# Protocol of data exchange with mobile beacon via USB and UART interfaces

Version 2015.11.18 Valid for firmware v4.07 and newer

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

- 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.
- 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, firmware versions V4.02+ support configurable from the Dashboard baudrate 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.



The hedgehog constantly streams out packets of data without any request.

Data is represented in binary format.

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



## **Packets format**

## 1. General packet format

All packets have same general structure:

Offset	Size (bytes)	Туре	Description	Value
0	1	uint8_t	Address (constant value now)	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	Ν
5	Ν	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.

Offset	Size (bytes)	Туре	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	0x0001
4	1	uint8_t	Number of bytes of data transmitting	0x10
5	4	uint32_t	Timestamp – internal time of beacon measured in alpha-cycle periods (1/64 sec) from the moment of the latest wakeup	
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 17 – reserved (0)	
16	5	5 bytes	Reserved (0)	
21	2	uint16_t	CRC-16 (see appendix)	

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

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

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Offset	Size (bytes)	Туре	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)	



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Offset	Size (bytes)	Туре	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)

Format of data structure for every of N beacons:



# Appendix1. 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;
}
```







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Packet packet header Vpe	11 04 12 00 00 address x: 0x00 Y: 0x00 Y: 0x00 Y: 0x00	00 00 69 00 00 2 : 0x12= 18 00 = 0 cm 00 = 0 cm 99 = 185 cm	<b>b</b> R8 00 00 00 89 00 0 address: 0x2b = 43 X: 0x00A8 = 168 cm Y: 0x000B = 0 cm, 2: 0x00b9 = 185 cm	4A C3 00 addres X: 0x00 Y: 0x00 2: 0x00	80 00 89 00 s: 0x4a= 74 IC3= 195 cm IBD= 185 cm IBD= 185 cm	0 00 4	E E2 FF 36 0 address: 0x X: 0xFFE2= Y: 0x008 Z: 0x0089 =	89 00 00 He= 78 30 cm 54 cm 185 cm	BE E1 FI Uncorr	F 47 01	00 10 58 00 10 69 00 10 78 00 10 88 00 10 80	74 00 0 74 00 0	0 00 00 00 00 00 00 00 00 00 00 00 00 0	321         00         321         (1)           09         00         1E         (1)           08         00         1E         (1)           19         00         1E         (1)           19         00         1E         (1)           24         00         21         (1)           24         00         21         (1)           25         00         21         (1)           23         00         21         (1)           23         00         21         (1)           23         00         21         (1)           25         00         21         (1)	00 00 00 00 00 00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00 00 00 00 00 00 0	50         30         EFF         4           9E         31         EFF         4         4           9E         31         EFF         4         4         5         4           76         26         EFF         FFF         4         4         5         9         FFF         4         4         16         59         FFF         4         16	17         01         00         10         55           17         01         00         10         61           17         01         00         10         80           17         01         00         10         81           17         01         00         10         81           17         01         00         10         91           17         01         00         10         83           17         01         00         10         82           17         01         00         10         82           17         01         00         10         82           17         01         00         10         84           17         01         00         10         10           17         01         00         10         10           17         01         00         10         08           17         01         00         10         10           17         01         00         10         10           17         01         00         10         10
Packet packet packet of the adder type a constraint of the add	11 04 12 00 00 address x: 0x00 x: 0x00 y: 0x00 y y: 0x00 y: 0x00 y: 0x00 y: 0x00 y: 0x00 y: 0x	00 00 69 00 00 2 : 0x12= 18 00 = 0 cm 00 = 0 cm 99 = 185 cm	address; 0x2b = 43 X: 0x00A8 = 166 cm Y: 0x00A9 = 0 cm Z: 0x00b9 = 105 cm	4A C3 00 addres X: 0x00 Y: 0x00 Z: 0x00	80 00 89 00 s: 0x4a= 74 1C3= 195 cm 18D = 189 cm 189 = 185 cm	0 00 4	E E2 FF 36 0 address: 0x X: 0xFFE2= Y: 0x0036= 2: 0x0089 =	e= 78 30 cm 54 cm 185 cm	BE E1 91-919	F 47 01	000 10 56 000 10 56 000 10 69 000 10 78 000 10 88 000 10 88 000 10 88 000 10 88 000 10 88 000 10 88 000 10 10 88 000 10 10 10 000 10 10 24 000 10 24	74 00 0 74 00 0	0 80 00 0 99 00 0 99 00 0 98 00 0 98 00 0 80 00 0 81 00 0 80 00000000	321         70         321         (1)           009         000         110         (1)         (1)           019         000         110         (1)         (1)         (1)           119         000         110         (1)         (1)         (1)         (1)           24         000         21         (1)         (2)         (1)         (1)         (1)           24         000         21         (1)         (2)         (2)         (1)         (1)           25         000         21         (1)         (2)         (2)         (1)         (2)           23         000         21         (1)         (2)         (2)         (1)         (2)           23         000         21         (1)         (2)         (2)         (1)         (2)           23         000         21         (1)         (2)	00 00 00 00 0 00 00 00 0 00 00 00 0 00 00	20 00 21 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	80 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	17         01         00         10         55:           17         01         00         10         87           17         01         00         10         80           17         01         00         10         81           17         01         00         10         91           17         01         00         10         92           17         01         00         10         83           17         01         00         10         83           17         01         00         10         83           17         01         00         10         83           17         01         00         10         10           17         01         00         10         10           17         01         00         10         10           17         01         00         10         10           17         01         00         10         10           17         01         00         10         10           17         01         00         10         10 <td< th=""></td<>
acket packet Packet 0002	1 04 12 00 00 address successed to address successed to address address successed to address successed to address	00 00 69 00 00 2 : 0x12= 18 00 = 0 cm 00 = 0 cm 69 = 185 cm	address; 0x2b = 43 X: 0x0048 = 168 cm 2; 0x0049 = 168 cm 2; 0x0049 = 165 cm	4A C3 00 addres X: 0x00 Y: 0x00 Z: 0x00	BO 00 B9 00 S: 0x4a= 74 JC3= 195 cm IBD= 189 cm IBD= 185 cm beacon	0 00 4	E E2 FF 36 00 address: 0x X: 0xFFE2= Y: 0x0036= Z: 0x0089 =	e= 78 30 cm 54 cm 185 cm	Checksum CRC-16 CRC-16	F 47 01	00         10         58           00         10         69           00         10         69           00         10         78           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00    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       23         00         21         0           23         00         21         0           23         00         21         0</th> <th>900 00 00 00 00 00 00 00 00 00 00 00 00</th> <th>20 00 20 00 00 00 00 00 00 00 00 00 00 0</th> <th>80         FFF         4           80         FFF         4           81         FFF         4           82         FFF         4           83         FFF         4           84         FFF         4           85         FFF         4           86         FFF         4           87         FFF         4           80         FFF         4           81         FFF         4           82         FFF         4           83         FFF         4</th> <th>47         01         00         10         52           47         01         00         10         80           47         01         00         10         91           47         01         00         10         91           47         01         00         10         92           47         01         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acket packet on a constraint of the sector o	1 04 12 00 00 address x: 0x00 y: 0x00 y: 0x00 y: 0x00 y: 0x00 u: 1-st b	00 00 09 00 00 2 : 0x12= 18 00 = 0 cm 00 = 0 cm 00 = 0 cm 00 = 185 cm eacon	E ## 00 00 00 E9 00 00 endfesser: (0/20 = 413 X: 000008 = 168 cm Y: 001000 = 0 cm Y: 001000 = 105 cm	4A C3 00 addres X: 0x00 Y: 0x00 Z: 0x00 3-rd	BO 00 B9 00 s: 0x4a= 74 IC3= 195 cm IBD= 189 cm IBD= 185 cm IBD= 185 cm		E E2 FF 36 0 address: 0x X: 0xFF2= Y: 0x0036= 2: 0x0089 =	189 00 00	BE EI 01-020	F 47 01	00         10         58           00         10         69           00         10         69           00         10         78           00         10         88           00         10         88           00         10         86           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         88           00         10         10           00         10         13           00         10         10           00         10         10           00         10         10           00         10         10           00         10         10	74 00 0 74 00 0 75 00 0 75 00 0 75 00 0 75 00 0	1         0         00         00         00         0         99         00         0         99         00         0         99         00         0         99         00         0         99         00         0         90         0	21 00 21 ( 09 00 1E ( 09 00 1E ( 19 00 1F ( 24 00 21 ( 24 00 21 ( 24 00 21 ( 23 00	200 00 00 00 00 00 00 00 00 00 00 00 00	70 00 01 00 00 00 00 00 00 00 00 00 00 00 00 00	80         FFFF         FFF           80         FFFF         FFF         FFF           80         FFFF         FFF         FFF         FFF           80         FFFF         FFF         FFF         FFF         FFF           80         FFFF         FFF         FFF	47         51         50         10         52           47         51         00         10         53           47         01         00         10         91           47         01         00         10         91           47         01         00         10         91           47         01         00         10         91           47         01         00         10         83           47         01         00         10         83           47         01         00         10         84           47         01         00         10         84           47         01         00         10         10           47         01         00         10         10           47         01         00         10         10           47         01         00         10         10           47         01         00         10         10           47         01         00         10         10           47         01         00         10         10

