Marvelmind Indoor Navigation System Modem v5.1 operating manual

v2020_11_08

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Version changes

V2020_11_08

- Modem v5.1 only for FCC

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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

1.1   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

Fig.1: HW v5.1 Modem

- Radio coverage further extended to a few hundred meters by using a lower bitrate of 38kbps and full-size antennas, which have been tested to provide up to 400m in ideal conditions

- There modem support the 915MHz band

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

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2. Setting up the system (NIA)

2.1 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

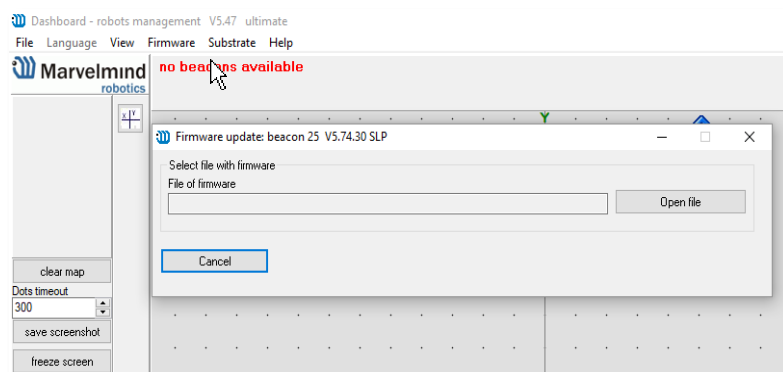4.1.6 Charge all the beacons using USB cable. Full charging takes about 1-2 hours

4.1.7 Turn the beacons on: Place DIP switches as shown on the picture below
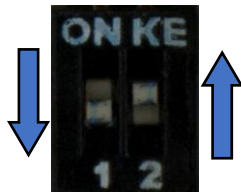
4.1.8 Download SW Pack

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

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- Choose the DFU driver (file) for the beacon
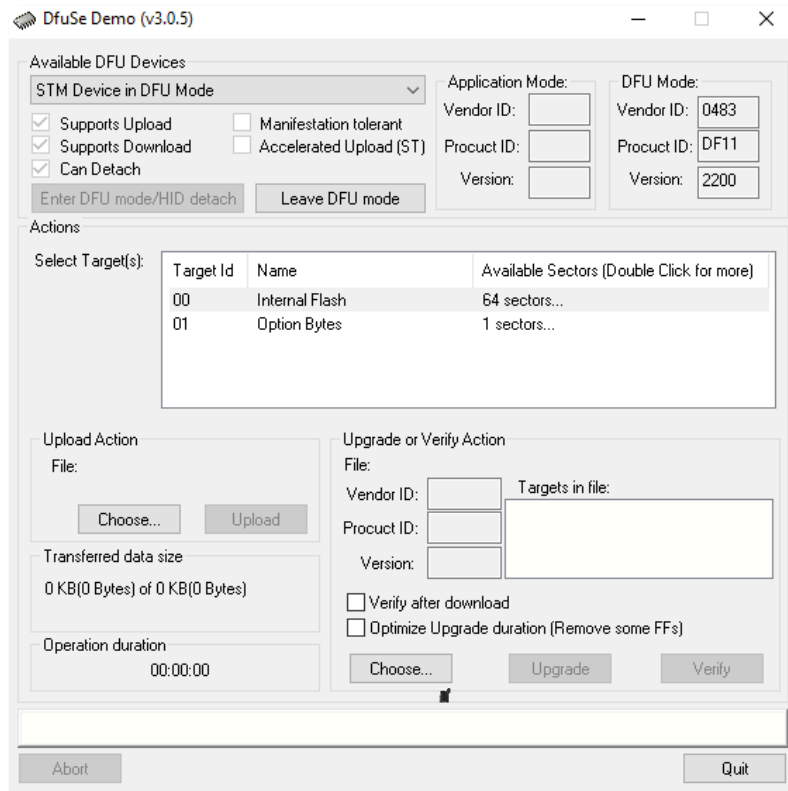
- Click the **UPGRADE** button

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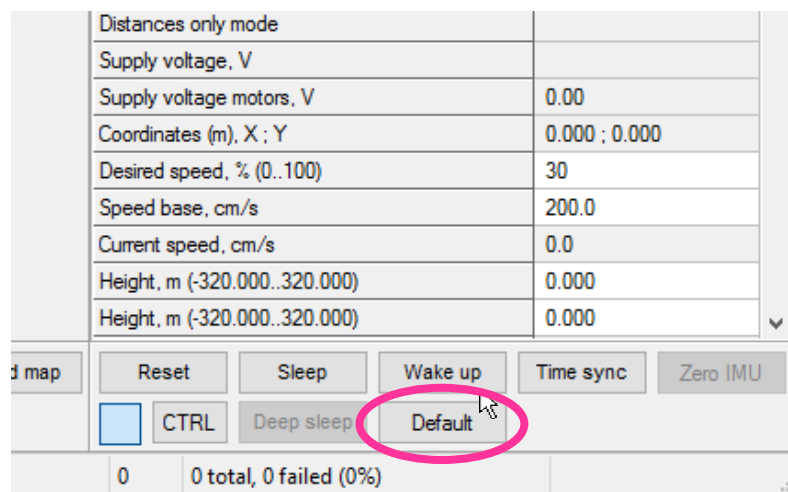
  - Here is the link for the modem DFU programming. The steps are similar to those for beacon DFU programming

  - After uploading DFU driver by DfuSe short circuit pins as shown on the picture (for v5.1) and press **Reset** button
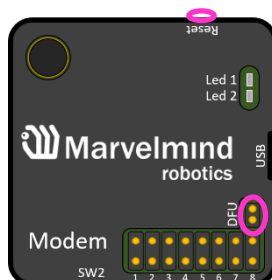
- Modem will go to DFU mode. Press **UPGRADE** button in the DfuSe program

- 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

Distances only mode	
Supply voltage, V	
Supply voltage motors, V	0.00
Coordinates (m), X ; Y	0.000 ; 0.000
Desired speed, % (0..100)	30
Speed base, cm/s	200.0
Current speed, cm/s	0.0
Height, m (-320.000..320.000)	0.000
Height, m (-320.000..320.000)	0.000

d map	Reset	Sleep	Wake up	Time sync	Zero IMU
CTRL	Deep sleep	Default		
0	0 total, 0 failed (0%)			

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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, ℃	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

4.1.12 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.**

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4.1.18 It may take up to 7-10 seconds for the beacons to wake up
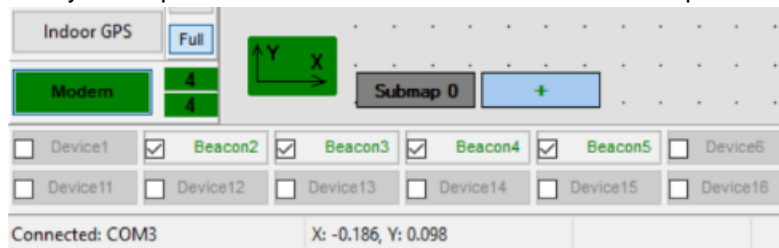
4.1.19 Notice, that if the modem is not active and is not powered, the beacons will go into sleep mode automatically after 1 minute

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

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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)

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FCC NOTICE:

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and 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.

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

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

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

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

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

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3. Contacts

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