Hardware interface and protocol of data exchange with mobile beacon via USB, UART and SPI interfaces.

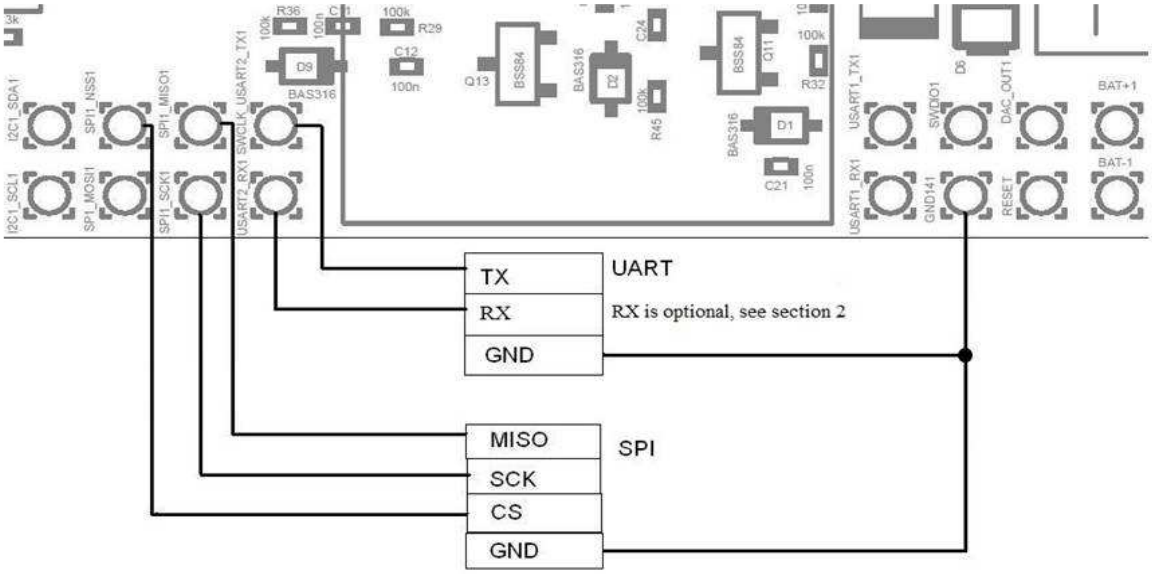
Version 2019.08.20
Valid for firmware v5.93 and newer

I. Marvelmind communication protocol.

For communication with mobile beacon (hedgehog), it shall be connected to an external device (robot, copter, AGV, etc.) via any of the following interfaces:

1. Connect to USB-host as an USB device of CDC class (virtual COM port in Windows, ttyUSB or ttyACM in Linux). In the Windows, it requires driver - the same driver as for modem. In Linux, the driver is not required, since the required driver is integrated into Linux kernel. Because real RS-232 is not used in the interface, parameters of serial port opened on the host (baudrate, number of bits, parity, etc) may be any.
2. Connect to UART on a hedgehog – 2 wires soldering to pins required. See the picture of beacon interface below. To have the location data out, it is sufficient to connect only 2 wires: GND and USART2_TX. Logic level of UART transmitter is CMOS 3.3V. Default baudrate is 500 kbps, configurable from the Dashboard from following list: 4.8, 9.6, 19.2, 38.4, 57.6, 115.2, 500 kbps. Format of data: 8 bit, no parity, 1 stop bit.
3. Connect to SPI. Hedgehog acts as SPI slave device. Parameters of SPI: SPI mode 0, MSB inside each byte transmits first. Connection was tested on SCK speed up to 8 MHz. Be careful to provide quality wiring connections on high speeds (more than 500 kHz). Formats of packets transmitting via SPI are same as for serial ports (USB and UART).

UART and SPI interfaces v4.5



The hedgehog constantly streams packets of location data, defined in section 1, to UART and USB without any request. To get data from SPI, master should provide signals of chip select (CS) and clock (SCK).

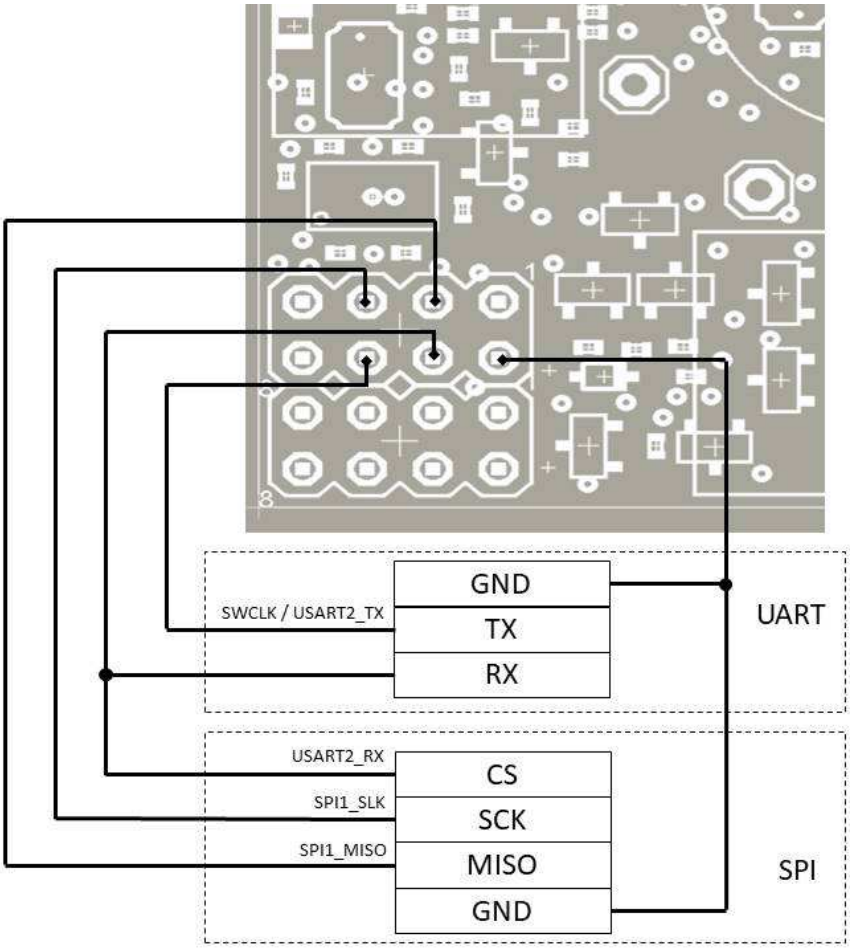
The section 2 defines the protocol for reading/writing common data from/to user device through the hedgehog's UART or USB. One of the applications is transmission of movement path to the robot, copter or any another vehicle.

Data is represented in binary format.

Multibyte numbers are transmitted starting from low byte (little endian format).

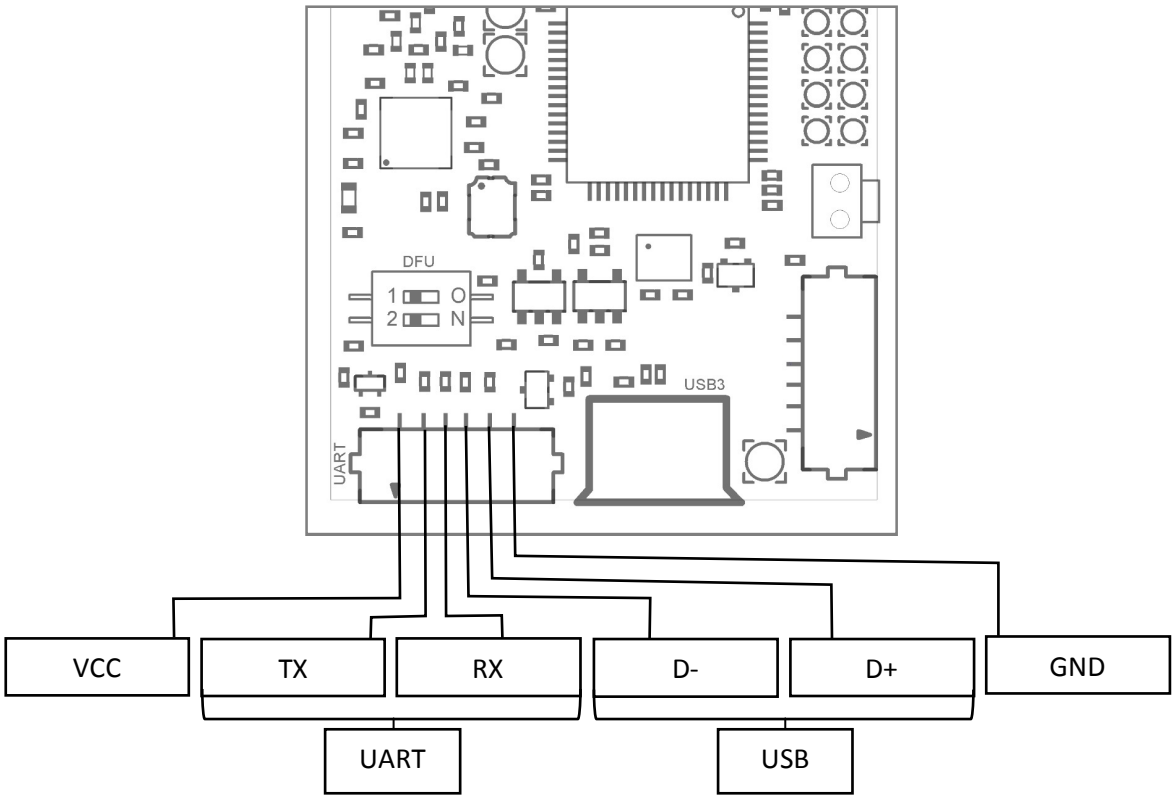
Marvelmind robotics

UART and SPI interfaces v4.9



Note: As you see, the UART RX and SPI CS use the same shared pin. The function of this pin (UART receiver, SPI chip select or others) can be selected in dashboard by parameter 'PA15 pin function' in 'Interfaces' section.

UART and interfaces beacon Mini-RX

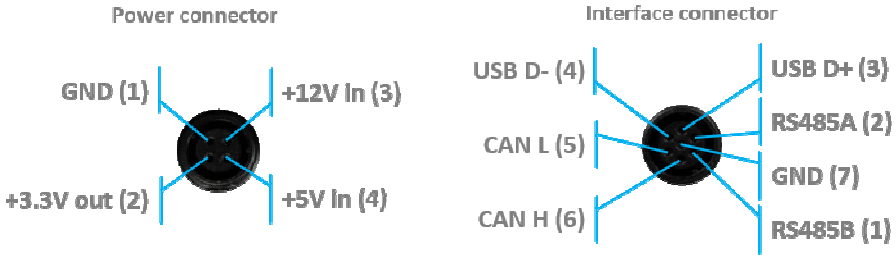


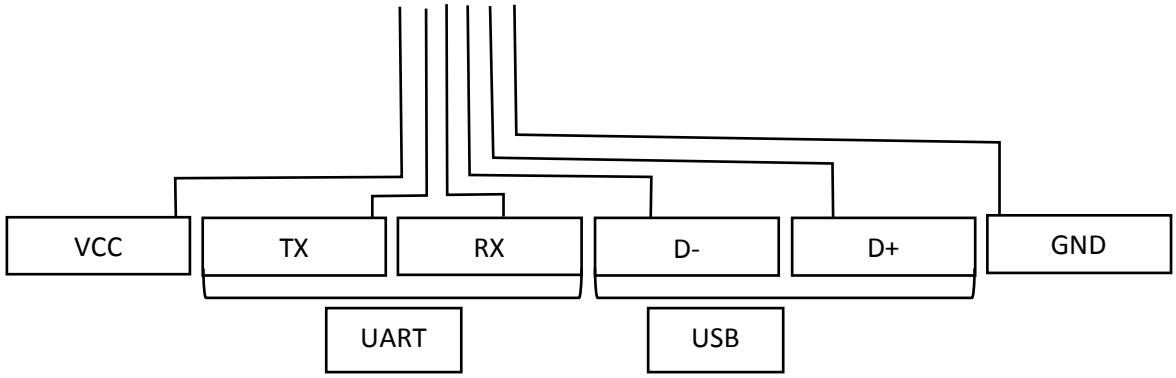
Marvelmind robotics

UART and interfaces beacon Industrial-TX

RS485 modification pinouts

CAN modification pinouts





Marvelmind robotics

1. Streaming packet format

All streaming packets have same general structure:

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Destination address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	See detail
4	1	uint8_t	Number of bytes of data transmitting	N
5	N	N bytes	Payload data according to code of data field	
5+N	2	uint16_t	CRC-16 (see appendix)	

1.1. Packet of hedgehog coordinates (code of data 0x0001).

This packet is transmitted every time new coordinates are measured or failed to measure.

1.1.1. Packet with cm resolution coordinates.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Destination address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	0x0001
4	1	uint8_t	Number of bytes of data transmitting	0x10
5	4	uint32_t	Timestamp – internal time of beacon ultrasound emission, in milliseconds from the moment of the latest wakeup event. See note.	
9	2	int16_t	Coordinate X of beacon, cm	
11	2	int16_t	Coordinate Y of beacon, cm	
13	2	int16_t	Coordinate Z, height of beacon, cm	
15	1	uint8_t	Byte of flags: Bit 0: 1 - coordinates unavailable. Data from fields X,Y,Z should not be used. Bit 1: timestamp units indicator (see note) Bit 2: 1 - user button is pushed (V5.23+) Bit 3: 1 - data are available for uploading to user device, see section 2 (V5.34+) Bit 4: 1 - want to download data from user device, see section 2 (V5.34+) Bit 5: 1 – second user button is pushed (V5.74+) Bit 6: 1 – data for another hedgehog (not same one that sending this packet) Bit 7: – reserved (0)	
16	1	uint8_t	Address of hedgehog	
17	2	uint16_t	Bit 0…11: orientation of hedgehogs pair in XY plane, decidegrees (0…3600) Bit 12: 1 – coordinates are given for center of beacons pair; 0 – coordinates for specified beacon Bit 13…15: reserved (0)	
19	2	uint16_t	Time passed from ultrasound emission to current time, milliseconds (V5.88+)	
21	2	uint16_t	CRC-16 (see appendix)	

1.1.2. Packet with mm resolution coordinates (firmware V5.35+).

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Destination address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	0x0011
4	1	uint8_t	Number of bytes of data transmitting	0x16
5	4	uint32_t	Timestamp – internal time of beacon ultrasound emission, in milliseconds from the moment of the latest wakeup event. See note.	
9	4	int32_t	Coordinate X of beacon, mm	
13	4	int32_t	Coordinate Y of beacon, mm	
17	4	int32_t	Coordinate Z, height of beacon, mm	
21	1	uint8_t	Byte of flags: Bit 0: 1 - coordinates unavailable. Data from fields X,Y,Z should not be used. Bit 1: timestamp units indicator (see note) Bit 2: 1 - user button is pushed (V5.23+) Bit 3: 1 - data are available for uploading to user device, see section 2 (V5.34+) Bit 4: 1 - want to download data from user device, see section 2 (V5.34+) Bit 5: 1 – second user button is pushed (V5.74+) Bit 6: 1 – data for another hedgehog (not same one that sending this packet) Bit 7: – 1 – out of geofencing zone	
22	1	uint8_t	Address of hedgehog	
23	2	uint16_t	Bit 0…11: orientation of hedgehogs pair in XY plane, decidegrees (0…3600) Bit 12: 1 – coordinates are given for center of beacons pair; 0 – coordinates for specified hedgehog Bit 13…15: reserved (0)	
25	2	uint16_t	Time passed from ultrasound emission to current time, milliseconds (V5.88+)	
27	2	uint16_t	CRC-16 (see appendix)	

Note: For firmware versions before 5.20, timestamp is in alpha-cycle periods (1/64 sec). This is indicated by zero value of bit 1 in byte of flags. For firmware version 5.20+ the timestamp is in milliseconds and bit 1 in byte of flags has value 1.

1.2. Packet of all beacons coordinates (code of data 0x0002).

This packet is transmitted when system becomes frozen, and repeats every 10 sec.

1.2.1. Packet with cm resolution coordinates.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	0x0002
4	1	uint8_t	Number of bytes of data transmitting	1+N*8
5	1	uint8_t	Number of beacons in packet	N
6	1	N*8 bytes	Data for N beacons	
6+N*8	2	uint16_t	CRC-16 (see appendix)	

Format of data structure for every of N beacons:

Offset	Size (bytes)	Type	Description
0	1	uint8_t	Address of beacon
1	2	int16_t	Coordinate X of beacon, cm
3	2	int16_t	Coordinate Y of beacon, cm
5	2	int16_t	Coordinate Z, height of beacon, cm
7	1	uint8_t	Reserved (0)

1.2.2. Packet with mm resolution coordinates (firmware V5.35+).

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	0x0012
4	1	uint8_t	Number of bytes of data transmitting	1+N*14
5	1	uint8_t	Number of beacons in packet	N
6	1	N*14 bytes	Data for N beacons	
6+N*14	2	uint16_t	CRC-16 (see appendix)	

Format of data structure for every of N beacons:

Offset	Size (bytes)	Type	Description
0	1	uint8_t	Address of beacon
1	4	int32_t	Coordinate X of beacon, mm
5	4	int32_t	Coordinate Y of beacon, mm
9	4	int32_t	Coordinate Z, height of beacon, mm
13	1	uint8_t	Reserved (0)

1.3. Packet of raw inertial sensors data (code of data 0x0003).

This packet is transmitted when new inertial sensors data available.
Available on mobile beacon with enabled “raw inertial sensors data” option or via modem when enabled ‘IMU via modem’ option on mobile beacon.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	0x0003
4	1	uint8_t	Number of bytes of data transmitting	0x20
5	32		Data packet (see lower)	
37	2	uint16_t	CRC-16 (see appendix)	

Format of data packet

Offset	Size (bytes)	Type	Description	Value
0	2	int16_t	Accelerometer, X axis, 1 mg/LSB	
2	2	int16_t	Accelerometer, Y axis, 1 mg/LSB	
4	2	int16_t	Accelerometer, Z axis, 1 mg/LSB	
6	2	int16_t	Gyroscope, X axis, 0.0175 dps/LSB	
8	2	int16_t	Gyroscope, Y axis, 0.0175 dps/LSB	
10	2	int16_t	Gyroscope, Z axis, 0.0175 dps/LSB	
12	2	int16_t	Compass, X axis, 1100 LSB/Gauss	
14	2	int16_t	Compass, Y axis, 1100 LSB/Gauss	
16	2	int16_t	Compass, Z axis, 980 LSB/Gauss	
18	1	uint8_t	Address of beacon	
19	5	5 bytes	Reserved (0)	
24	4	uint32_t	Timestamp, ms	
28	4	4 bytes	reserved	

1.4. Packet of raw distances data (code of data 0x0004).

This packet is transmitted every time new coordinates are measured or failed to measure, after the packet with coordinates (code 0x0001/0x0011).

Available only on mobile beacon with enabled “raw distances data” option.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	0x0004
4	1	uint8_t	Number of bytes of data transmitting	0x20
5	32		Data packet (see lower)	
37	2	uint16_t	CRC-16 (see appendix)	

Format of data packet

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of hedgehog	
1	6		Distance item 1	
7	6		Distance item 2	
13	6		Distance item 3	
19	6		Distance item 4	
25	4	uint32_t	Timestamp – internal time of beacon ultrasound emission, in milliseconds from the moment of the latest wakeup event (V5.89+).	
29	2	uint16_t	Time passed from ultrasound emission to current time, milliseconds (V5.89+)	
31	1	uint8_t	reserved	

Format of distance item

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of beacon (0 if item not filled)	
1	4	uint32_t	Distance to the beacon, mm	
5	1	uint8_t	Reserved (0)	

1.5. Packet of processed IMU data (code of data 0x0005).

This packet is transmitted when new inertial sensors data available, update rate 100 Hz (if getting data from mobile beacon) or system update rate (if getting data from modem).
Available on mobile beacon with enabled “raw inertial sensors data” option or via modem when enabled ‘IMU via modem’ option on mobile beacon.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	0x0005
4	1	uint8_t	Number of bytes of data transmitting	0x2a
5	42		Data packet (see lower)	
47	2	uint16_t	CRC-16 (see appendix)	

Format of data packet

Offset	Size (bytes)	Type	Description	Value
0	4	int32_t	Coordinate X of beacon (fusion), mm	
4	4	int32_t	Coordinate Y of beacon (fusion), mm	
8	4	int32_t	Coordinate Z of beacon (fusion), mm	
12	2	int16_t	W field of rotation quaternion	
14	2	int16_t	X field of rotation quaternion	
16	2	int16_t	Y field of rotation quaternion	
18	2	int16_t	Z field of rotation quaternion	
20	2	int16_t	Velocity X of beacon (fusion), mm/s	
22	2	int16_t	Velocity Y of beacon (fusion), mm/s	
24	2	int16_t	Velocity Z of beacon (fusion), mm/s	
26	2	int16_t	Acceleration X of beacon, mm/s^2	
28	2	int16_t	Acceleration Y of beacon, mm/s^2	
30	2	int16_t	Acceleration Z of beacon, mm/s^2	
32	1	uint8_t	Address of beacon	
33	1	1 byte	Reserved (0)	
34	4	uint32_t	Timestamp, ms	
38	4	4 bytes	Reserved (0)	

Note: Quaternion is normalized to 10000 value.

1.6. Packet of telemetry data (code of data 0x0006).

This packet is transmitted from mobile beacon with selected rate, if the option “Telemetry output” is enabled.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	0x0006
4	1	uint8_t	Number of bytes of data transmitting	0x10
5	16		Data packet (see lower)	
21	2	uint16_t	CRC-16 (see appendix)	

Format of data packet

Offset	Size (bytes)	Type	Description	Value
0	2	uint16_t	Battery voltage, mV	
2	1	int8_t	RSSI, dbM	
3	13		Reserved (0)	

1.7. Packet of positioning quality (code of data 0x0007).

This packet is transmitted from mobile beacon or modem after location update, if the option “Quality data stream” is enabled.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address	0xff
1	1	uint8_t	Type of packet	0x47
2	2	uint16_t	Code of data in packet	0x0007
4	1	uint8_t	Number of bytes of data transmitting	0x10
5	16		Data packet (see lower)	
21	2	uint16_t	CRC-16 (see appendix)	

Format of data packet

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Device address	
1	1	uint8_t	Positioning quality, %	
2	14		Reserved (0)	

2. Protocol of reading/writing data from/to user device.

2.1. Packet from user device of confirmation readiness to transmit/receive data.

User device should monitor stream from hedgehog (see section 1.1). If the byte of flags contains in bits 3 or 4 values "1", this indicates ready data for uploading to user device or request to download data. The user device can reply by the following confirmation packet.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of hedgehog (get from 0x0001 packet of streaming)	
1	1	uint8_t	Type of packet	0x48
2	2	uint16_t	Code of data in packet	0x0100
4	1	uint8_t	Number of bytes of data transmitting	0x04
5	1	uint8_t	Status byte: Bit 0: 1 - user device ready to receive data Bit 1: 1 - user device ready to send data Bit 2...7: reserved (0)	
6	3	3 bytes	Reserved (0)	0
9	2	uint16_t	CRC-16 (see appendix)	

After this reply, if hedgehog detects set bits of readiness, it should send requests for read/write as shown in following sections.

2.2. Sending data from user device via hedgehog.

If the user device needs to transmit data via Marvelmind system, it should send following frame via USB/UART:

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Destination address	0x00
1	1	uint8_t	Type of packet	0x49
2	2	uint16_t	Code of data in packet	0x0200
4	1	uint8_t	Number of bytes of data transmitting	N
5	N	N bytes	Payload data	
5+N	2	uint16_t	CRC-16 (see appendix)	

The data will be transmitted via radio to the modem by the parts of the size defined as 'User payload data size' in 'Interfaces' section of dashboard settings for hedgehog. The rate of sending these parts is equal to update rate of hedgehog. Buffer size in hedgehog is 128 bytes. Take this in attention to avoid overflow the buffer.

2.3. Writing data from hedgehog to user device.

This packet is transmitted from hedgehog if it wants to send data to user device and bit 1 in status byte of confirmation packet (see section 2.1) is set to 1.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Destination address	0xff
1	1	uint8_t	Type of packet	0x4a
2	2	uint16_t	Code of data in packet	0x0200... 0x02ff
4	1	uint8_t	Number of bytes of data transmitting	N
5	N	N bytes	Payload data	
5+N	2	uint16_t	CRC-16 (see appendix)	

For this command the codes of data from 0x200 to 0x2ff are reserved.

If the user device successfully processed the request, it sends response in following format:

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of hedgehog (get from 0x0001 packet of streaming)	
1	1	uint8_t	Type of packet	0x4a
2	2	uint16_t	Code of data in packet	0x0200... 0x02ff
4	2	uint16_t	CRC-16 (see appendix)	

If the user device failed to process the request, it sends response in following format:

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Address of hedgehog (get from 0x0001 packet of streaming)	
1	1	uint8_t	Type of packet	0xca
2	2	uint16_t	Code of requested data	0x0200... 0x02ff
4	1	uint8_t	Code of error (see Appendix 3)	1
5	2	uint16_t	CRC-16 (see appendix)	

In the following sections (2.3.x) described the specific data writing requests.

2.3.1. Request of writing the movement path.

This packet contains one command of elementary movement. The hedgehog sends one after another all commands for elementary movements in the path.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Destination address	0xff
1	1	uint8_t	Type of packet	0x4a
2	2	uint16_t	Code of data in packet	0x201
4	1	uint8_t	Number of bytes of data transmitting	0x0c
5	12	12 bytes	Payload data	
17	2	uint16_t	CRC-16 (see appendix)	

Format of payload data:

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Type of elementary movement: 0 - move forward 1 - move backward 2 - rotate right (clockwise) 3 - rotate left (counterclockwise) 4 - pause 5 - repeat program from start 6 - move to specified point 7 - setup speed	
1	1	uint8_t	Index of this elementary movement (0 is the first)	
2	1	uint8_t	Total number of elementary movements	
3	2	int16_t	Parameter of movement: Types 0; 1 - distance of movement, cm Types 2; 3 - angle of rotation, degrees Type 4: time of pause, ms Type 6: X target coordinate, cm Type 7: speed, %	
5	2	int16_t	Parameter of movement: Type 6: Y target coordinate, cm	
7	2	int16_t	Parameter of movement: Type 6: Z target coordinate, cm	
9	3	3 bytes	Reserved (0)	

2.3.2. Request of writing zones.

This packet contains one item of sequence of zones list. The hedgehog sends one after another all commands for zones list.

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Destination address	0xff
1	1	uint8_t	Type of packet	0x4a
2	2	uint16_t	Code of data in packet	0x202
4	1	uint8_t	Number of bytes of data transmitting	0x25
5	37	37 bytes	Payload data	
42	2	uint16_t	CRC-16 (see appendix)	

Format of payload data:

Offset	Size (bytes)	Type	Description	Value
0	1	uint8_t	Index of the zone	
1	1	uint8_t	Number of points in zone polygon (N)	
2	1	uint8_t	Index of first point in this packet: M=0…N-1	
3	1	uint8_t	Flags: Bit 0: 1 = no service zone Bit 1: 1= no driving zone Bit 2: 1= inverted zone Bit 3: 1= active zone Bit 4…7: reserved (0)	
4	1	uint8_t	Number of zones	
5	32	4x8 bytes	Up to 4 points of zone polygon (see below)	

Format of payload data:

Offset	Size (bytes)	Type	Description	Value
0	4	int32_t	X coordinate of the point, mm	
4	4	int32_t	Y coordinate of the point, mm	

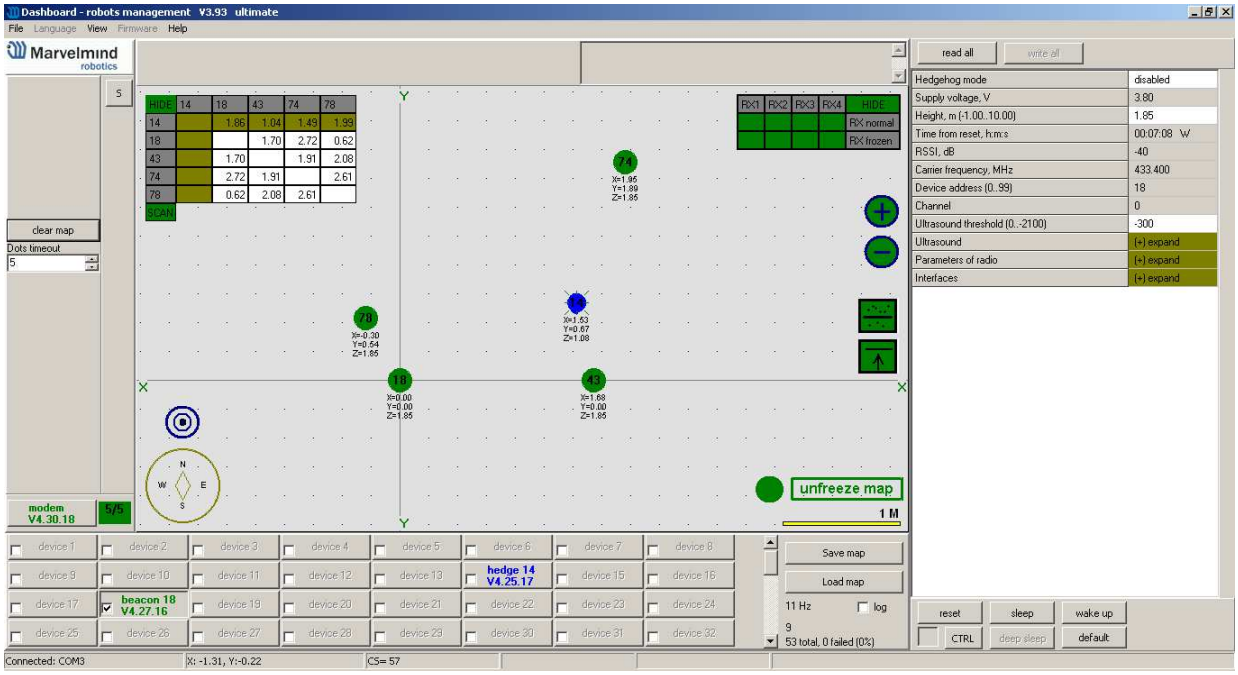
Appendix 1. Calculating CRC-16

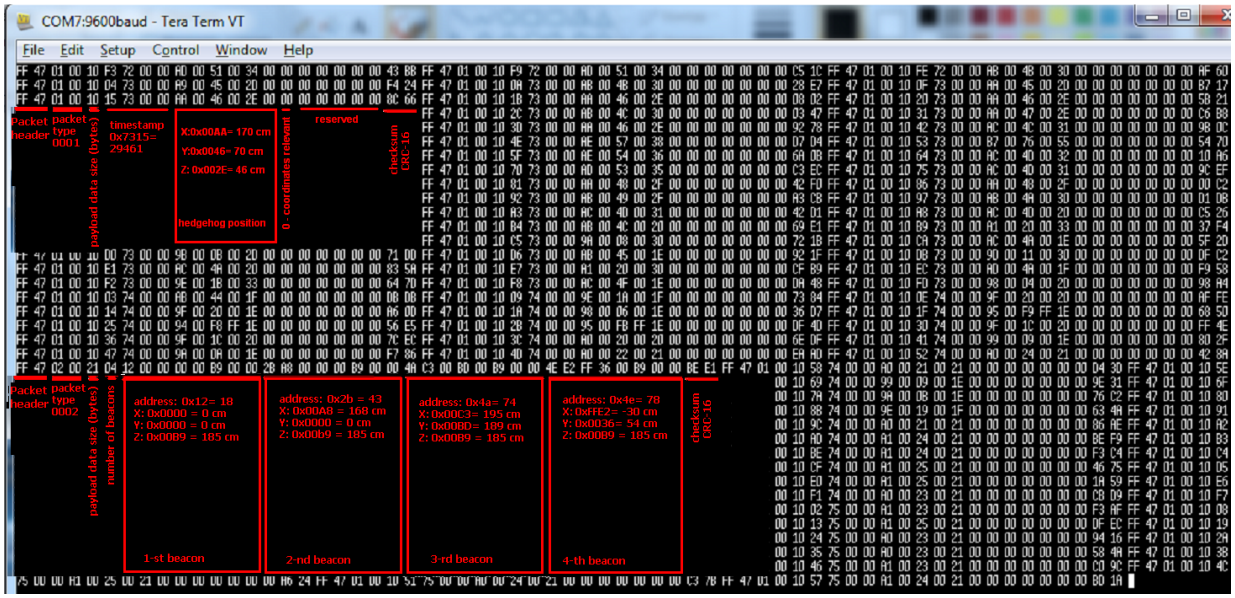
For checksum the CRC-16 is used. Last two bytes of N-bytes frame are filled with CRC-16, applied to first (N-2) bytes of frame. To check data you can apply CRC-16 to all frame of N bytes, the result value should be zero.

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

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

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

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

        crc.w = 0xffff;

        while(length--){
                chari;
                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. Data dump





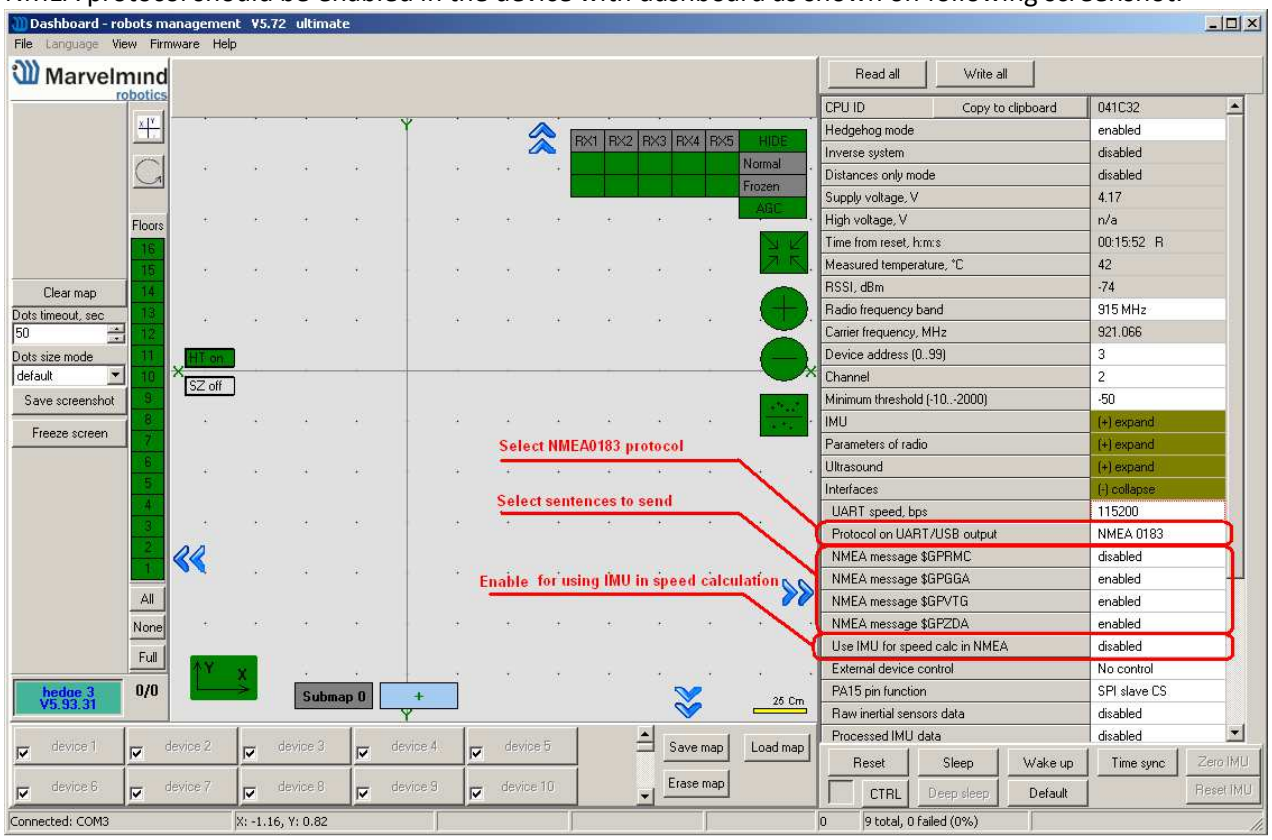
Appendix 3. Codes of errors, reported by user device

If user device could not process request from hedgehog, it should send reply with one of following error codes:

1 - unknown field "type of packet" in request
2 - unknown field "code of data" in request
3 - incorrect payload data in request
6 - device is busy and cannot retrieve requested data now

II. NMEA0183 communication protocol.

Mobile beacon can output some of the NMEA0183 sentences via UART and USB (virtual UART) interfaces. NMEA protocol should be enabled in the device with dashboard as shown on following screenshot:

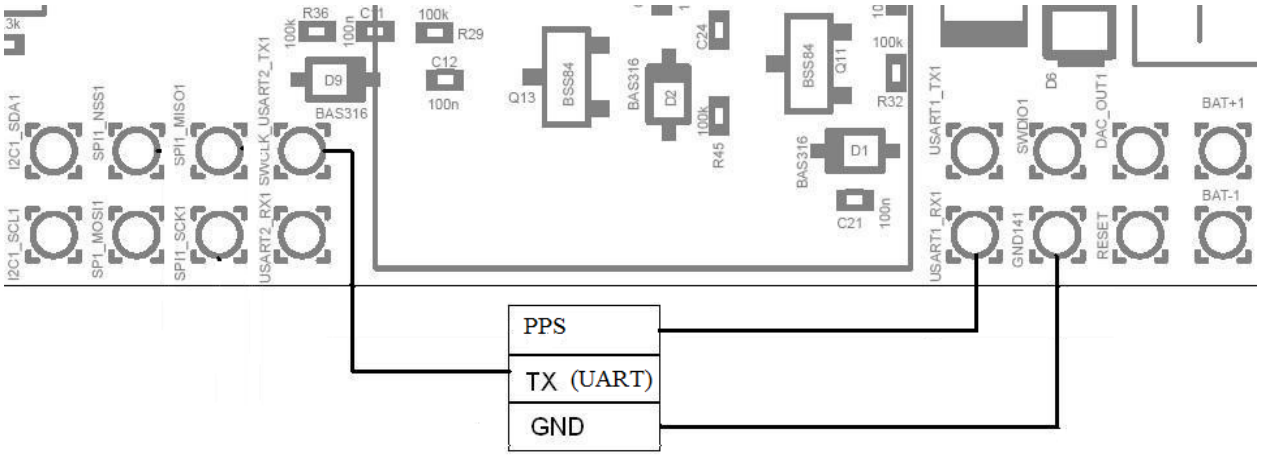


The device sends all enabled messages every time it receives updated position.

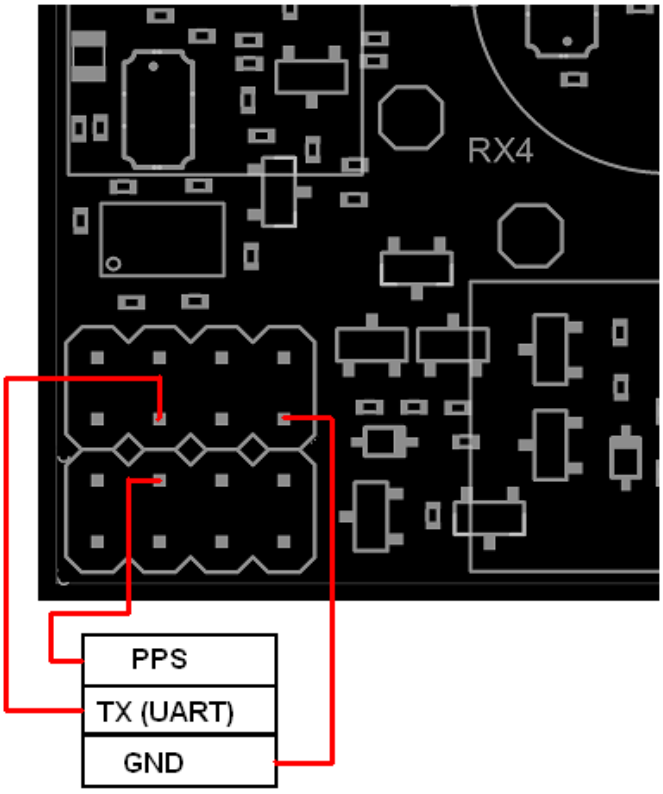
To get NMEA data from mobile beacon (hedgehog), it shall be connected to an external device (robot, copter, AGV, etc.) via any of the following interfaces:

1. Connect to USB-host as an USB device of CDC class (virtual COM port in Windows, ttyUSB or ttyACM in Linux). In the Windows, it requires driver - the same driver as for modem. In Linux, the driver in most cases is not required, since the required driver is integrated into Linux kernel. Because real RS-232 is not used in the interface, parameters of serial port opened on the host (baudrate, number of bits, parity, etc) may be any.
2. Connect to UART on a hedgehog – 2 wires soldering to pins required. See the picture of beacon interface below. To have the location data out, it is sufficient to connect only 2 wires: GND and USART2_TX. Logic level of UART transmitter is CMOS 3.3V. Default baudrate is 500 kbps, it is configurable from the Dashboard (see parameter “UART speed, bps” on above picture) from following list: 4.8, 9.6, 19.2, 38.4, 57.6, 115.2, 500 kbps. Format of data: 8 bit, no parity, 1 stop bit.

UART connection for beacon HW v4.5:



UART connection for beacon HW v4.9:



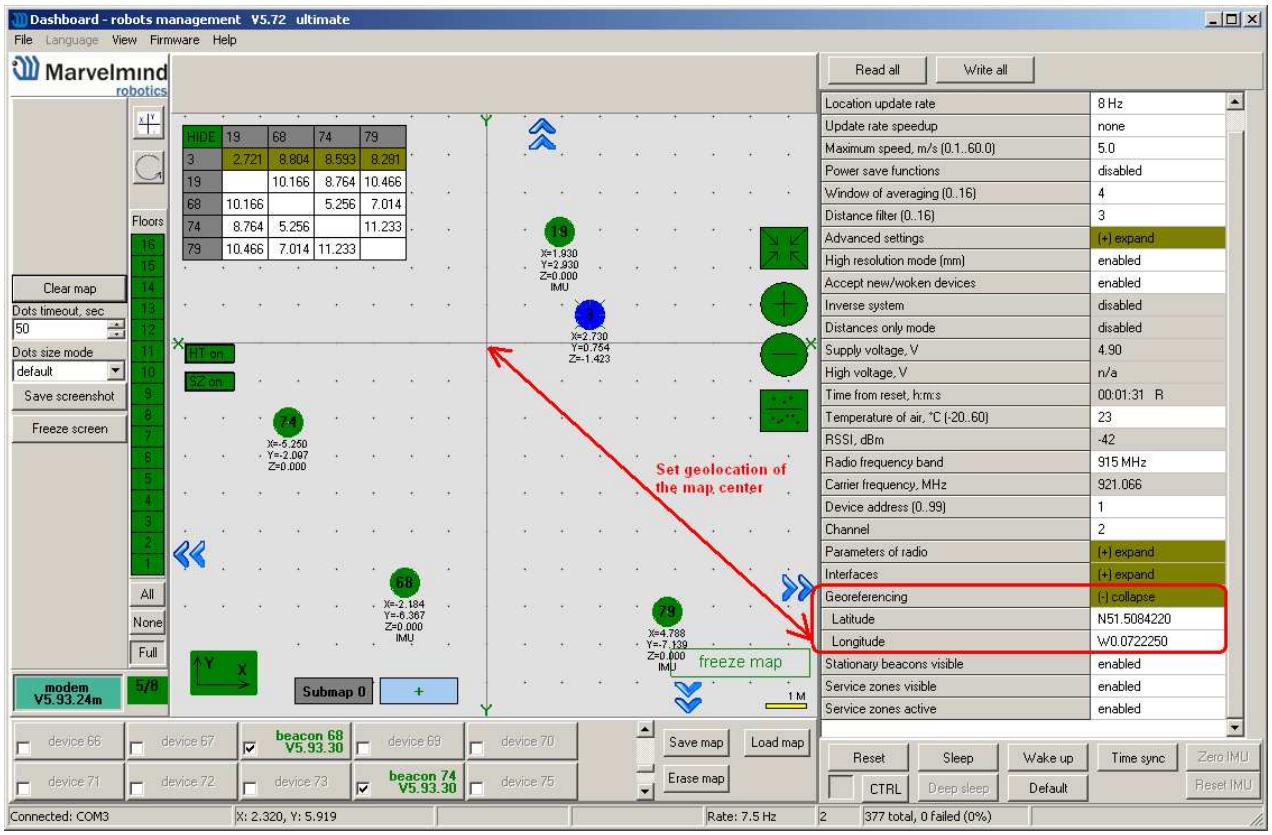
In addition to NMEA data transmission, the PPS (pulse-per-second) signal is generated. This signal is available on the mobile beacon pin, as shown on the picture above. This signal is 10 ms pulse of 3.3V level with 1000 ms interval. Precision of the interval length is equal to precision of onboard quartz resonator and is about 30 microseconds.

General agreements for coordinates translation.

Marvelmind system measures position in form of rectangular Cartesian system coordinates (X, Y, Z), where Z in most cases is the height. For translation to GPS coordinates following agreements are used:

- Z axis is directed up, Z coordinate means altitude above sea level;
- Y axis is directed to north, so Y is latitude;
- X axis is directed to east, so X is longitude;
- point (X= 0, Y= 0) has GPS coordinates according to georeference point (by default: 0 ° North, 0 °' West);

Georeference coordinates can be set as shown on the screenshot:



GPS coordinates are calculated according to specified georeference point and WGS-84 Earth model.

More, detailed,

Lat= Lat_ref + y*9.013373

where

Lat - latitude, microdegrees

Lat_ref - georeference latitude, microdegrees

y - y coordinates in Marvelmind system, meters

Long= Long_ref + x*8.98315/cos(Lat_ref/1000000)

Long - longitude, microdegrees

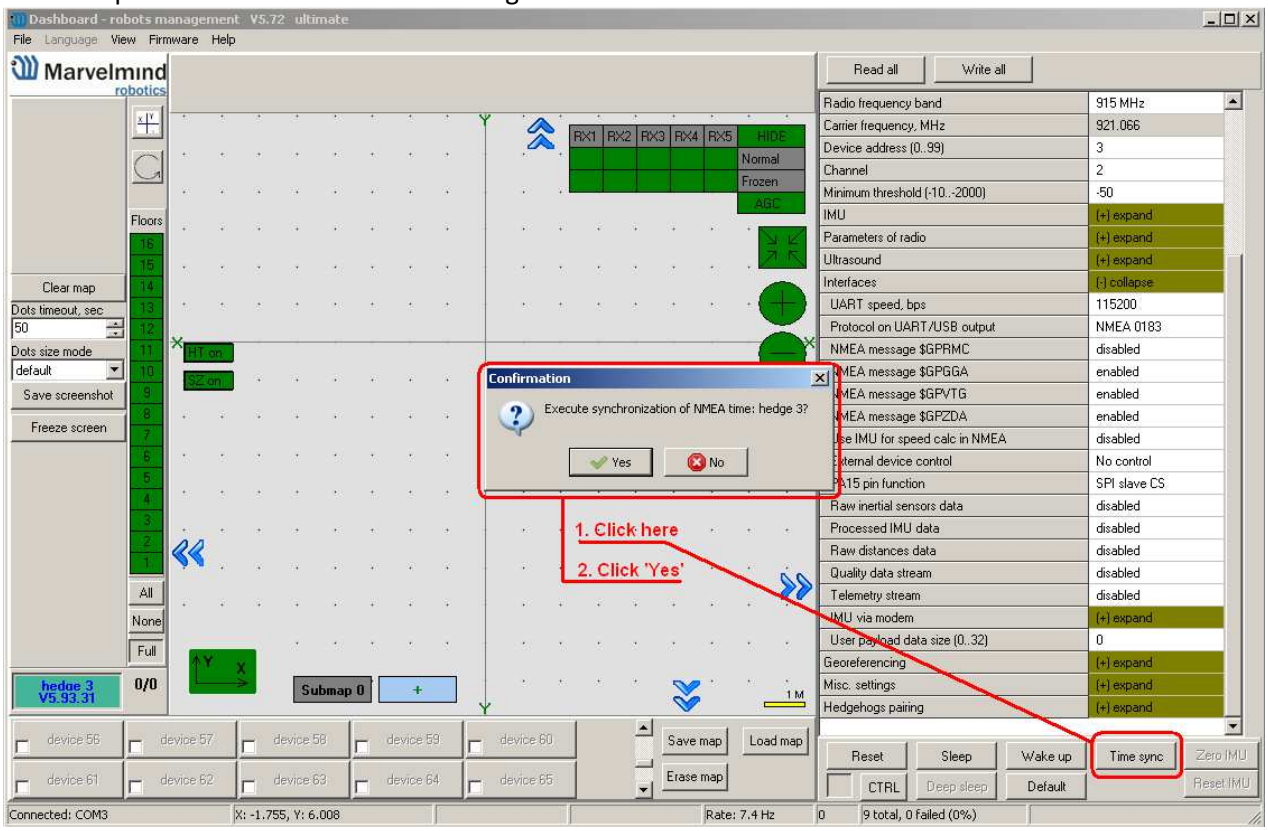
Long_ref - georeference longitude, microdegrees

Lat_ref - georeference latitude, microdegrees

x - x coordinates in Marvelmind system, meters

General agreements for time.

After power on, mobile beacon counts time starting from 2016.08.01 00:00:00. User can synchronize time with computer clock as shown on following screenshot.



Description of "NMEA0183" messages implementation.

NMEA 0183 messages are ASCII coded text frames, consist of several parts, separated by commas, and terminated by end of line. Before end of line, every message is finished by '*' symbol, followed by two symbols of checksum, calculated according to NMEA 0183 standard.

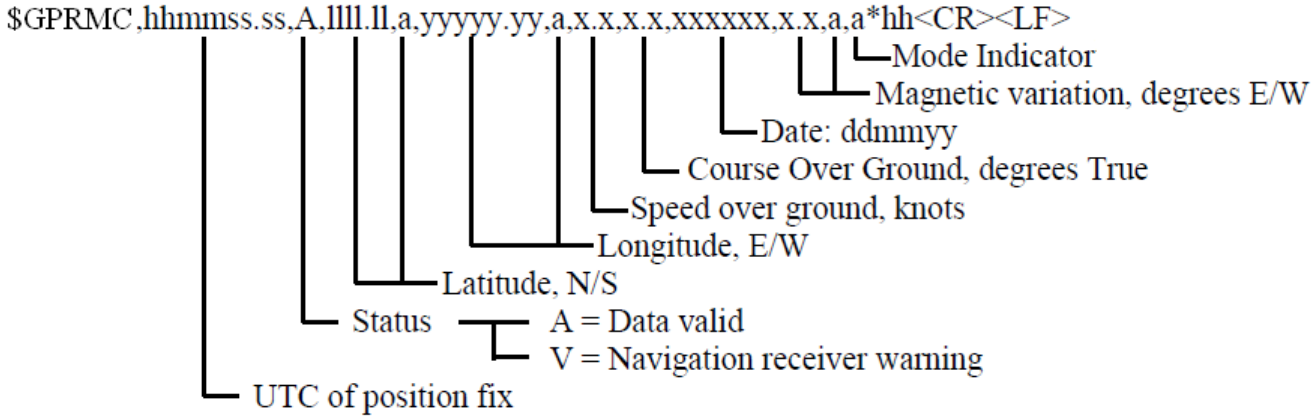
Each part of NMEA 0183 message represents certain parameter.

Below is description of all supported messages and parameter fields.

Messages format is taken from NMEA 0183 standard version 3.01, January 1, 2002.

1. $GPRMC -Recommended Minimum Specific GNSS Data

General format from NMEA 0183 standard:



Description of fields implementation:

1.1. '$GPRMC' – designation of message type

1.2. 'hhmmss.ss' – UTC position fix

According to general agreements, time is counted from default 2016.01.01 or synchronized with computer clock.

1.3. 'A' – status

'A' value is sent if last position update was successful

'V' value is sent if any error occurred in last position update

1.4. 'llll.llllll,a' – latitude, N/S

According to general agreements (see above), latitude corresponds to the Y coordinate relative to georeference location. Latitude is presented with 6 digits of decimal-fraction of minutes, which gives resolution not more than 2 mm,

1.5. 'yyyyy.yyyyyy,a' – longitude, E/W

According to general agreements (see above), longitude corresponds to the X coordinate relative to georeference location Longitude is presented with 6 digits of decimal-fraction of minutes, which gives resolution not more than 2 mm.

1.6. 'x.x' – speed over ground, knots

Marvelmind system measures the coordinates; the speed is calculated from dynamics of coordinates with applying of some filtering. Optionally, it can use IMU fusion for speed calculation.

1.7. 'xxxxxx' - date: ddmmyy

According to general agreements, time is counted from default 2016.01.01 or synchronized with computer clock.

1.8. 'x.x,a' - magnetic variation

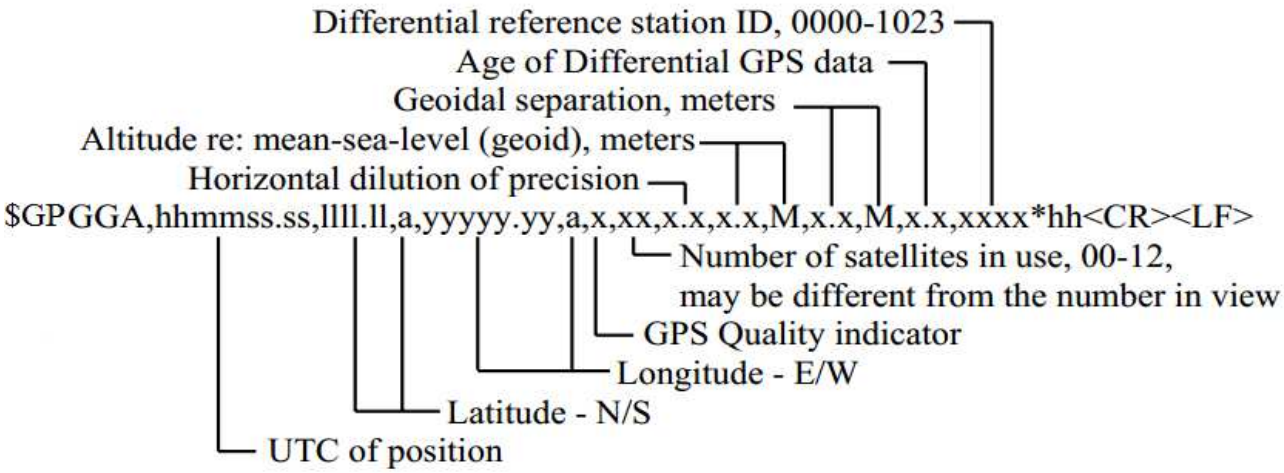
This parameter value is always a null field.

1.9. 'a' - mode indicator

‘A’ value (autonomous mode) is sent if last position update was successful
‘N’ value (data not valid) is sent if any error occurred in last position update

2. $GPGGA -Global Positioning System Fix Data

General format from NMEA 0183 standard:



Description of fields implementation:

2.1. '$GPGGA' – designation of message type

2.2. ‘hhmmss.ss’ – UTC position fix

According to general agreements, time is counted from default 2016.01.01 or synchronized with computer clock.

2.3. 'llll.llllll,a' – latitude, N/S

According to general agreements (see above), latitude corresponds to the Y coordinate relative to georeference location. Latitude is presented with 6 digits of decimal-fraction of minutes, which gives resolution not more than 2 mm

2.4. 'yyyyy.yyyyyy,a' – longitude, E/W

According to general agreements (see above), longitude corresponds to the X coordinate relative to georeference location. Longitude is presented with 6 digits of decimal-fraction of minutes, which gives resolution not more than 2 mm

2.5. 'x' – GPS quality indicator

‘1’ (GPS SPS Mode, fix valid) value is sent if last position update was successful
‘0’ (Fix not available or invalid) value is sent if any error occurred in last position update

2.6. 'xx' – number of satellites in use

Always '08' in current implementation.

2.7. 'x.x' – horizontal dilution of precision

Always '1.2' in current implementation.

2.8. 'x.x, M' – altitude re: mean-sea-level (geoid), meters

This corresponds to the Z coordinate according to general agreements.

2.9. 'x.x, M' – geoidal separation, meters

Always '0.0,M' value is transmitted.

2.10. 'x.x' – age of differential GPS data

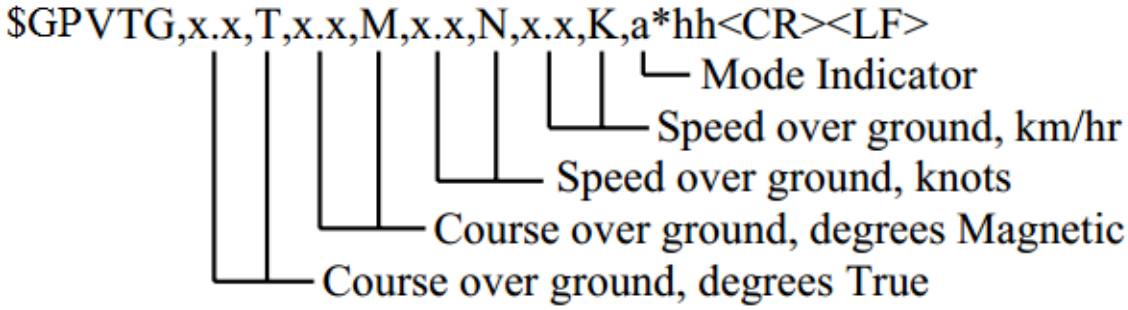
This parameter value is always a null field, DGPS is not used.

2.11. 'xxxx' – differential reference station ID

This parameter value is always a null field.

3. $GPVTG -Course Over Ground and Ground Speed

General format from NMEA 0183 standard:



Description of fields implementation:

3.1. '$GPVTG' – designation of message type

3.2 . 'x.x, T' – course over ground, degrees True

According to NMEA standard, the course is the angle between vector of speed and direction to the north. As shown in general agreements above, the Y axis is taken as direction to north.

3.3. 'x.x, M' – course over ground, degrees Magnetic

In current implementation, magnetic course is same as true course.

3.4. 'x.x, N' – speed over ground, knots

Marvelmind system measures the coordinates; the speed is calculated from dynamics of coordinates with applying of some filtering. Optionally, it can use IMU fusion for speed calculation.

3.5. 'x.x, K' – speed over ground, km/hr

It is the same speed in another units

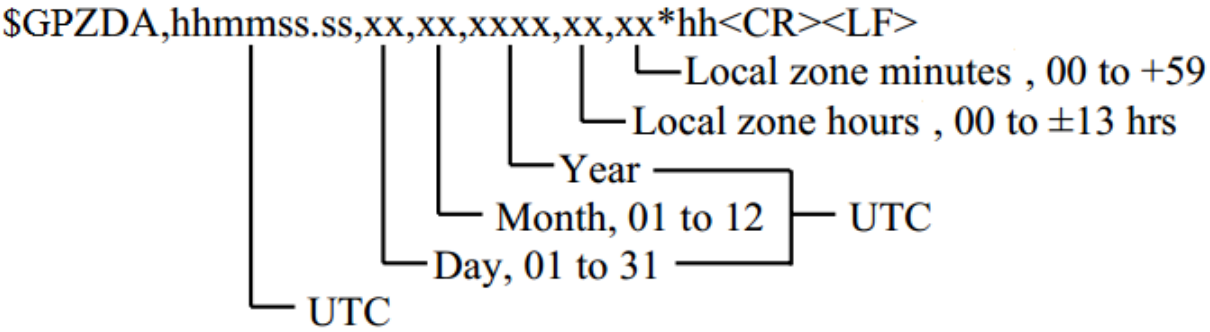
3.6. 'a' – mode indicator

'A' value (autonomous mode) is sent if last position update was successful

'N' value (data not valid) is sent if any error occurred in last position update

4. $GPZDA –Time & Date

General format from NMEA 0183 standard:



According to general agreements, time is counted from default 2016.01.01 or synchronized with computer clock.

Description of fields implementation:

4.1. '$GPZDA' – designation of message type

4.1. 'hhmmss.ss' – UTC

Time (hours, minutes, seconds).

4.2. ‘xx’ – day, 01 to 31
Day.
4.3. ‘xx’ – month, 01 to 12
Month.
4.4. ‘xxxx’ – year
Year.
4.4. ‘xx – local zone hours
Local zone is always “00” hours.
4.5. ‘xx – local zone minutes
Local zone is always “00” minutes.

Appendix 1. Examples of NMEA data receiving.

On the next screenshot is example of data, received from mobile beacon, connected via USB (virtual COM port) to the OpenCPN software, running on the computer under MS Windows.