LORAWAN TRACKING DEVICE

VEGA LM-1

User manual

LM-1 tracking device operates with LoRaWAN technology and has accelerometer which can trigger by start moving. Also, device can determinate itself coordinates by satellites.

There are two options for the device:

- with 6400 mAh battery;
- with 12800 mAh battery.

Document Information

Title	LoRaWAN tracking device Vega LM-1
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This document applies to the following products:

Product name	Type number
End devices	Vega LM-1

Revision History

Revision	Date	Name	Comments
01	01.06.2018	KEV	Document creation date
02	12.11.2018	KEV	Minor changes
03	24.12.2018	KEV	"Marking" part added, device AppEui added in specification, setting "by the air" description, communication protocol changed
04	03.04.2019	KEV	Minor changes
05	15.04.2019	KEV	Warranty changed, minor changes

CONTENTS

INTRODUCTION

This manual is designated for Vega LM-1 tracking device (hereinafter – the device) manufactured by Vega-Absolute LLC and provides information on powering and activation procedure, control commands and functions of the device.

This manual is targeted at specialists familiar with installation work fundamentals of electronic and electrical equipment.

The device shall be installed and adjusted by qualified specialists in order to ensure proper operation of the device

1 DESCRIPTION AND OPERATION

DEVICE DESCRIPTION 5

Vega LM-1 tracking is designed to determine the height above sea level, an angle of deviation from the vertical, moving beginning, and the coordinates by GLONASS/GPS satellites with the accumulating and transferring that data to the LoRaWAN network.

Tracking device can used for security and search of any objects inside the local territory with LoRaWAN network.

The device is powered by a 6400 mAh built-in battery or also available with two batteries with a total capacity of 12 800 mAh.

Set up the device via the "Vega LoRaWAN Configurator" application.

FUNCTIONAL

Vega LM-1 tracking device is A class device (LoRaWAN classification) and has the following features:

- o ADR support (Adaptive Data Rate)
- o Sending of confirmed packets (configurable)
- o Two operating submodes: "Static" and "Movement"
- o Time referencing of coordinates determination by internal clock
- o Communication in case of accelerometer actuation
- o Temperature measurement
- o Charge measuring of the built-in battery (%)

MARKING

Device marked with sticker that contain the next information:

- o Device model;
- o DevEUI;
- o Month and year of manufacture;
- o QR-code containing DevEUI for automatized count.

Sticker located in three places – on device case, in factory certificate and on the packing box.

Besides, there is an additional sticker located on the packing box and contains:

- o Information about firmware version;
- o QR-code containing DevEUI and keys for device registration in network via OTAA method.

2 SPECIFICATION

| Main	
Built-in GPS-antenna	yes
Built-in accelerometer	yes
USB-port	micro-USB, type B
Operating temperatures	-40...+70 °C
Internal temperature sensor	yes
Accuracy of angle of deviation from the vertical measurement	±1 º
LoRaWAN	
AppEui by default	76656761204C4D31
LoRaWAN class	A
Quantity of LoRaWAN channels	16
Frequency plan	RU868, EU868, IN865, AS923, AU915, KR920, US915, KZ865, custom (EU868 based)
Activation type	ABP or OTAA
Communication period	5, 15, 30 minutes, 1, 6, 12 or 24 hours
Data collection period	1, 5, 15, 30 minutes, 1, 6, 12 or 24
Memory amount for storing packets	240 packets
Type of the LoRaWAN antenna	internal
Sensitivity	-138 dBm
Radio coverage in restrained urban conditions	up to 5 km
Radio coverage within line of sight	up to 15 km
Transmitter power by default	25 mW (configurable)
Maximum transmitter power	100 mW
Power	
Built-in battery	6400 mAh or 12800 mAh
Warranty number of packets sent by the device, not less	10 000 or 20 000
Case	
Housing dimensions (without cable gland and SMA-connector)	90 x 75 x 40 mm
Ingress protection rating	IP67
Mounting	on magnets

3 OPERATION

INDICATION

There is one red LED on the board. The indication is only used when the device is activated in the LoRaWAN network.

LED on the board
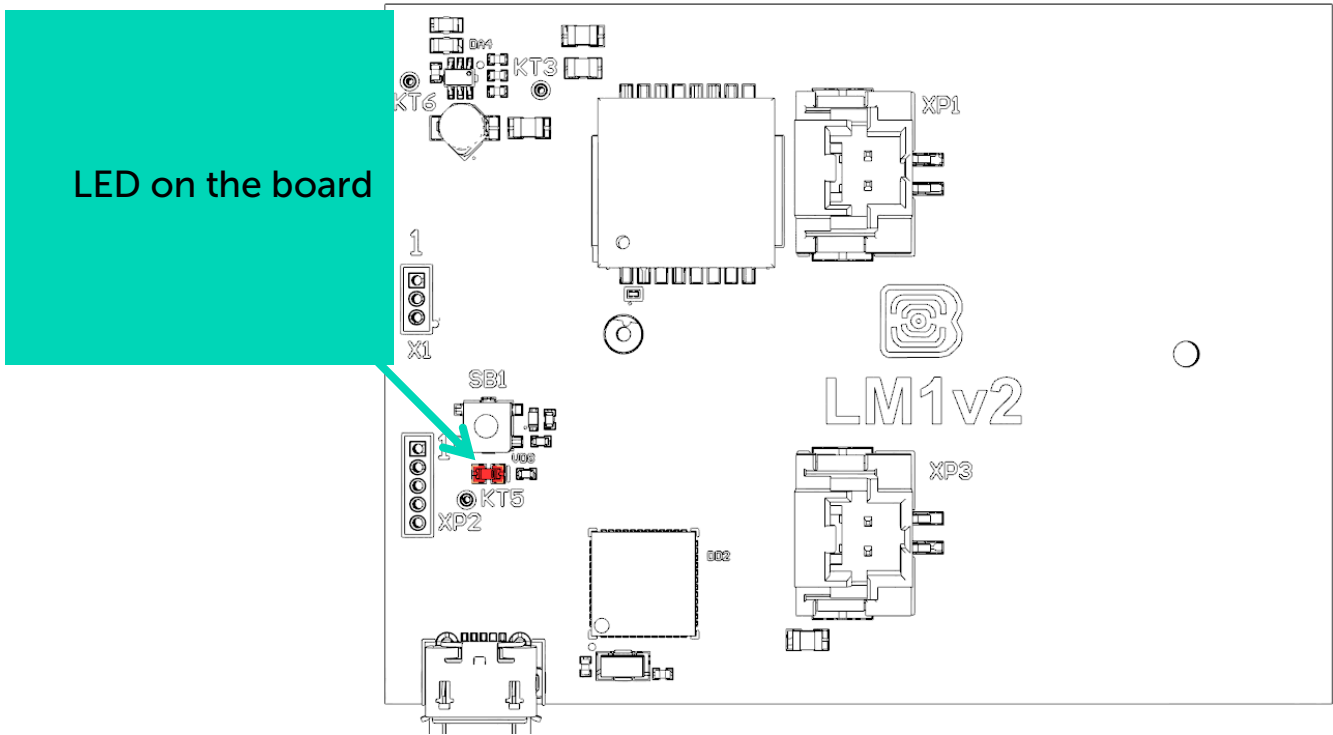
LED signal		Meaning
●●●	Series of short flashings	Linking to the network
▬▬▬▬	One long flashing	The device connected to the network and is in active mode
▬▬ ▬▬ ▬▬	Three long flashings	Linking to the network is unsuccessful or the device switched to the «Storage» mode

> In case of connection attempt fail, the device will continue to accumulate data and will attempt to connect to the network every 6 hours

INITIAL STARTUP

Vega LM-1 tracking device is operating with the built-in battery, which you must connect to the power connector on the board before starting. The Vega LM-1 6400 mAh has a one battery which may be connected to any of two power connectors on the board. For the Vega LM-1 12800 mAh you should to connect two batteries to the both connectors.


Power connectors on the board
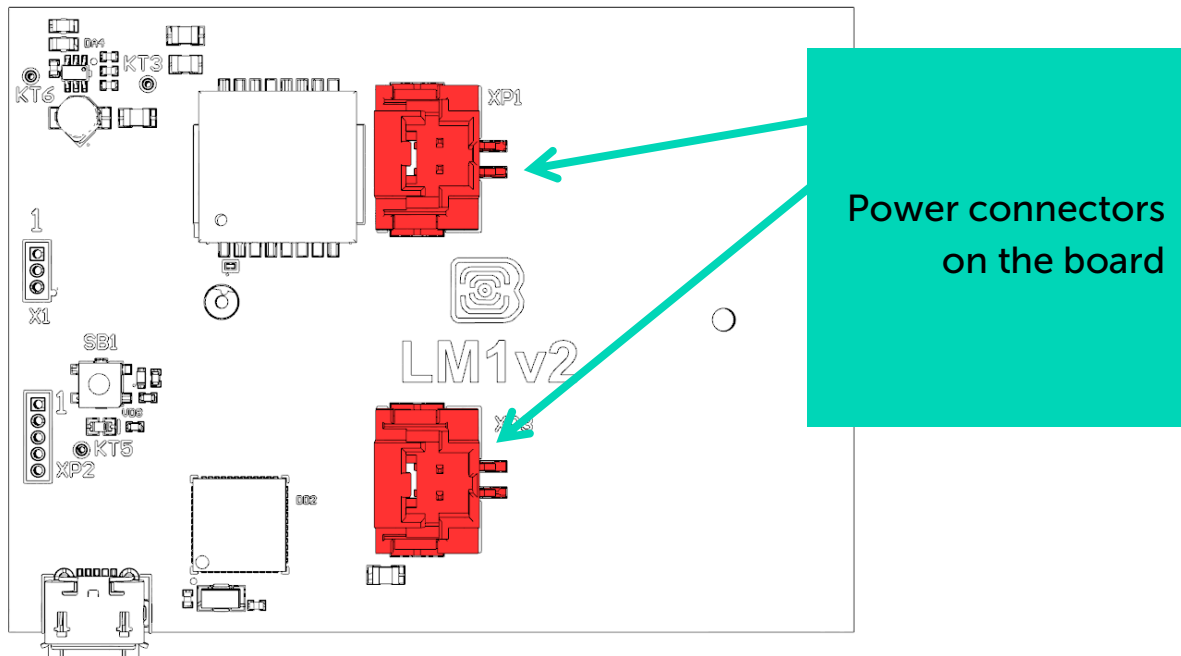
Vega LM-1 supports two activation methods in the LoRaWAN network - ABP and OTAA. Select one of the methods using the «Vega LoRaWAN Configurator» application (see part 4).

1. ABP. After pressing the start button, the device immediately starts working in the "Active" mode.

2. OTAA. After pressing the start button, the device makes three attempts to connect to the network within the set frequency plan. After the activation in the LoRaWAN network is confirmed, the device sends a signal (LED flashing for 3 seconds) and switches to the "Active" mode. If all attempts fail, the device will continue to accumulate data and will attempt to connect to the network every 6 hours.

Hold the start button pressed (min. 5 seconds) to switch the device from the "Active" mode back to the "Storage" mode.

Push start button on the board
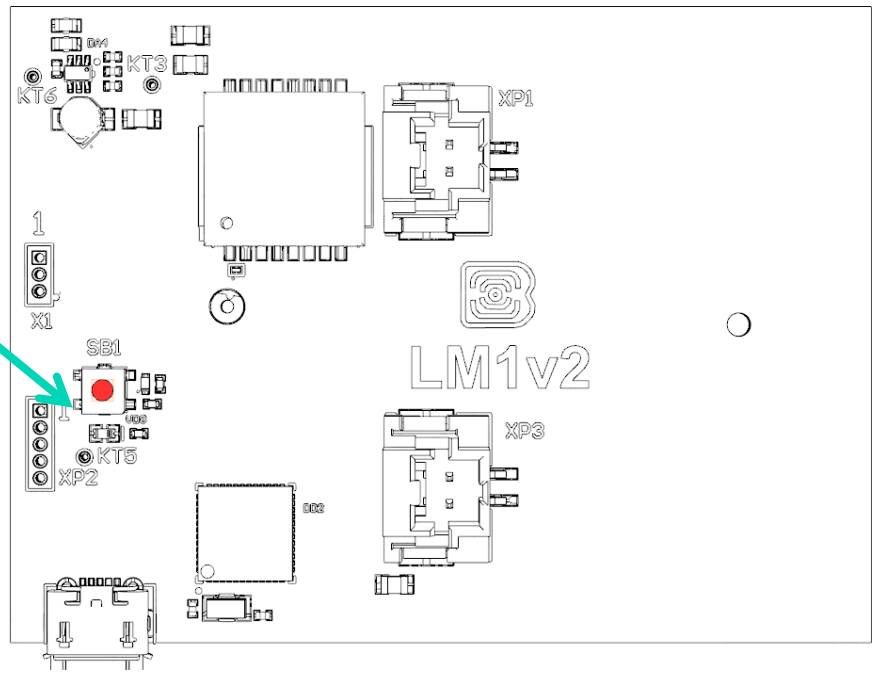
SUBMODES DESCRIPTION

Tracking device Vega LM-1 has two operating submodes – a "Static" and a "Movement".

Switching between the submodes is carried out automatically by the built-in accelerometer signals. The device switch from the "Static" submode to the "Movement" at the moment when the accelerometer fixes the movement. Switching from the "Movement" submode to the "Static" is after two minutes without moving.

For every submode the communication and data collection periods set up separately in "Vega LoRaWAN Configurator" application (see part 4).

Also, there is an ability to set the alarm message sending when the device switch from the "Static" submode to the "Movement".

CONNECTING VIA USB

The tracking device can be adjusted with the "Vega LoRaWAN Configurator" application (See part 4).

USB port on the board
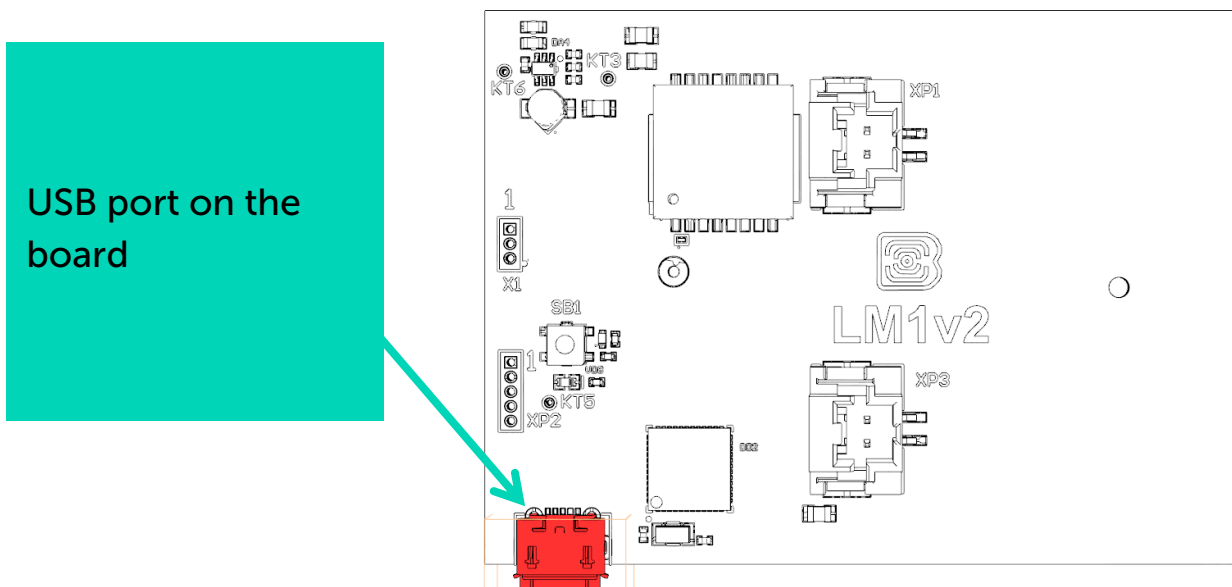
Before connecting the device to the computer for the first time, you must install the driver for the COM port **stsw-stm32102**, which can be download from iotvega.com. After running the executable file **VCP_V1.4.0_Setup.exe**, the installer window will appear:
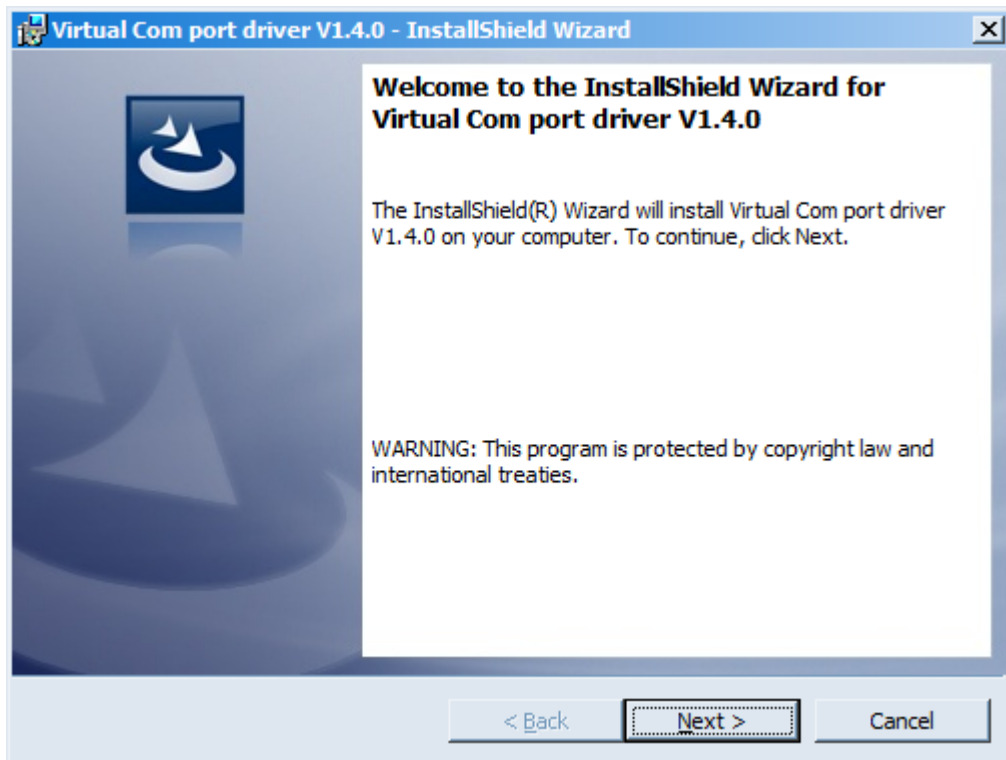
In this window, you need to click **Next**, then **Install**, and then the installation will begin. When the installation complete successfully, the following screen appears:
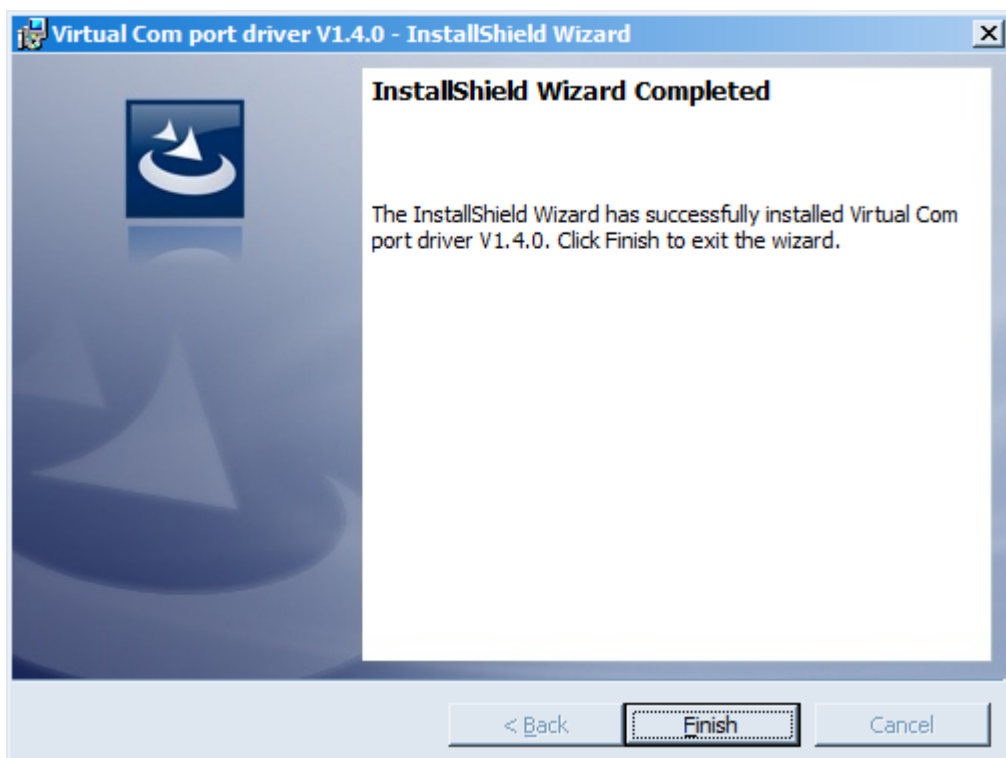
After pressing **Finish** the driver is ready for operation, - it is possible to connect the tracking device via USB.

4 VEGA LORAWAN CONFIGURATOR

The "Vega LoRaWAN Configurator" application (hereinafter referred to as the configurator) is intended for setting up the device via USB.

The configurator has two modes of operation - "Simple" and "Expert". In the "Simple" mode, only basic settings are available. In the "Expert" mode, the basic settings, advanced settings and the ability to check the coverage area of the signal from the gateways are available. Next, the work of the application considering in the "Expert" mode.

INTERFACE OF THE APPLICATION

The "Vega LoRaWAN Configurator" application does not require the special installation. When the executable file launching, the window for working with the application appears.
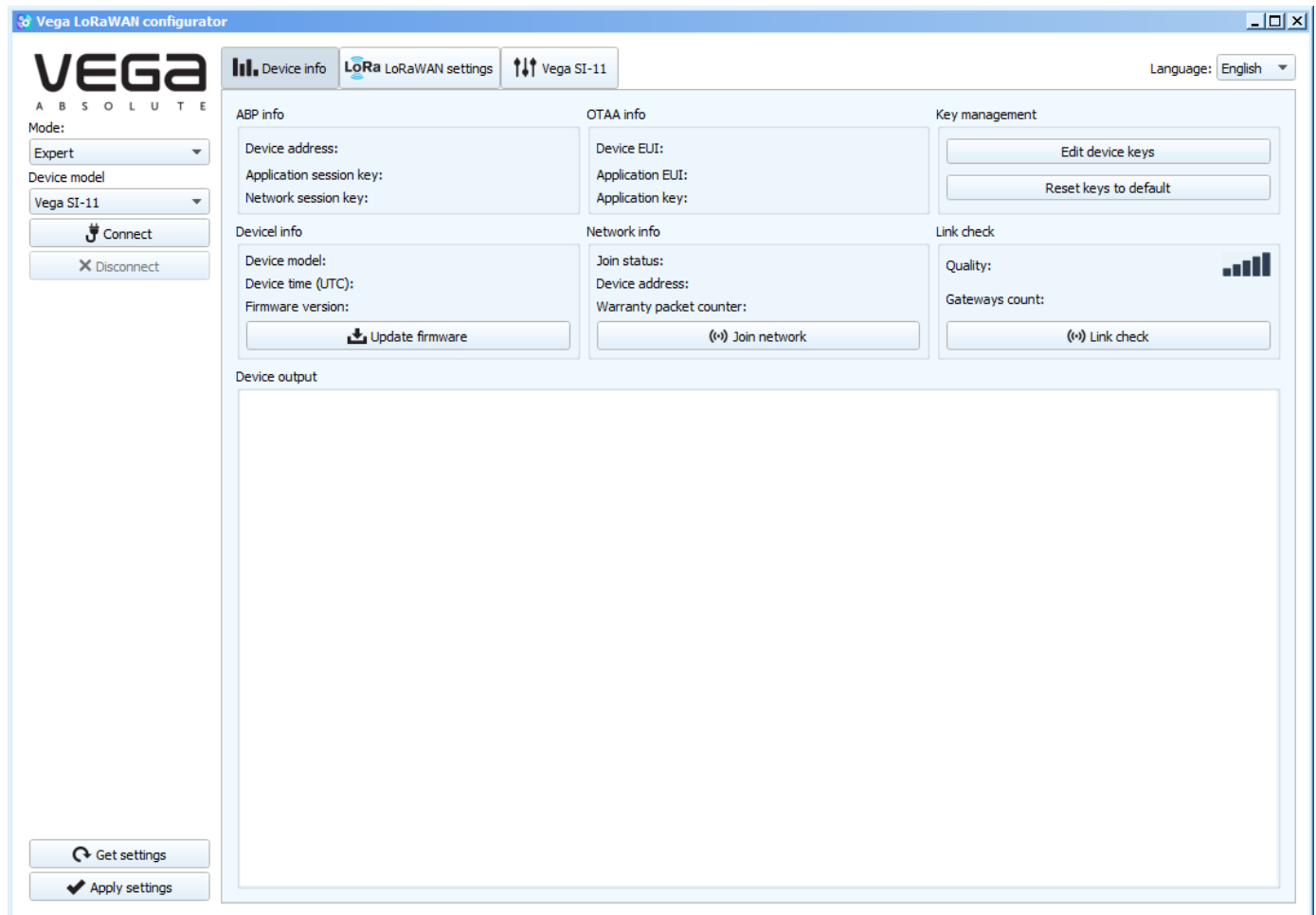
The menu on the left allows you to switch between the "Simple" and "Expert" modes, select the device model, connect to the device or disconnect from it, get and apply settings.

The application window contains three tabs – Device info, LoRaWAN settings and device settings.

The language selection menu is in the upper right corner.

CONNECTION TO THE DEVICE

For the connection to the device, perform the following steps:

1. Connect the USB cable to the device.
2. Start the "Vega LoRaWAN Configurator" application.
3. Click the "Connect" button in the menu on the left.

The application automatically recognizes the type of device, and the device selection menu becomes inactive.
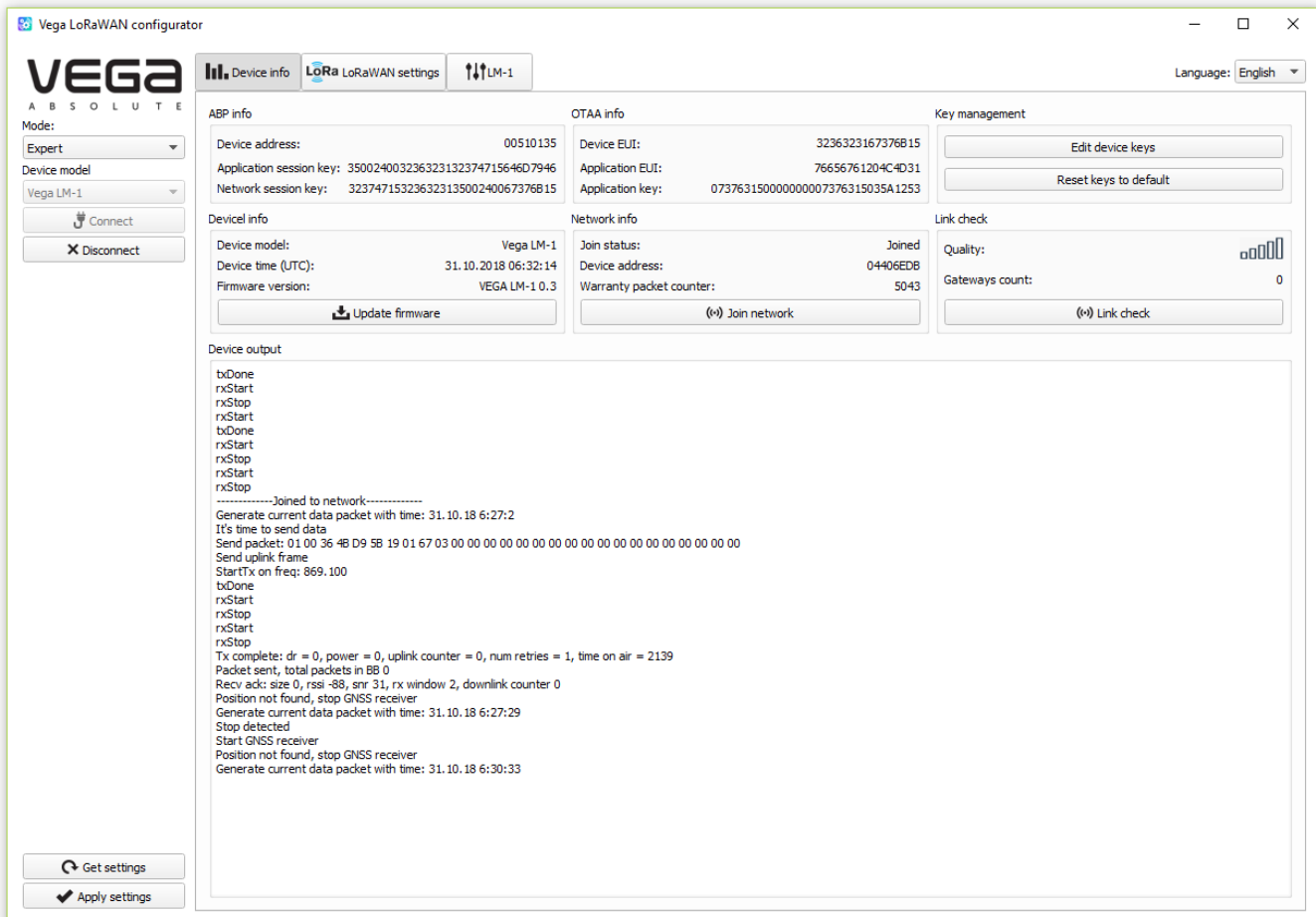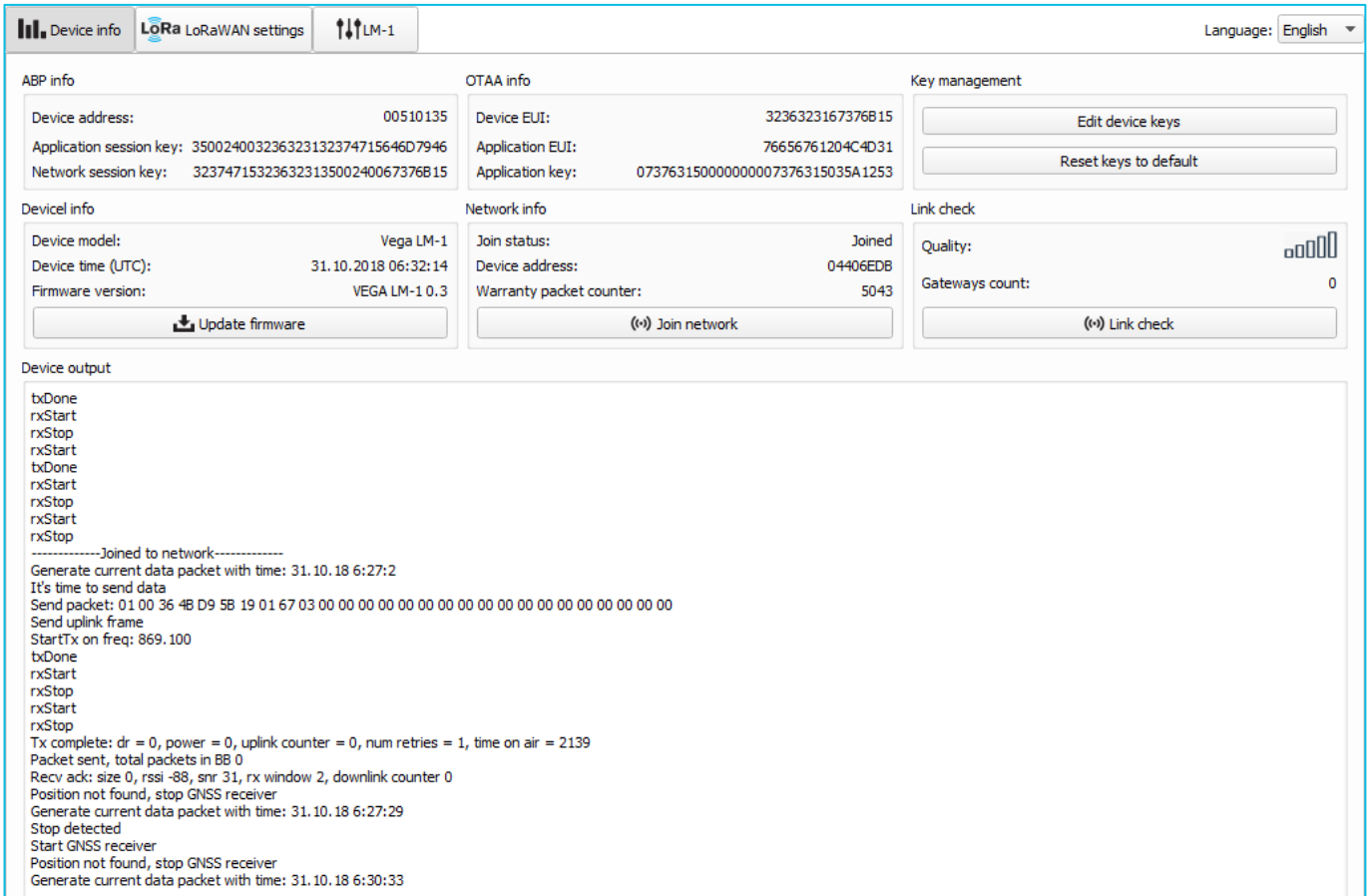

To read the settings from the device, you need to click the "Get settings" button, until this point the application will display the default settings or from the last connected device.

After making the necessary changes to the settings, you should click the "Apply settings" button and only then disconnect from the device with the "Disconnect" button.

"DEVICE INFO" TAB

The "Device info" tab displays information about the device, its current status, and the data needed to register the device in the LoRaWAN network.

ABP info – displays the data necessary to register the device in the LoRaWAN network with ABP method (Activation By Personalization).

OTAA info – the data required to register the device in the LoRaWAN network with OTAA method (Over The Air Activation) is displayed.

Key management (not displayed in the "Simple" mode) – allows you to change the factory keys to register the device on the network, and reset the keys back to the factory settings.

Device info – the configurator reads information about the device model, its firmware and automatically corrects the device's time when connected to it.

Update firmware – allows you to select the firmware file from your computer's hard drive and load it into the device. The device will automatically disconnect from the configurator when the download is complete. The current version of the device firmware can be download from iotvega.com.

Network info – shows whether the device is connected to the LoRaWAN network and its network address.

Join network button - launch the LoRaWAN network connection procedure with the previously selected ABP or OTAA method. If the device is already connected to the network, reconnection procedure will occurs.
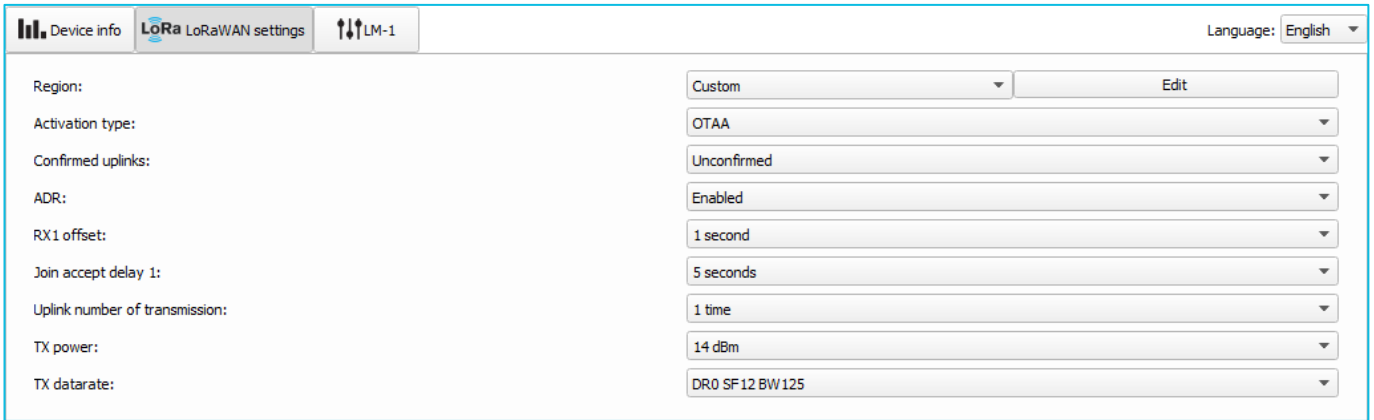
Link check (not displayed in the "Simple" mode) - when pressed, the device sends a special signal to the LoRaWAN network, in response to which the network informs it of the number of gateways that received this signal and the signal quality. This button only works when the device is connected to the network.
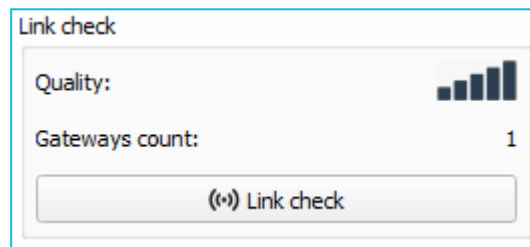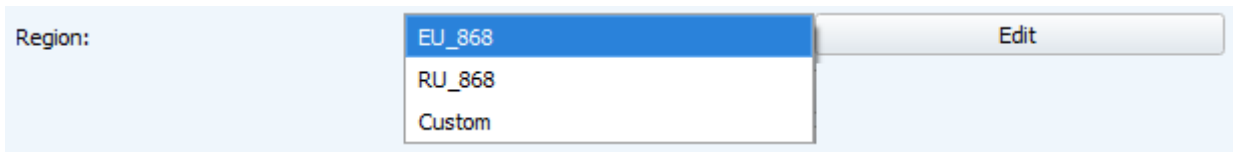

Device output (not displayed in the "Simple" mode) - monitoring the device status, all events in real time are displayed.

"LORAWAN SETTINGS" TAB

The "LoRaWAN Settings" tab allows you to configure various parameters of the LoRa network.

Region - allows you to select one of installed frequency plans or specify a custom frequency plan. Custom frequency plan is EU-868 based.

Tracking device supports the next frequency plans:

Frequency plan[1]	Channel	Frequency	Modulation
EU-868	1	868.1	MultiSF 125 kHz
	2	868.3	MultiSF 125 kHz
	3	868.5	MultiSF 125 kHz
	RX2	869.525	SF12 125 kHz
RU-868	1	868.9	MultiSF 125 kHz
	2	869.1	MultiSF 125 kHz
	RX2	869.1	SF12 125 kHz
Custom		Set up in application	

In the device frequency plan, only those channels are active by default, on which sending requests for connection to the network (join channels). The remaining channels (that the device should use) can be transferring by the LoRaWAN network server during the device activation procedure (only OTAA).

If you select "Custom" in the "Region" field, you must manually specify the frequencies that the device will use. To do this, click the "Edit" button, the channel frequency editing window will appear:

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[1] By default, the device supports only two frequency plans and a custom, however it is able to order the firmware for other frequency plans as: IN865, AS923, AU915, KR920, US915, KZ865

This frequency plan allows you to set up to 16 channels, as well as the frequency and speed of the second receiving window.

> **The first three channels and the second receiving window parameters are mandatory. Without these parameters the custom frequency plan will be considered empty**

Activation type – displays ABP or OTAA device activation method.

Confirmed uplinks – when you choose "confirmed", the device will retry sending the packet until it receives the server confirmation, or until the "Uplink number of transmission" is over (see below).

> **If you choose to send a packet without confirmation, the modem will not know whether the packet is delivered or not**

ADR – this option activates the Adaptive Data Rate algorithm for automatic control of the data transfer rate from the LoRaWAN network server side. The higher the quality of the signal received by the network, the higher the speed will be installed on the device. This option is recommended only on permanently installed devices.

| ADR: | Enabled |
| | Disabled |

RX1 offset (not displayed in the "Simple" mode) – specifies the time between end of packet transmission and first receiving window opening. The second receiving window always opens after 1 second after the first.

RX1 offset:	1 second
	2 seconds
	3 seconds
	4 seconds
	5 seconds
	6 seconds
	7 seconds
	8 seconds
	9 seconds
	10 seconds
	11 seconds
	12 seconds
	13 seconds
	14 seconds
	15 seconds

Join accept delay 1 (not displayed in the "Simple" mode) – sets the time that the device will open the first receiving window to receive confirmation for the join request from the LoRaWAN network while OTAA mode active. The second window always opens after 1 second after the first.

Join accept delay 1:	1 second
	2 seconds
	3 seconds
	4 seconds
	5 seconds
	6 seconds
	7 seconds
	8 seconds
	9 seconds
	10 seconds
	11 seconds
	12 seconds
	13 seconds
	14 seconds
	15 seconds

Uplink number of transmission (not displayed in the "Simple" mode) – if the "Confirmed uplinks" function is disabled, the device will simply send each packet as many times as specified in this option. If "Confirmed uplinks" is enabled, the device will send packets until it receives a confirmation or until it sends as many packets as specified in this option.

Uplink number of transmission:	1 time
	2 times
	3 times
	4 times
	5 times
	6 times
	7 times
	8 times
	9 times
	10 times
	11 times
	12 times
	13 times
	14 times
	15 times

TX power (not displayed in the "Simple" mode) – the device RF transmitter power is adjusted to this value when sending packets to the LoRaWAN network. This option can be changed by the network server.

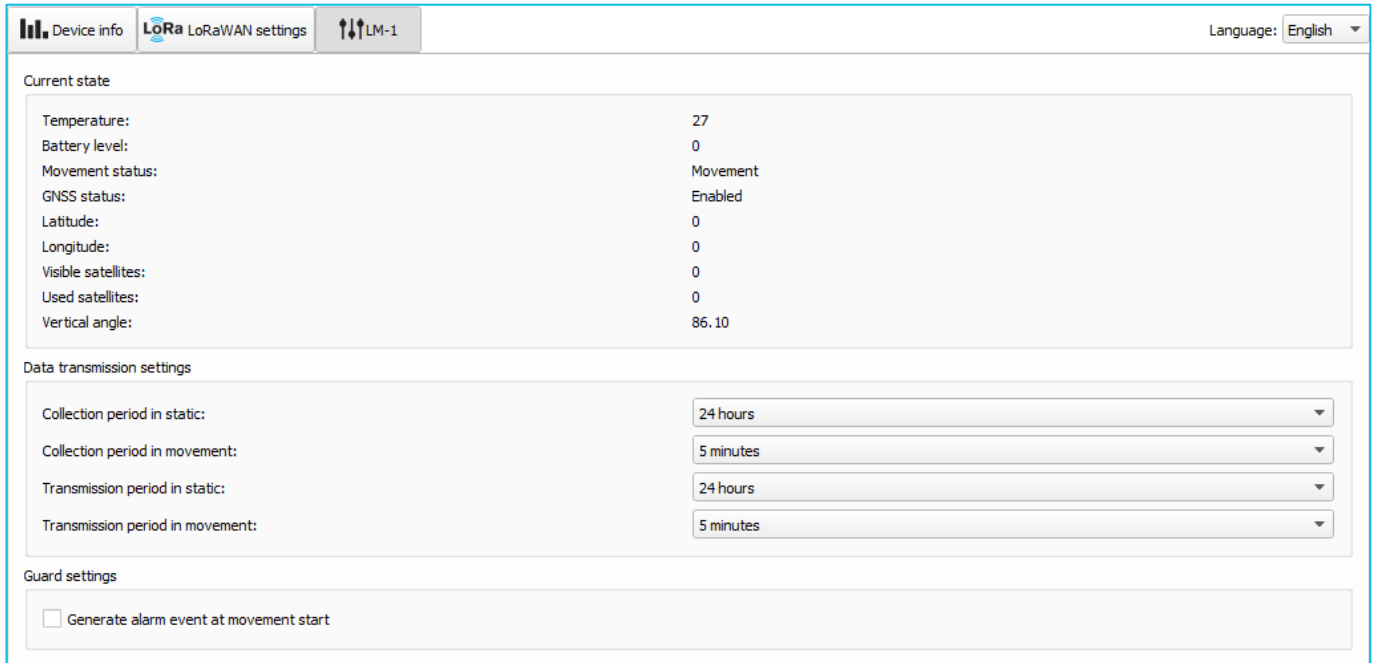| TX power: | 2 dBm |
	5 dBm
	8 dBm
	11 dBm
	14 dBm
	20 dBm

TX datarate (not displayed in the "Simple" mode) – the device transmission datarate at which it will transfer packets to the LoRaWAN network. This speed can be changed by the network server if the ADR algorithm is enabled.

TX datarate:	DR0 SF12 BW125
	DR1 SF11 BW125
	DR2 SF10 BW125
	DR3 SF9 BW125
	DR4 SF8 BW125
	DR5 SF7 BW125

"VEGA LM-1" TAB

The "Vega LM-1" tab contains the settings of the connected device.

Current state – displays the current parameters of the device - the temperature, the battery level, the accelerometer and GNSS module states, latitude and longitude, the number of visible and used satellites and the angel of deviation from the vertical.

Data transmission settings – allows to set up the periods of data accumulation and transmission for both submodes – the "Static" and the "Movement".

Guard settings – allows to set the parameter "Generate alarm event at movement start". If the checkmark is presence, then the alarm message will send at the LoRaWAN network each time the device will switch from "Static" to the "Movement" submode.

5 COMMUNICATION PROTOCOL

This part describes the LM-1 data exchange protocol with LoRaWAN network.

> **In fields consisting of several bytes, the little endian byte order is used**

VEGA LM-1 TRACKING DEVICE TRANSMITS THE FOLLOWING TYPES OF PACKETS

1. Packet with current readings, sent regularly on LoRaWAN port 2

Size in bytes	Field description
1 byte	Packet type, this packet == 1
1 byte	Battery charge, %
4 bytes	Reading time for values in this packet (unixtime UTC)
1 byte	Temperature, °C
1 byte	Movement presence byte 0 – the static 1 – the movement
2 bytes	An angel of deviation from the vertical
1 byte	Coordinates validation byte 0 – not valid 1 – valid
4 bytes	Latitude in degrees multiplied by 1000000
4 bytes	Longitude in degrees multiplied by 1000000
2 bytes	Course in degrees
2 bytes	Speed, in km/h
2 bytes	The height above the sea level
1 byte	The number of visible satellites at the moment when the packet formed
1 byte	The number of satellites used in navigation decision
1 byte	Alarm byte 0 – normal 1 – alarm

The device has internal clock and calendar; time and date are factory preset. When sending a packet with the current readings, the device uses the data taken at the nearest time, which is multiple to the interval, set by the switches:

- 1 hour period: the readings of the beginning of the current hour are sent;
- 6 hours period: 00:00, 06:00, 12:00, 18:00 readings are sent;
- 12 hours period: 00:00, 12:00 readings are sent;
- 24 hours period: the readings of 00:00 of the current day are sent.

Time zone taken into account during collection data from an external meter.

2. Packet with time correction request, sent every seven days on LoRaWAN port 4

Size in bytes	Field description
1 byte	Packet type, this packet == 255
4 bytes	Time of the modem at the moment of the packet transmission (unixtime UTC)

After receiving this type of package, the application can send to modem the packet with time correction.

3. Settings packet – transmitting on LoRaWAN port 3 when settings request command received, or device connected to the network

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 0	
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----
...	...	...
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----

VEGA LM-1 TRACKING DEVICE RECEIVES PACKETS OF THE FOLLOWING TYPES

1. Real-time clock adjustment – send by application on LoRaWAN port 4

Size in bytes	Field description
1 byte	Packet type, this packet == 255
8 bytes	The value in seconds for which you need to adjust the time. Can be positive or negative

When packet received then the device set the internal clock and the date according to the data in that packet.

2. Packet with request of settings – sent by application on LoRaWAN port 3

Size in bytes	Field description
1 byte	Packet type, this packet == 1

Answering that packet, the device sends the packet with settings.

3. Packet with settings is identical to such packet from device

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 0	
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----
...	...	...
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----

The package with settings sent to the device may not contain all the settings supported by the device, but only the part that needs to be changed.

Table of ID of LM-1 parameters and these possible values

ID of parameter	Description	Data length	Possible values
4	Confirmed uplinks	1 byte	1 – confirmed 2 – unconfirmed
5	Automatically Data Rate (ADR)	1 bute	1 – on 2 – off
8	Uplinks number of transmission	1 byte	from 1 to 15
16	Communication period	1 byte	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours 5 – 5 minutes 6 – 15 minutes 7 – 30 minutes
49	Data collection period	1 byte	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours 5 – 5 minutes 6 – 15 minutes 7 – 30 minutes
62	Collection period in movement	1 byte	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours 5 – 5 minutes 6 – 15 minutes 7 – 30 minutes 8 – 1 minute
63	Transmission period in movement	1 byte	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours 5 – 5 minutes 6 – 15 minutes 7 – 30 minutes 8 – 1 minute
71	Generate alarm event at movement start	1 byte	0 – do not generate 1 – generate

6 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega LM-1 tracking device shall be stored in the original packaging in heated room at temperatures +5°C to +40°C and relative humidity less than 85%.

The device shall be transported in covered freight compartments of all types at any distance at temperatures -40°C to +85°C.

7 CONTENT OF THE PACKAGE

The tracking device is delivered complete with:

Vega LM-1 tracking device – 1 pc.

Magnets – 4 pcs.

Factory certificate – 1 pc.

8 WARRANTY

The warranty period for the device is 3 years from the date of sale.

The manufacturer is obligated to provide repair services or replace the failed device during the entire warranty period.

The consumer is obliged to comply with the conditions and rules of transportation, storage and operation specified in this user manual.

Warranty does not apply to:

- power supplies of devices sending more than 10,000 packets for variation with 6400 mAh battery or more than 20,000 packets for variation with two 6400 mAh batteries;

- the device with mechanical, electrical and / or other damages and defects caused by violation of the transportation, storage and operation requirements;

- the device with traces of repair performed not by the manufacturer's service center;

- the device with traces of oxidation or other signs of liquids leaking inside the device.

In the event of a warranty claim, contact the service center:

113/1, Kirova Str., Novosibirsk, 630008, Russia.

Tel.: +7 (383) 206-41-35.

vega-absolute.ru

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