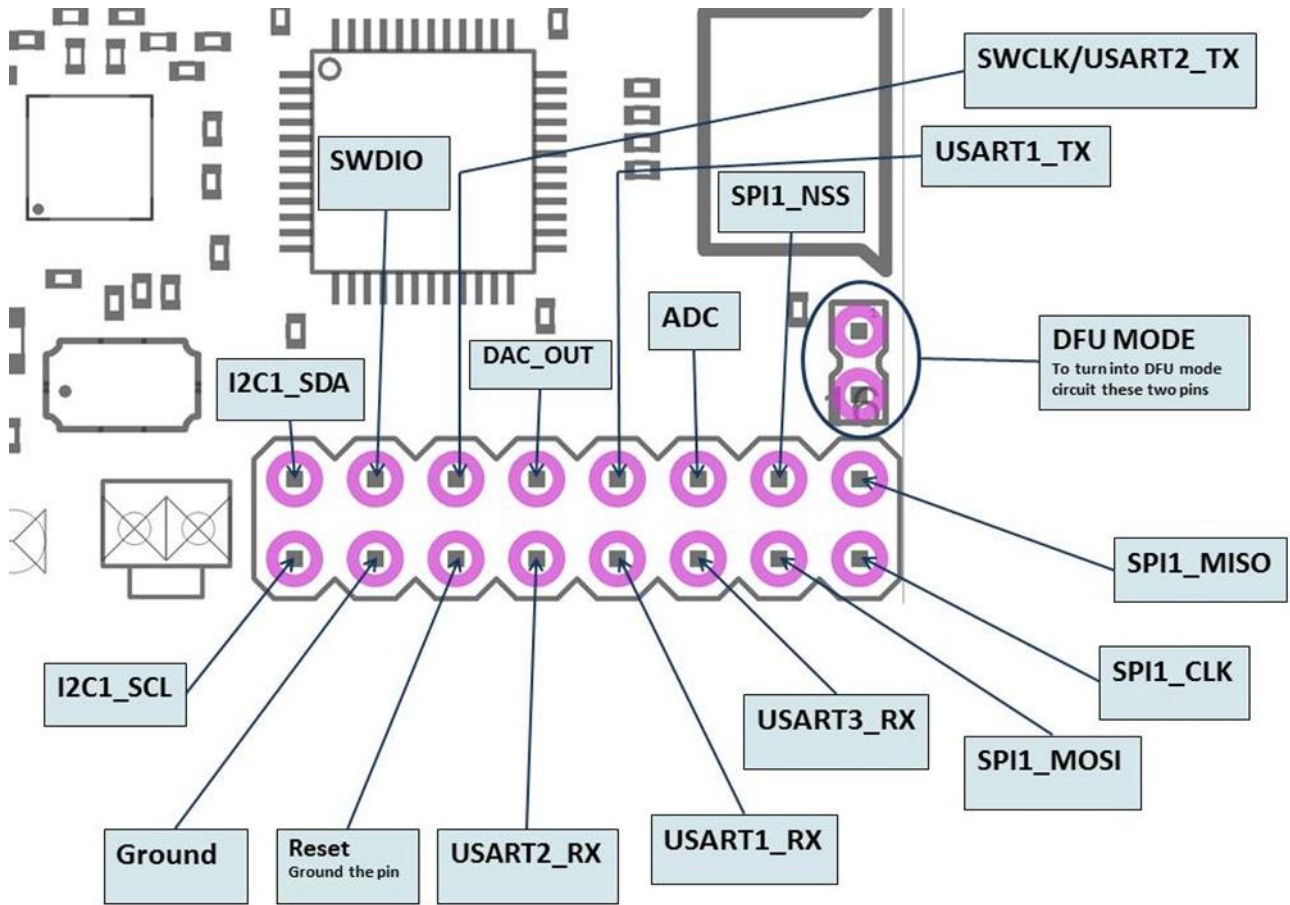
List of supported interfaces is shown below:

More on the interfaces can be found on the link: <http://marvelmind.com/#Interfaces>

Supported interfaces

- **Mobile beacon:**
 - UART
 - SPI
 - Virtual UART via USB
 - NMEA
- **Modem:**
 - UART
 - SPI
 - Virtual UART via USB
- **Integrated with:**
 - Windows (PC & tablets)
 - Linux
 - Mac OS
 - Android (beacon)
 - ROS (beacon)
 - Raspberry (beacon)
 - Arduino (beacon)
 - PixHawk (beacon)
- **Sample code:**
 - C
 - Python

5.1 Modem HW v.4.9 external interface pinout

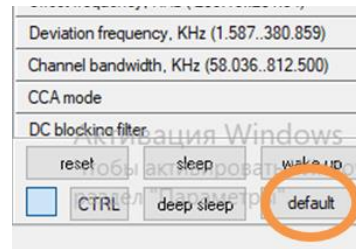


6 Advanced system settings and optimization

Start using advanced settings only when you know what you are doing.

If you ran into troubles, connect modem to PC via USB and use **Default button**.

(lower right corner of the Dashboard)



It will upload “factory settings” to the board while keeping the device address untacked.

7 Frequently Asked Questions

<http://www.marvelmind.com/forum/viewforum.php?f=2>

8 Contacts

For more support, you may send us your questions to info@marvelmind.com. We will guide and advise you

9 FCC Statement

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

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This product must be installed and operated with a minimum distance of 20cm between the radiator and user body.