Protocol of data exchange with modem via USB interface
Version 2019.08.20

- Modem connects to USB-host as USB device of CDC class (virtual COM port in Windows, ttyUSB or ttyACM in Linux)
- Because real RS-232 is not used in this interface, parameters of serial port set on the host (baudrate, number of bits, parity, etc.) may be any
- Data is in binary format
- «Network address» of modem is **0xff**
- Multibyte numbers are transmitted starting from low byte (little endian format)

1. Reading the latest coordinates pack (firmware V5.13+)
Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	2	uint16_t	Code of data in packet	0x4110
4	2	uint16_t	Access mode	0x0000
6	2	uint16_t	CRC-16 (see appendix)	0xc004

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	1	uint8_t	Number of bytes of data transmitting	0x64
3	100 (0x64)	100 bytes	Data structure (see lower)	
103	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

Format of data field (100 bytes)

Offset	Size (bytes)	Description
0	96 (6*16)	Six last coordinates structures received by modem (see lower)
96	1	Byte of flags: Bit 0…1: reserved Bit 2: 1 = user data available (see section 12) Bit 3…7: reserved
97	3	Reserved

Format of coordinates structure (16 bytes)

Offset	Size (bytes)	Description
0	1	Address of device
1	4	Coordinate X, mm (int32_t)
5	4	Coordinate Y, mm (int32_t)
9	4	Coordinate Z, mm (int32_t)
13	1	Byte of flags: Bit 0: 1 – no relevant coordinates (red mode in dashboard) Bit 1: 1 – temporary mobile beacon on frozen map (blue mode) Bit 2: 1 – beacon is used for hedgehog positioning
14	2	Reserved (0)

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2. Reading/writing modem configuration
2.1 Reading modem configuration (firmware V5.30+)

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	2	uint16_t	Code of data in packet	0x5000
4	2	uint16_t	Access mode	0x0000
6	2	uint16_t	CRC-16 (see appendix)	0x0550

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	1	uint8_t	Number of bytes of data transmission	0x30
3	0x30	structure	Data structure (see section 2.3)	
0x33	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

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2.2 Writing modem configuration

Warning! To write modem configuration you must read configuration, setup the data fields described in following section, and then write it. Do not change any other bytes in structure, this may degrade the work of modem

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data in packet	0x5000
4	2	uint16_t	Access mode	0x0000
6	1	uint8_t	Number of bytes of data transmission	0x30
7	0x30	structure	Data structure (see section 2.3)	
0x37	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data	0x5000
4	2	uint16_t	reserved	
6	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

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2.3 Structure of modem configuration data

Many fields of data structure are not explained. Do not change the fields! They are used for adjustment system from the Dashboard program; unauthorized changing may degrade the work of modem

Offset	Size (bytes)	Type	Description
0	20	20 bytes	Not explained
20	1	int8_t	Temperature of air setting Vt (signed). Temperature is (Vt+23)°C
21	1	uint8_t	Address of the beacon that should have map coordinates X=0,Y=0
22	4	4 bytes	Not explained
26	1	uint8_t	Address of the beacon that should have map coordinates X>0,Y=0
27	1	uint8_t	Address of the beacon that should have map coordinates with Y>0
28	1	uint8_t	Control flags: Bit 0: not explained Bit 1: 1 - enabled filtering of mobile beacons movement Bit 2: not explained Bit 3: 1 - high resolution mode (output coordinates in mm instead cm) Bit 4: not explained Bit 5: 1 = mirroring of all map Bit 6: 1= power save mode (power save works only when all of the submaps are frozen) Bit 7: not explained
29	2	2 bytes	Not explained
31	1	uint8_t	N, determines maximum frequency of retrieving hedgehog coordinates $F(N)= 2^{(N-1)}$ Hz, N= 0...4, F(5)= 12 Hz, F(6)= 16 Hz, F(7)= 16+ (maximum)
32	16	16 bytes	Not explained

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3. Reading/writing submap configuration
3.1 Reading submap configuration (firmware V5.30+)

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	2	uint16_t	Code of data in packet	0x60XX where XX is number of submap
4	2	uint16_t	Access mode	0x0000
6	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	1	uint8_t	Number of bytes of data transmission	0x50 (80)
3	80	structure	Data structure (see section 3.3)	
83	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

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3.3 Structure of submap configuration data

Many fields of data structure are not explained. Do not change the fields! They are used for adjustment system from the Dashboard program; unauthorized changing may degrade the work of modem

Offset	Size (bytes)	Type	Description
0	1	uint8_t	Address of starting beacon for building submap
1	1	uint8_t	Control word: Bit 0: 1 - submap is frozen (freeze submap) Bit 1: 1 - beacons are higher than hedgehogs Bit 2...4: not explained Bit 5: 1 - mirroring submap Bit 6...7: not explained
2	1	uint8_t	Limitation of distances: Bit 0...6: manual limitation distances (if bit 7 = 1) Bit 7: 0 - automatic limitation, 1 = manual
3	13	13 bytes	Not explained
16	2	int16_t	X shift of submap, cm
18	2	int16_t	Y shift of submap, cm
20	2	uint16_t	Rotation of submap, centidegrees
22	58	58 bytes	Not explained

3.2 Writing submap configuration (firmware V5.30+)

Warning! To write modem configuration you must read configuration, setup the data fields described in following section, and then write it. Do not change any other bytes in structure, this may degrade the work of modem

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data in packet	0x60XX where XX is number of submap
4	2	uint16_t	Access mode	0x0000
6	1	uint8_t	Number of bytes of data transmission	0x50 (80)
7	80	structure	Data structure (see section 3.3)	
87	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data	0x5000
4	2	uint16_t	reserved	
6	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

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4. Sleeping/waking up devices

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of device	0x01…0xfe
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data in packet	0xb006
4	2	uint16_t	Access mode	For wake: 0x0002 Others: 0x0001
6	1	uint8_t	Number of bytes of data transmission	0x08
7	1	uint8_t	Password, byte 0	0x2d
8	1	uint8_t	Password, byte 1	0x94
9	1	uint8_t	Password, byte 2	0x5e
10	1	uint8_t	Password, byte 3	0x81
11	1	uint8_t	Command: 0 – standard sleep 1 – deep sleep (wake only on HW reset) 2 – wake up from standard sleep 3…255 - reserved	0…2
12	3	3 bytes	reserved	
15	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame for waking command (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of device	0x01…0xfe
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data	0xb006
4	2	uint16_t	reserved	
6	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame for sleeping commands (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet (modem reply)	0x7f
2	2	uint16_t	Code of data	0xb006
4	2	uint16_t	reserved	
6	2	uint16_t	CRC-16 of bytes 0…5 (see appendix)	
8	1	uint8_t	Address of device	0x01…0xfe
9	1	uint8_t	Type of packet	0x10
10	2	uint16_t	Code of data	0xb006
12	2	uint16_t	reserved	
14	2	uint16_t	CRC-16 for bytes 8…13(see appendix)	

Format of error reply is described in Appendix 2.

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5. Setting address of device

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of device	0x01…0xfe
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data in packet	0x0101
4	2	uint16_t	Access mode	0x0000
6	1	uint8_t	Number of bytes of data transmission	0x02
7	1	uint8_t	Code of data item (address)	0x00
8	1	uint8_t	New address of device	
9	2	uint16_t	CRC-16 (see appendix)	

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6. Reading measured raw distances

This command is accessible in two modes:
- With code of data 0x4000 – reading last eight distances. Answer frame contains last 8 measured distances from the moment of request
- With code of data 0x4001 – reading all distances frame by frame. Answer frame for every next request contains next 8 saved measured distances. When all table of distances is transmitted, it starts from the beginning

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	2	uint16_t	Code of data in packet	0x4000 or 0x4001
4	2	uint16_t	Access mode	0x0000
6	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	1	uint8_t	Number of bytes of data transmitting	0x28
3	40 (0x28)	40 bytes	Data structure (see lower)	
43	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

Format of data field (40 bytes)

Offset	Size (bytes)	Description
0	32 (8*4)	Eight raw distances structures (see lower)
32	8	Reserved

Format of distance structure (4 bytes)

Offset	Size (bytes)	Description
0	1	Address of ultrasonic receiver
1	1	Address of ultrasonic transmitter
2	2	Measured distance between devices, mm (uint16_t)

7. Reading beacons' state (firmware V5.33+)

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of device	0x01...0xfe
1	1	uint8_t	Type of packet	0x03
2	2	uint16_t	Code of data in packet	0x0003
4	2	uint16_t	Access mode	0x0002
6	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of device	0x01...0xfe
1	1	uint8_t	Type of packet	0x03
2	1	uint8_t	Number of bytes of data transmission	0x20
3	32	32 bytes	Data structure (see lower)	
35	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

Format of data field:

Offset	Size (bytes)	Type	Description
0	4	uint32_t	Time of work from reset or wake-up (seconds)
4	1	uint8_t	R, radio RSSI register value (received signal strength indicator). If R>128, RSSI(dBm) = ((R-256)/2) – 74. If R<=128) RSSI (dBm) = (R/2) - 74
5	1	uint8_t	Not explained
6	1	int8_t	Measured temperature Vt (signed). Temperature is (Vt+23)°C
7	2	uint16_t	Bit 0...11 : power supply voltage, mV. Bit 12...13: not explained. Bit 14: 1: low power, device will enter sleep after short time. Bit 15: 1: very low power, device will enter deep sleep after short time
9	23	23 bytes	Not explained

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8. Marvelmind robots control commands

8.1. Robot control command

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of robot	0x01…0xfe
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data in packet	0x1000
4	2	uint16_t	Access mode	0x0001
6	1	uint8_t	Number of bytes of data transmission	0x10
7	16 (0x10) bytes	uint8_t	Robot control data (see lower)	
23	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet (modem reply)	0x7f
2	2	uint16_t	Code of data	0x1000
4	2	uint16_t	reserved	
6	2	uint16_t	CRC-16 of bytes 0…5(see appendix)	
8	1	uint8_t	Address of robot	0x01…0xfe
9	1	uint8_t	Type of packet (robot reply)	0x10
10	2	uint16_t	Code of data	0x1000
12	2	uint16_t	reserved	
14	2	uint16_t	CRC-16 of bytes 8…13(see appendix)	

Format of error reply is described in Appendix 2.

Format of robot control data:

Offset	Size (bytes)	Type	Description
0	1	uint8_t	Mode of control: 0 - no control (wait mode) 1 - motors power control 2 - speed control 3 - writing movement program 4 - pause movement program 5 - continue movement after pause
1	1	uint8_t	Code of operation: 0 - move forward 1 - move backward 2 - rotate clockwise 3 - rotate counterclockwise 4 - pause for given time (for mode 3) 5 - repeat movement program from start (for mode 3) 6 - move to given point by coordinates (for mode 3) 7 - setup movement speed (for mode 3)
2	1	uint8_t	Control byte 1:

			For mode 1: power on motors, % For mode 2: speed of movement, % For mode 3: number of the program step (starting from zero)
3	2	Int16_t	Data for program (mode 3): Code of operation 0 or 1: distance of movement, cm Code of operation 2 or 3: angle of rotation, degrees Code of operation 4: time of pause, ms Code of operation 6: X coordinate of movement target, cm Code of operation 7: speed of movement, %
5	1	uint8_t	For mode 3: total number of steps in program. Maximum supported number of steps is 8.
6	2	int16_t	Additional data for program (mode 3): Code of operation 6: Y coordinate of movement target, cm
8	2	int16_t	Code of operation 6: Z coordinate of movement target, cm
10	6	6 bytes	Reserved (0)

Some comments for this complicated command.

There are three main modes of robot control specified in byte 0 of robot control structure:

- power control (mode 1)
- speed control (mode 2)
- move by program (mode 3)

Mode 1 and mode 2 are generally used for test purposes. In mode 1 robot moves forward, backward, rotates left or right with selected power on motors. In mode 2 robot makes the same, but adjusting power to keep selected speed. The power or speed is set in byte 2 of structure, type of movement - in byte 1.

Mode 4 and mode 5 are special commands for pausing movement during program execution and continuing movement after pause.

The main mode for moving on complex trajectories is mode 3.

It allows to program to robot the sequence of primitive actions, which combination builds the trajectory. Each item of the sequence should be sent by one command of this type. Each command should contain the number of the current step in the byte 2 of robot control structure, and total number of steps in the byte 5 (maximum supported number of steps is 8).

In the byte 1 of robot control structure the type of primitive movement is specified. Parameters of the primitive movement are specified in fields "data for program" (bytes 3...4) and "additional data for program" (bytes 6...7).

So the following primitives are available:

- move forward by given distance;
- move backward by given distance;
- rotate clockwise by given angle;
- rotate counterclockwise by given angle;
- pause by given time;
- restart the movement program from first item (for looping movements);
- move to given point (X, Y) in Marvelmind navigation system coordinates;
- change movement speed.

Robot begins execution of the program after receiving the sequence of primitives. After program execution, robot stops. But if the program contains item with code of operation 5 (repeat from start), the program repeats loop which will be executed forever, until receiving stop command or uploading new program..

8.2. Stop robot

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of robot	0x01...0xfe
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data in packet	0x403
4	2	uint16_t	Access mode	0x0001
6	1	uint8_t	Number of bytes of data transmission	0x04
7	4 bytes	4 bytes	Reserved (0)	0
11	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet (modem reply)	0x7f
2	2	uint16_t	Code of data	0x403
4	2	uint16_t	reserved	
6	2	uint16_t	CRC-16 of bytes 0...5 (see appendix)	
8	1	uint8_t	Address of robot	0x01...0xfe
9	1	uint8_t	Type of packet (robot reply)	0x10
10	2	uint16_t	Code of data	0x403
12	2	uint16_t	reserved	
14	2	uint16_t	CRC-16 of bytes 8...13 (see appendix)	

Format of error reply is described in Appendix 2.

This command simply terminates execution of any robot movement or program of movements. The robot stops and waits for new commands.

9. Reading/writing device control settings (firmware V6.01+)

Note size of data for these frames is 8 bytes for DSP beacon and 16 bytes for HW4.9 beacon.

9.1 Reading device control settings
Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of device (beacon/modem)	0x01…0xfe or 0xff
1	1	uint8_t	Type of packet	0x03
2	2	uint16_t	Code of data in packet	0x1201
4	2	uint16_t	Access mode	0x0001
6	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03 if request was sent to modem 0x7f if request was sent to beacon
2	1	uint8_t	Number of bytes of data transmission	0x08/0x10
3	8	structure	Data structure (see section 9.3). Relevant only if request was send to modem (0xff)	
11	2	uint16_t	CRC-16 of bytes 0…10 (see appendix)	
following data will be received of the request was sent to beacon				
13	1	uint8_t	Address of device	0x01…0xfe
14	1	uint8_t	Type of packet	0x03
15	1	uint8_t	Number of bytes of data transmission	0x08/0x10
16	8	structure	Data structure (see section 9.3).	
24	2	uint16_t	CRC-16 of bytes 12…22 (see appendix)	

Format of error reply is described in Appendix 2.

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9.2 Write device control settings
Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of device (beacon/modem)	0x01...0xfe or 0xff
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data in packet	0x1201
4	2	uint16_t	Access mode	0x0001
6	1	uint8_t	Number of bytes of data transmission	0x08/0x10
7	8	structure	Data structure (see section 9.3)	
15	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03 if request was sent to modem 0x7f if request was sent to beacon
2	2	uint16_t	Code of data	0x1201
4	2	uint16_t	reserved	
6	2	uint16_t	CRC-16 of bytes 0...5 (see appendix)	
	following data will be received of the request was sent to beacon (with address 0x01...0xfe)			
8	1	uint8_t	Address of device	0x01...0xfe
9	1	uint8_t	Type of packet	0x10
10	2	uint16_t	Code of data	0x1201
12	2	uint16_t	reserved	
14	2	uint16_t	CRC-16 of bytes 8...13 (see appendix)	

Format of error reply is described in Appendix 2.

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9.3 Format of control settings payload data

Offset	Size (bytes)	Type	Description
0	1	uint8_t	Flags: Bit 0...5: not explained, should be always zero ! Bit 6: 0 - stationary beacon mode, 1 - hedgehog mode Bit 7: reserved (0)
1	1	uint8_t	UART baudrate setting: 0: 500000 bps (default value) 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps 5: 57600 bps 6: 115200 bps 7...255: reserved
2	1	uint8_t	Reserved (0)

3	1	uint8_t	Bit 0...3: radio profile:
			    0: 38.4 kbps
			    1: 150 kbps
			    2: 500 kbps
			    3...7: reserved
			Bit 4...6: radio band:
			    0: 433 MHz
			    1: 868 MHz
			    2: 915 MHz
			    3: 315 MHz
			    4...7: reserved
			Bit 7: reserved

4	1	uint8_t	Type of UART/USB output: 0: Marvelmind protocol 1: NMEA0183
5	1	uint8_t	Mask of NMEA frames to send in NMEA0183 mode: Bit 0: 1 - send $GPRMC frame Bit 1: 1 - send $GPGGA frame Bit 2: 1 - send $GPVTG frame Bit 3: 1 - send $GPZDA frame Bit 4...7: reserved (0)
6	1	uint8_t	Number of bytes of user payload data for sending from this hedgehog to modem (0...32)
7	1	uint8_t	Mask of IMU data for sending to modem in 'IMU via modem' mode: Bit 0: IMU fusion location Bit 1: quaternion Bit 2: speed Bit 3: acceleration Bit 4: raw accelerometer Bit 5: raw gyro Bit 6: raw compass Bit 7: 0 = send IMU fusion, 1 = send raw IMU
Next fields are available for HW4.9 beacon only			
8	1	uint8_t	Bit 0...6: interval of streaming telemetry (0 = no stream) Bit 7: reserved (0)
9	1	uint8_t	Bit 0: use IMU for speed calculation

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			Bit 1…7 – reserved (0)
10	6	6 bytes	Reserved (0)

Warning! If you change radio profile on beacon connected by radio, the radio connection will be lost. If you need to switch the profile, switch the radio profile for all beacons one after another, and then switch radio profile for modem. All beacons should be available on new radio profile after few seconds.

10. Reading list of devices in network (firmware V6.01+)

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	2	uint16_t	Code of data in packet	0x31xx where xx is number of devices group
4	2	uint16_t	Access mode	0x0000
6	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	1	uint8_t	Number of bytes of data transmitting	0x72
3	1	uint8_t	Total number of devices in network (K)	
4	112	112 bytes	0...16 structures of information about device in network, see description lower	
116	1	uint8_t	Reserved	0x00
117	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

Format of data about device in network (8 bytes)

Offset	Size (bytes)	Description
0	1	Address of device (0x01...0xfe)
1	1	Major version of firmware
2	1	Minor version of firmware

3	1	Bit 0...5: Type of device:
		    10: wheel robot
		    12: crawler robot
		    22: beacon (5 sensors, HW V4.5)
		    23: hedgehog (5 sensors, HW V4.5)
		    24: modem (HW V4.5/4.9)
		    30: beacon (5 sensors, HW V4.9)
		    31: hedgehog (5 sensors, HW V4.9)
		    32: DSP beacon (HW V5.05)
		    36: Mini TX beacon (HW V5.07)
		    37: IP67 TX beacon
		Bit 6: 1 -more than one device with this address exist
		Bit 7: 1 - sleeping mode

4	1	Second minor version of firmware
5	1	Firmware options: Bit 0: 1 – inverse system Bit 1…7 – reserved (0)
6	1	Bit 0…6 – reserved (0) Bit 7: 0 – device has not yet confirmed connection ('Connecting…' state in

		dashboard)
7	1	Reserved (0)

Note: At first you should send request with 0x3100 code of data. In reply will appear total number of devices in network and information about first 16 (or less) devices. If total number of devices is more than 16, you should repeat with request 0x3101 to get next 16 devices info. Continue until you receive all devices information.

11. Reading version of modem firmware

Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	2	uint16_t	Code of data in packet	0xfe00
4	2	uint16_t	Access mode	0x0000
6	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	1	uint8_t	Number of bytes of data transmitting	0x08
3	1	uint8_t	Minor version of firmware	
4	1	uint8_t	Major version of firmware	
5	3	3 bytes	Reserved	
8	1	uint8_t	Device type ID	
9	2	uint16_t	Reserved	
11	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

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12. Reading user data
Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	2	uint16_t	Code of data in packet	0x0004
4	2	uint16_t	Access mode	0x0000
6	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x03
2	1	uint8_t	Number of bytes of data transmitting	0x84
3	1	uint8_t	Total user data size	
4	3	3 bytes	Reserved (0)	
7	128	uint8_t	User data from hedgehogs	
135	2	uint16_t	CRC-16 (see appendix)	

Format of error reply is described in Appendix 2.

User data from hedgehogs is the sequence of records with following structure:

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of hedgehog	H
1	1	uint8_t	Number of bytes of user data from hedgehog	M
2	M	uint8_t	M bytes of data from hedgehog H	

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13. Writing manual device location
Format of request frame (from host to modem)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of device (beacon/modem)	0x01…0xfe
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data in packet	0x5003
4	2	uint16_t	Access mode	0x0002
6	1	uint8_t	Number of bytes of data transmission	0x20
7	8	structure	Data structure (see below)	
15	2	uint16_t	CRC-16 (see appendix)	

Format of answer frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	0x10
2	2	uint16_t	Code of data	0x5003
4	2	uint16_t	reserved	
6	2	uint16_t	CRC-16	

Format of error reply is described in Appendix 2.

Format of data structure:

Offset	Size (bytes)	Type	Description	Value
0	4	int32_t	X coordinate, mm	
4	4	int32_t	Y coordinate, mm	
8	4	int32_t	Z coordinate, mm	
12	1	uint8_t	Not explained	0xff
13	4	int32_t	Not explained	0
17	4	int32_t	Not explained	0
21	4	int32_t	Not explained	0
25	1	uint8_t	Not explained	0x02
26	6	6 bytes	Reserved	0

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Appendix 1. Calculating CRC-16.

        For checksum the CRC-16 is used. Last two bytes of N-bytes frame are filled with CRC-16, applied to first (N-2) bytes of frame. To check data you can apply CRC-16 to all frame of N bytes, the result value should be zero.

        Below is the implementation of the algorithm in the 'C'.

```c
typedef ushort ModbusCrc;//  ushort – two bytes

typedef union {
        ushort w;
        struct{
                uchar lo;
                uchar hi;
        } b;
        uchar bs[2];
} Bytes;

static ModbusCrc modbusCalcCrc(const void *buf, ushort length)
{
        uchar *arr = (uchar *)buf;
        Bytes crc;

        crc.w = 0xffff;

        while(length--){
                char i;
                bool odd;

                crc.b.lo ^= *arr++;
                for(i = 0; i < 8; i++){
                        odd = crc.w & 0x01;
                        crc.w >>= 1;
                        if(odd)
                                crc.w ^= 0xa001;
                }
        }

        return (ModbusCrc)crc.w;
}
```

Appendix 2. Format of error reply.

Format of error frame (from modem to host)

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of modem	0xff
1	1	uint8_t	Type of packet	
2	1	uint8_t	Code of error	
3	2	uint16_t	CRC-16 (see appendix)	

Type of the error packet is the type of packet for the request frame with added high bit. For example, if type of packet for request is 0x03, the type of error packet will be 0x83.

Code of error may be one of following:

1 – unknown type of packet in request

2 – unknown code of data in request

3 – error in data field of request

6 – device is busy

10 – error message from remote device

11 – timeout of reply from remote device

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