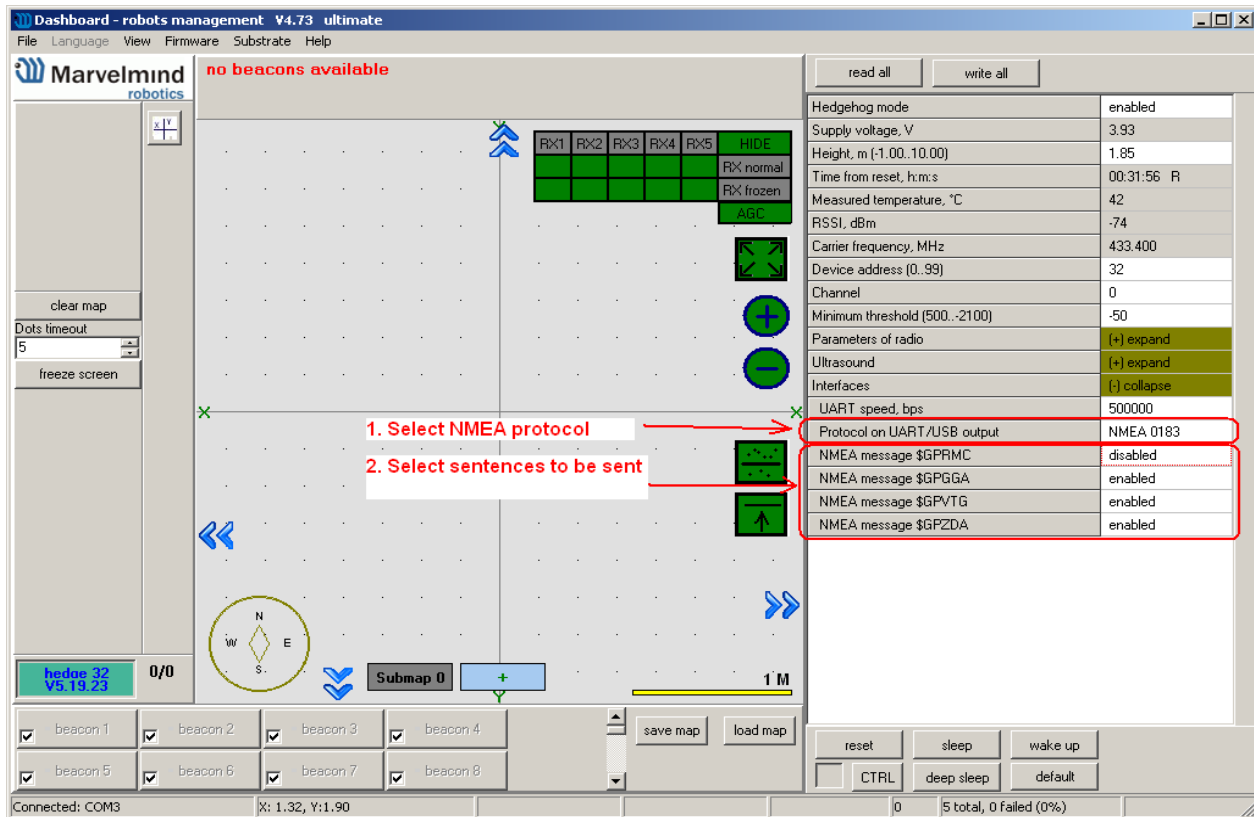


NMEA0183 and PPS implementation in Marvelmind mobile beacon

Version 2016.09.01

Valid for beacon firmware v5.19 and newer

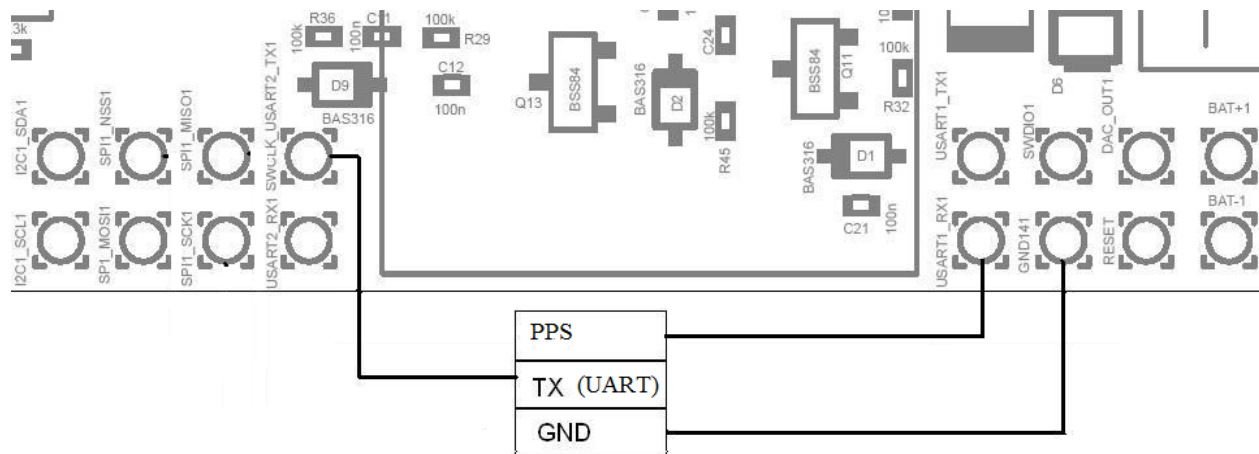
Mobile beacon can output some of the NMEA0183 sentences via UART and USB (virtual UART) interfaces. NMEA protocol should be enabled in the device with dashboard as shown on following screenshot:



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)
 - a. In the Windows, it requires driver - the same driver as for modem
 - b. In Linux, the driver is not required, since the required driver is integrated into Linux kernel
 - c. 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.



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) have GPS coordinates: 0 °0.54' North, 0 °0.54' West;
- 1000 meters for X and Y axis means 0.54'.

According to these agreements, following coordinates translations are executed:

Latitude (minutes) = $(Y \text{ (meters)} + 1000) * 0.54 / 1000$

Longitude (minutes) = $(-X \text{ (meters)} + 1000) * 0.54 / 1000$

General agreements for time

Because devices have no real time clock, date and time are not corresponding to UTC. After every reset or wake-up, the device starts counting time from 2016.08.01 00:00:00.

Description of “NMEA0183” messages implementation

NMEA 0183 messages are ASCII coded text frames, consisting 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.

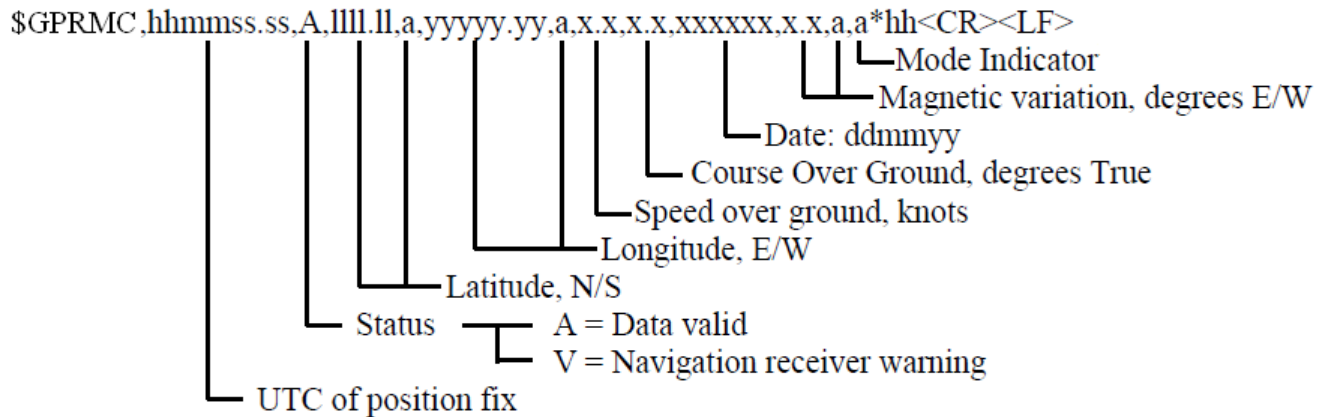
Each part of NMEA 0183 message represents certain parameter.

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

Because device has no real time clock, the time is not corresponds to UTC. Field value "000000.00" (midnight) means time of turning on (or waking up) of the device. So the field value is time from turning on the device.

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.ll,a' – latitude, N/S

According to general agreements (see above), latitude corresponds to the Y coordinate. It is always north latitude, because Y=0 is far shifted to north.

1.5. 'yyyy.yy,a' – longitude, E/W

According to general agreements (see above), longitude corresponds to the X coordinate. It is always west longitude, because X=0 is far shifted to west.

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

1.7. 'xxxxxx' - date: ddmmyy

Because device has no real time clock, the date is not corresponds to UTC. After every reset or waking up, the date starts from "010816"

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

This parameter value is always a null field

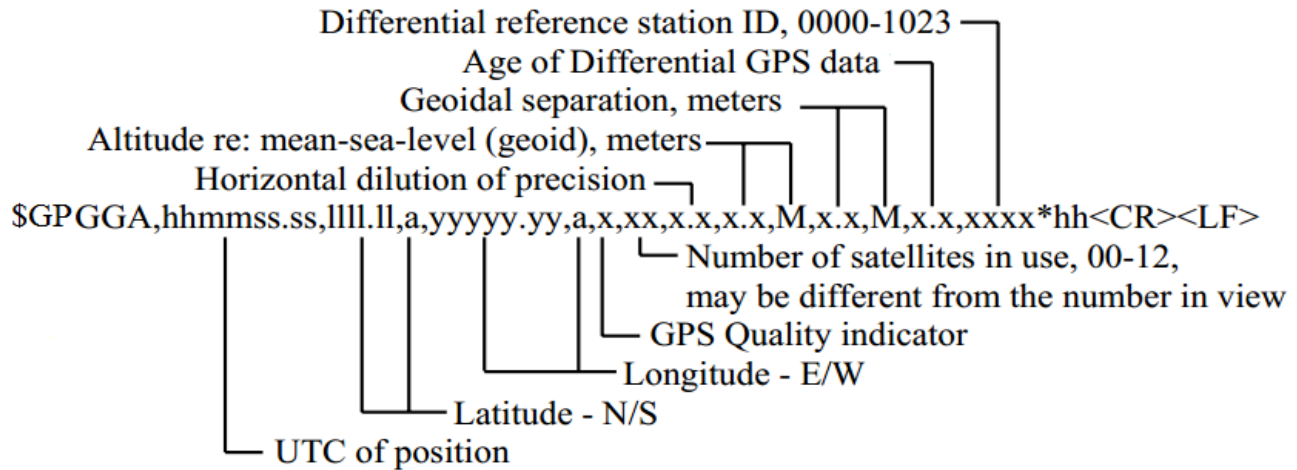
1.9. 'a' - mode indicator

'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

Because device has no real time clock, the time is not corresponds to UTC. Field value "000000.00" (midnight) means time of turning on (or waking up) of the device. So the field value is time from turning on the device

2.3. 'llll.ll,a' – latitude, N/S

According to general agreements (see above), latitude corresponds to the Y coordinate. It is always north latitude, because Y=0 is far shifted to north

2.4. 'yyyy.yy,a' – longitude, E/W

According to general agreements (see above), longitude corresponds to the X coordinate. It is always west longitude, because X=0 is far shifted to west

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 '04' 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

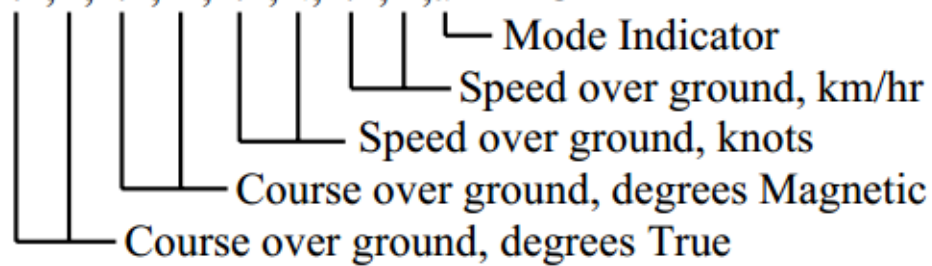
2.11. 'xxxx' – differential reference station ID

This parameter value is always a null field

3. \$GPVTG -Course Over Ground and Ground Speed

General format from NMEA 0183 standard:

`$GPVTG,x.x,T,x.x,M,x.x,N,x.x,K,a*hh<CR><LF>`



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

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

It is the same speed in other units

3.6. 'a' – mode indicator

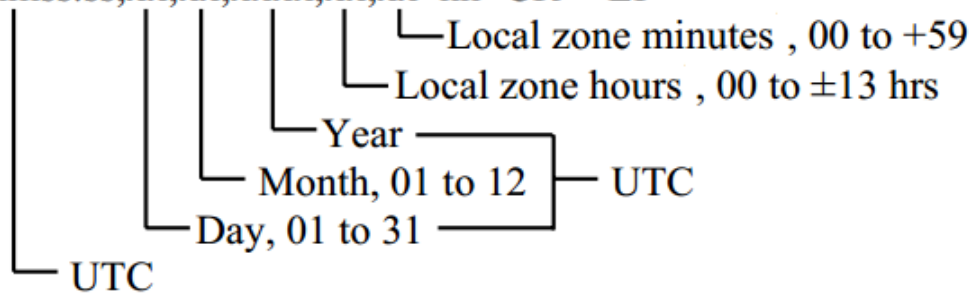
'A' value (autonomous mode) is sent if last position update was successful

'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:

`$GPZDA,hhmmss.ss,xx,xx,xxxx,xx,xx*hh<CR><LF>`



Because device has no real time clock, the date is not corresponds to UTC. After every reset or waking up, the date & time starts from “2016.08.01, 00:00”.

Description of fields implementation:

4.1. '\$GPZDA' – designation of message type

4.1. 'hhmmss.ss' – UTC

Time starts from “000000.00” after turning on or waking up

4.2. 'xx' – day, 01 to 31

Day starts from “01” after turning on or waking up

4.3. 'xx' – month, 01 to 12

Month starts from “08” after turning on or waking up

4.4. 'xxxx' – year

Year starts from “2016” after turning on or waking up

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

