



LORAWAN MODEM FOR ELSTER GAS METER VEGA GM-2

User manual

LoRaWAN modem GM-2 is used for reading of values from Elster gas meters and further transmitting of this data to LoRaWAN network.

Vega GM-2 has two security inputs and can send alarm message to the network by triggering one of them.

Document Information

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Revision	Date	Name	Comments
01	24.05.2018	KEV	Document creation date
02	05.07.2018	PKP KEV	A typo in the exchange protocol "Time Adjusted Package" (4 bytes → 8 bytes) is fixed, a description of the "Number of decimal places" parameter on page 24 is added
03	24.07.2018	KEV	Frequency band RU-868 is changed, some typos are fixed

CONTENTS

INTRODUCTION	4
1 DESCRIPTION AND OPERATION	5
2 SPECIFICATION	7
3 OPERATION.....	8
Contacts	8
Device's sensors	10
Indication	12
Initial Startup	13
Connecting via USB	14
4 VEGA LORAWAN CONFIGURATOR.....	16
Interface of the application	16
Connection to the device	17
"Device info" tab	18
"LoRaWAN settings" tab	20
"Vega GM-2" tab	24
5 COMMUNICATION PROTOCOL	26
Vega GM-2 modem transmits the following types of packets.....	26
VEGA GM-2 modem receives packets of the following types	28
6 STORAGE AND TRANSPORTATION REQUIREMENTS	29
7 CONTENT OF THE PACKAGE	30
8 WARRANTY	31

INTRODUCTION

This manual is designated for Vega GM-2 LoRaWAN modem (hereinafter – the modem) manufactured by Vega-Absolute LLC and provides information on powering and activation procedure, control commands and functions of the modem.

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



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

1 DESCRIPTION AND OPERATION

LoRaWAN modem GM-2 is designed for reading of values from Elster gas meters and further collection and transmitting of this data to LoRaWAN network.

The modem is equipped with two Hall sensors, one of which calculates the current meter readings and the other is located in such a way and has a sensitivity level that reacts only to the presence of an external magnetic field (for example, when a strong magnet is placed near the gas meter to disable the counting mechanism).

To protect against unauthorized access, the modem has a tamper. There are also two security inputs and two control outputs.

The modem is powered by a 3400 mAh built-in battery with service life up to 10 years, provided data transmitted once a day.



The readings are read from the meter with a configurable period from 5 minutes to 24 hours. The readings are stored in the device memory and transmitted during the next communication session with the LoRaWAN network.

The data transfer period can be adjusted from 1 to 24 hours and is counted from the moment the modem is transferred from the "Storage" mode to the "Active" mode. At the next communication session, the device starts sending accumulated packets with readings, from the earliest to the latest.

If the option " Confirmed uplinks" is enabled, the device will send the next packet only after receiving a confirmation of the delivery of the previous one. If such confirmation is not received after the fulfilled in the settings number of re-requests, modem completes the communication session until the next according to the schedule. In this case, the device

continues to collect data according to the data collection period and store it in memory. Non-transmitted packets remain in the modem memory until the next communication session.

With the "Confirmed uplinks" option turned off, the device just sends all accumulated packets to the network in order from the earliest to the latest. There are no checks of package delivery in this mode. There are no unsent packets in the device memory.

The internal clock is set automatically when device connected to the "Vega LoRaWAN Configurator" via USB, and can also be adjusted via LoRaWAN.

2 SPECIFICATION

Main

Security inputs	2
Open-drain outputs	2
USB-port	mini-USB, type B
Operating temperatures	-40...+85 °C
Built-in temperature sensor	yes

LoRaWAN

LoRaWAN class	A
Quantity of LoRaWAN channels	16
Frequency band	RU868, EU868, IN865, AS923, AU915, KR920, US915, custom (EU868 based)
Activation type	ABP or OTAA
Communication period	1, 6, 12 or 24 hours
Data collection period	5, 15, 30 minutes, 1, 6, 12 or 24 hours
Memory amount for storing packets	100 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
Nominal power output	25 mW (configurable)

Power

Built-in battery	3400 mAh
Wireless operation with battery	up to 10 years

Case

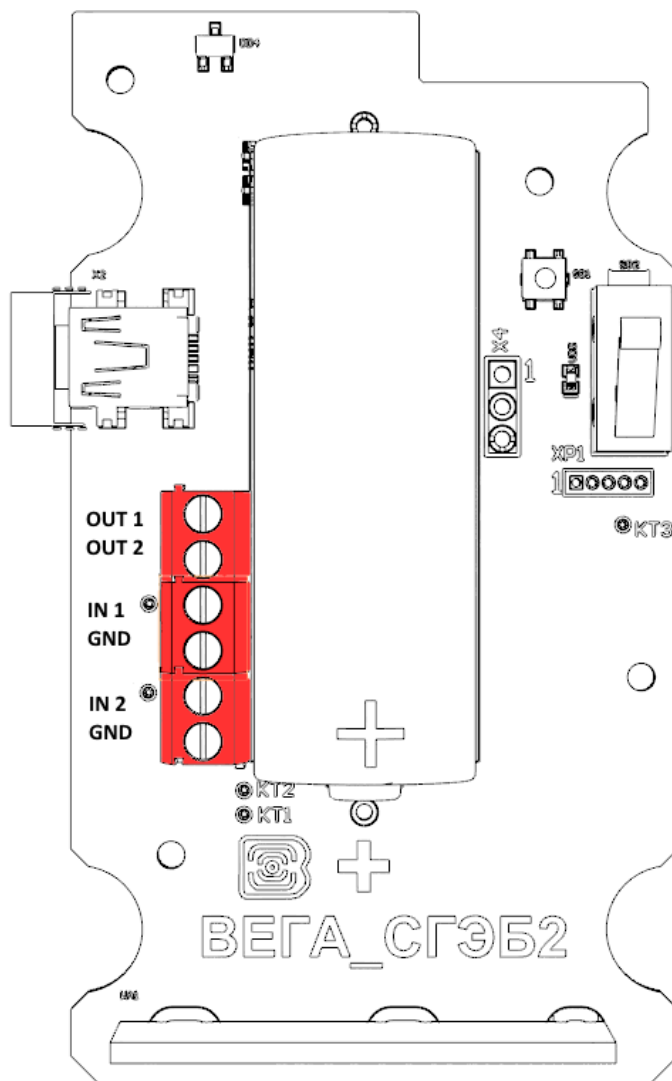
Housing dimensions with mounting	106 x 66 x 37 mm
Housing dimensions without mounting	88 x 52 x 37 mm
Ingress protection rating	IP53
Tamper	yes

Vega GM-2 modem is A class device (LoRaWAN classification) and has the following features:

- ADR support (Adaptive Data Rate)
- Sending of confirmed packets (configurable)
- Two operating modes: "Active" and "Storage"
- Two security inputs for connection an external leakage and safety sensors, etc.
- Storing undelivered packets in memory when sending packets with confirmation
- Adjustable data collection period
- Time referencing of readings by internal clock
- Communication in case of security inputs, hall sensor or tamper triggering
- Temperature measurement
- Charge measuring of the built-in battery (%)

3 OPERATION

CONTACTS



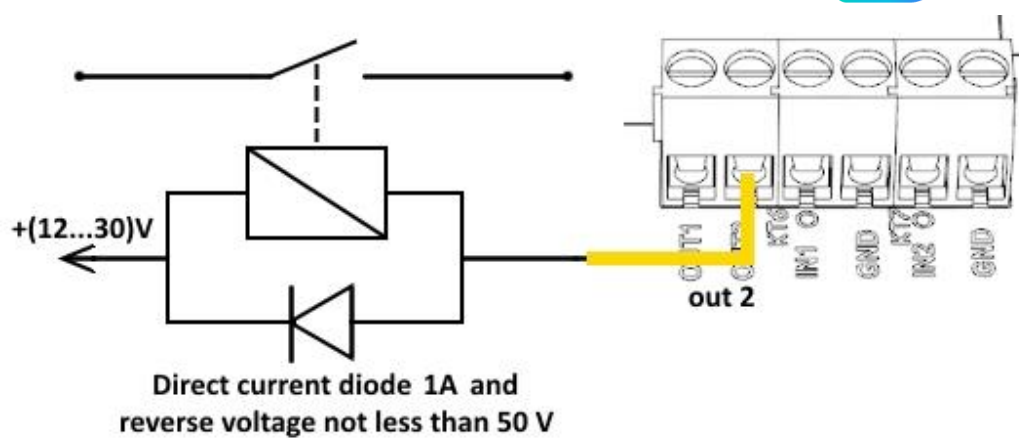
LoRaWAN modem has 2 security inputs. The device monitors its closure or opening, depending on the settings in the "Vega LoRaWAN Configurator" application. In the case of a security input triggering, the device is activated and sends an alarm message to the network.

The actuators are connected to the modem through the OUT1 and OUT2 outputs, which are of the "open drain" type.



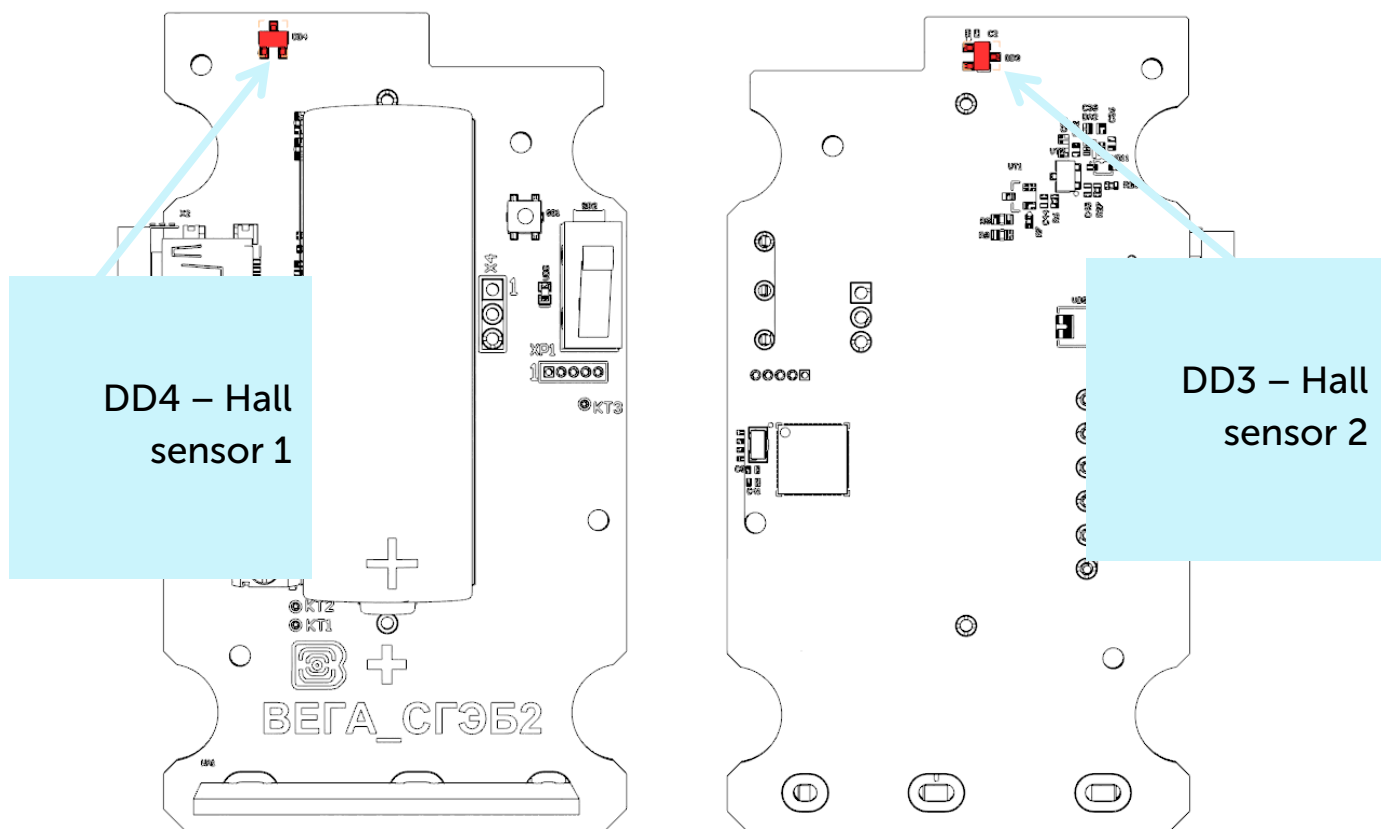
Permissible load for each digital output is 2 A

To increase the load on the outputs of the device, it is necessary to use an external relay. The relay connection is shown below.

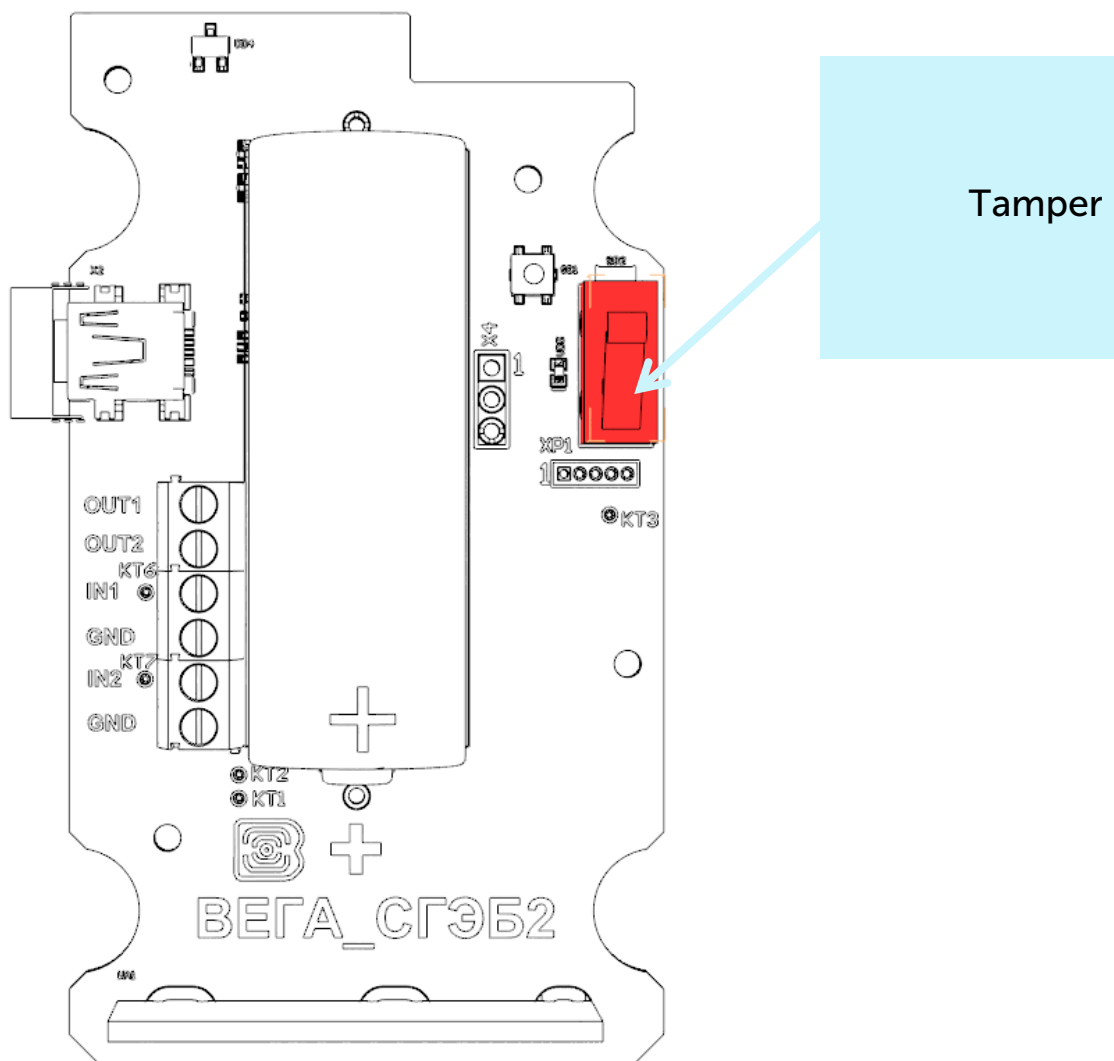


DEVICE'S SENSORS

On the upper side of the board is a Hall sensor of low sensitivity, reacting to the presentation of a strong magnet. On the underside of the board, there is a more sensitive Hall sensor that responds to the rotation of the magnet in the gas meter mechanism, thus allowing the readout of the connected device.

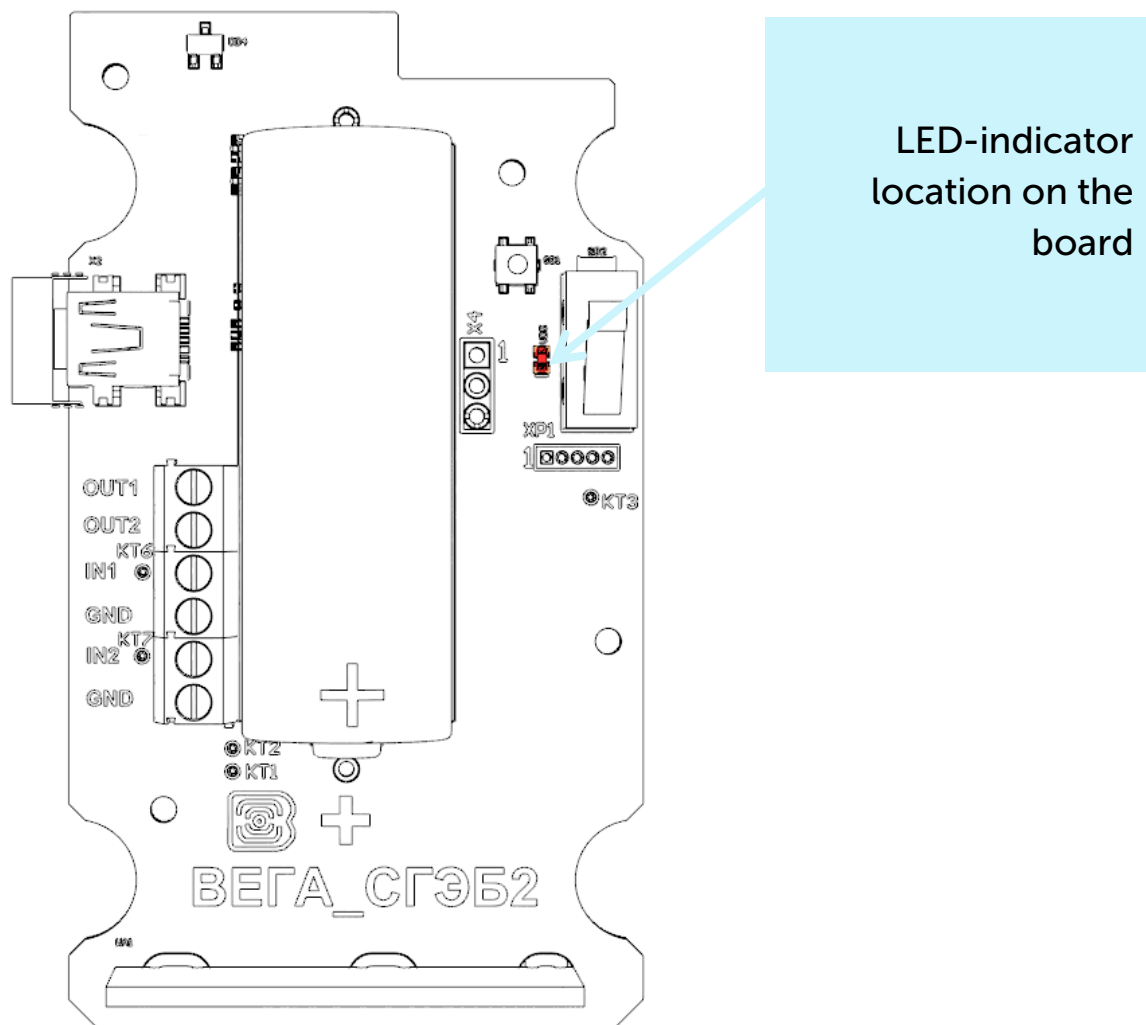





On the upper side of the board there is a tamper. When the Hall sensor 1 and / or tamper are triggered, a packet with the corresponding message is sent to the LoRaWAN network.



INDICATION

The device has one red LED on the board. The indication is only used during the activation phase of the device in the LoRaWAN network and when changing the operating modes.



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	The device switched to the «Storage» mode



In case the device fails to connect the network, it automatically switches to the "Storage" mode

INITIAL STARTUP

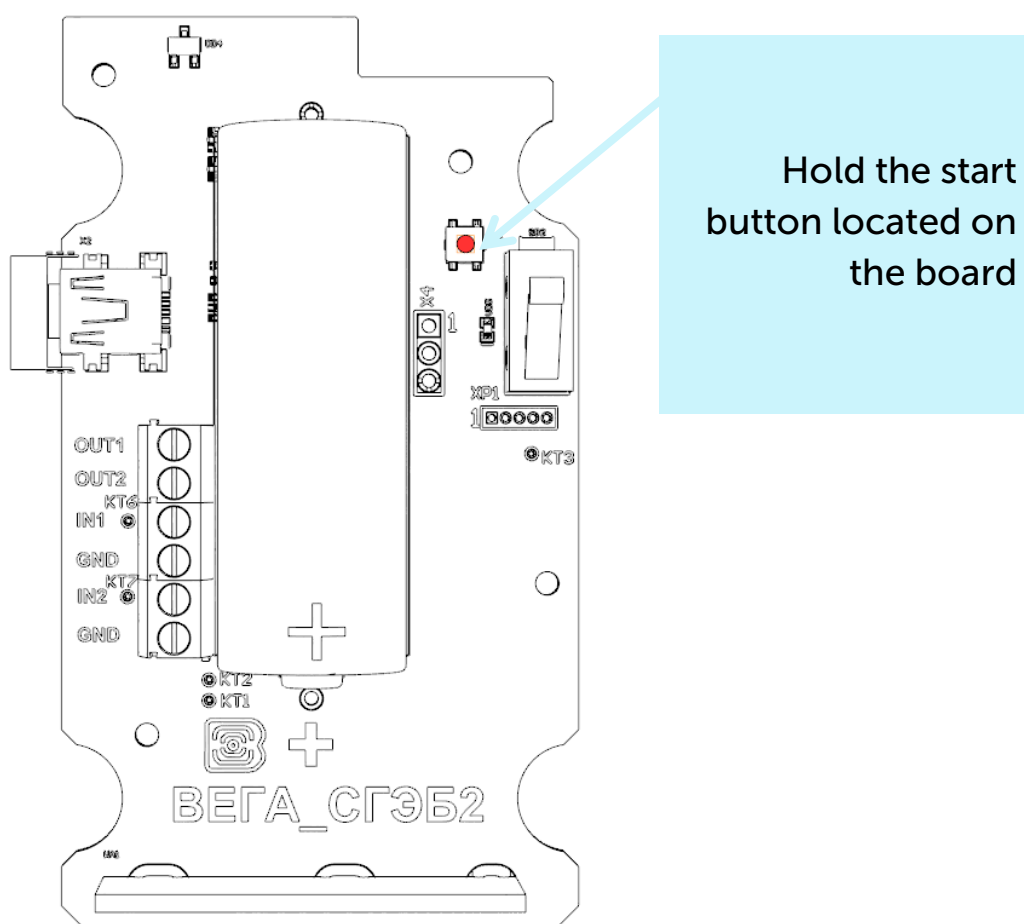
LoRaWAN modem GM-2 is constantly on, but can operate in a special "Storage" mode, designed for storage and transportation. The device does not regularly transmit data to the network in this mode. Before use switch the modem from the «Storage» mode.

Vega SI-11 supports two activation methods in the LoRaWAN network - ABP and OTAA. Select one of the methods via the "Vega LoRaWAN Configurator" application.

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

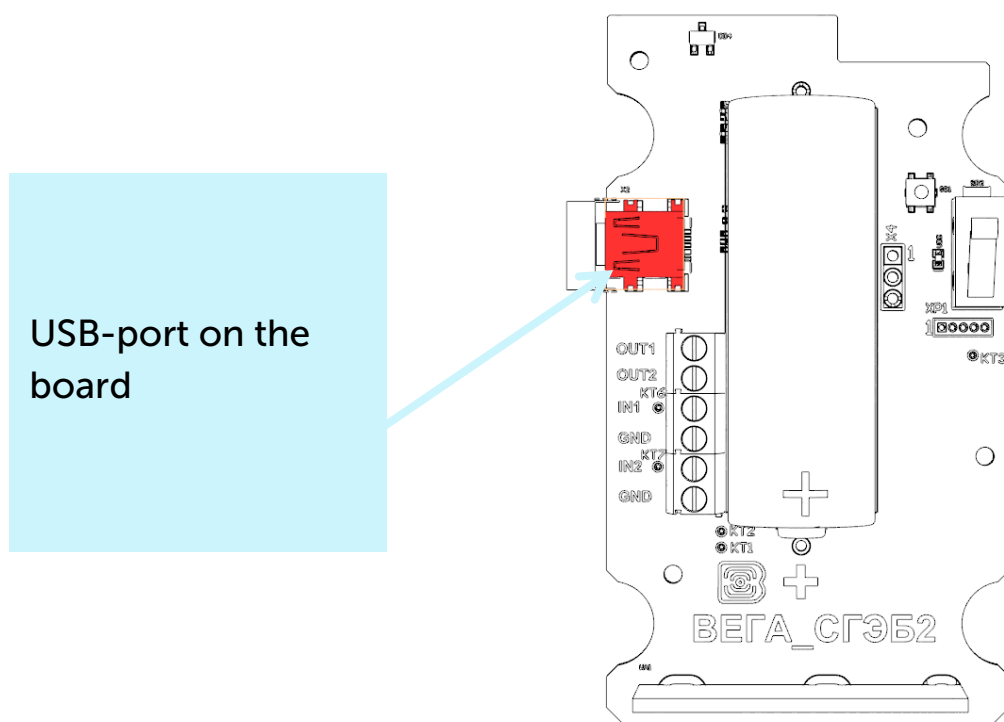
2. OTAA. After pressing the start button, the device makes three attempts to connect to the network within the set frequency band. After the activation in the LoRaWAN network is confirmed, the device sends a signal (LED flashing for 3 seconds) and switches to the "Active" mode. If all attempts fail, the modem 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.

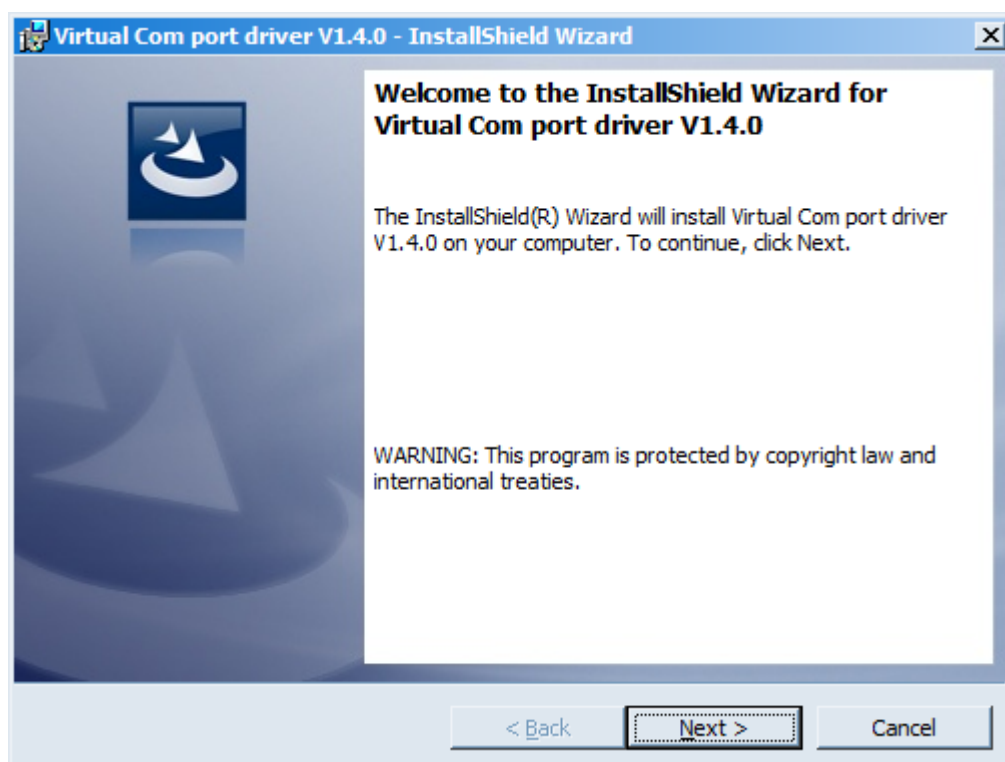


CONNECTING VIA USB

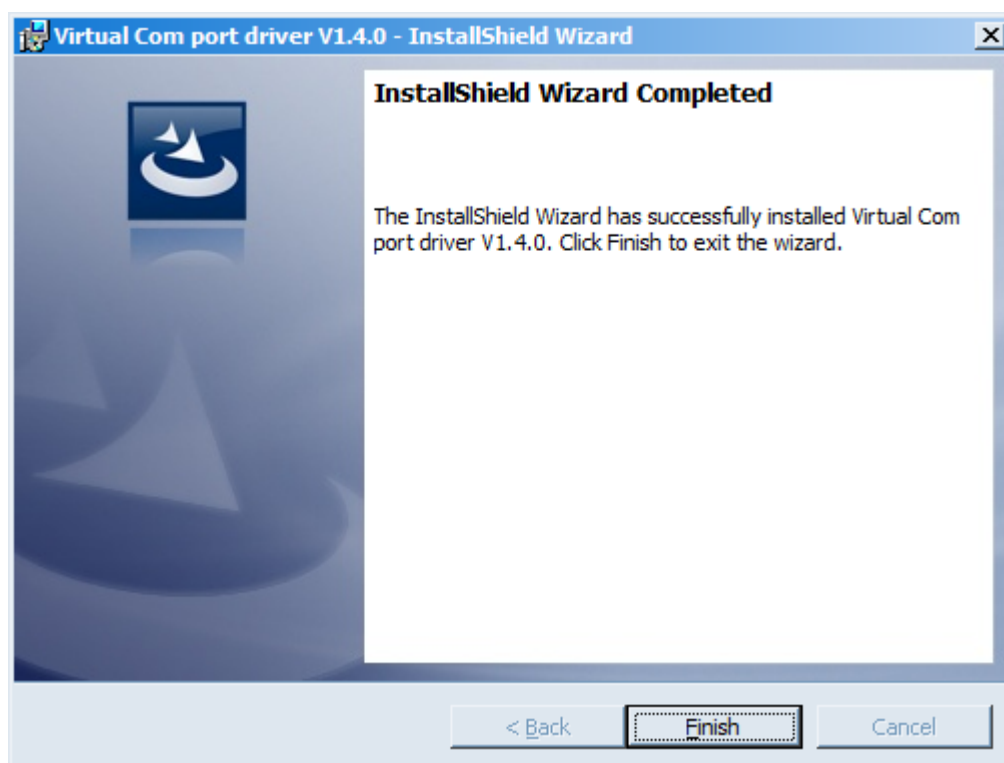
The modem can be adjusted with the "Vega LoRaWAN Configurator" application (See part 4).



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 downloaded 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 is completed successfully, the following screen appears:



After pressing **Finish** the driver is ready for operation, - it is possible to connect the modem via USB.

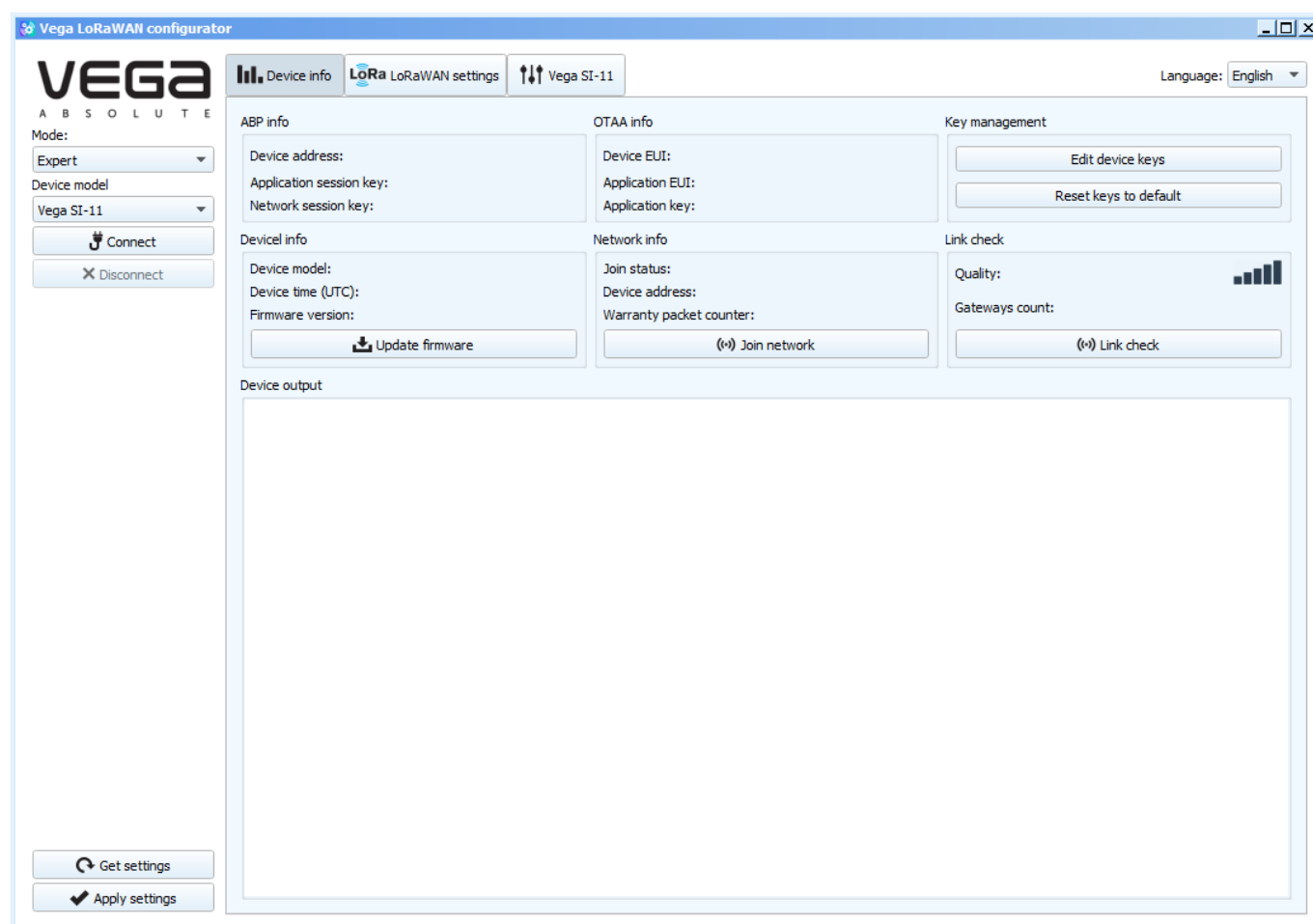
4 VEGA LORAWAN CONFIGURATOR

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 is considered in the "Expert" mode.

INTERFACE OF THE APPLICATION

The "Vega LoRaWAN Configurator" application does not require the special installation. When the executable file is launched, 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.

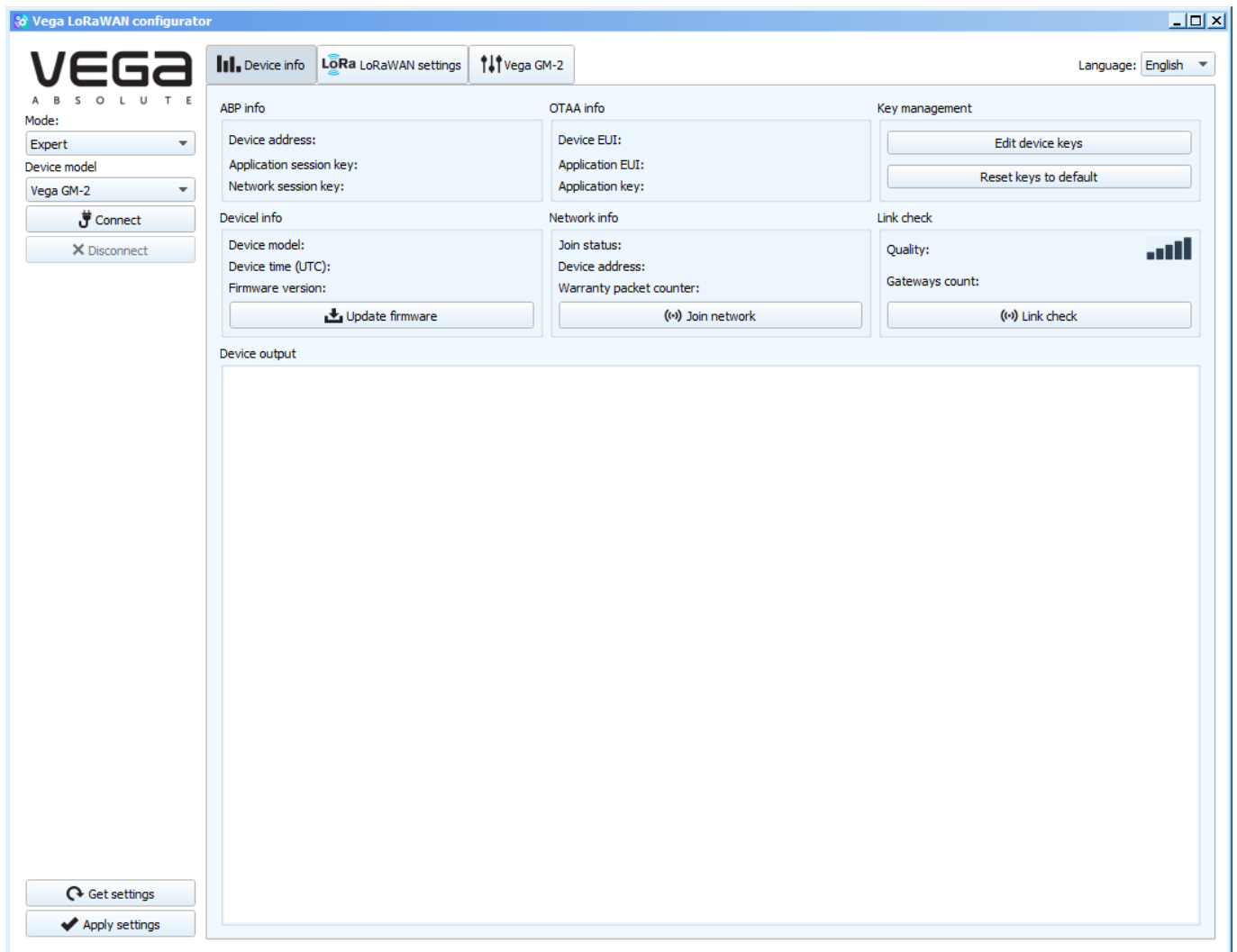
The language selection menu is in the upper right corner.

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.

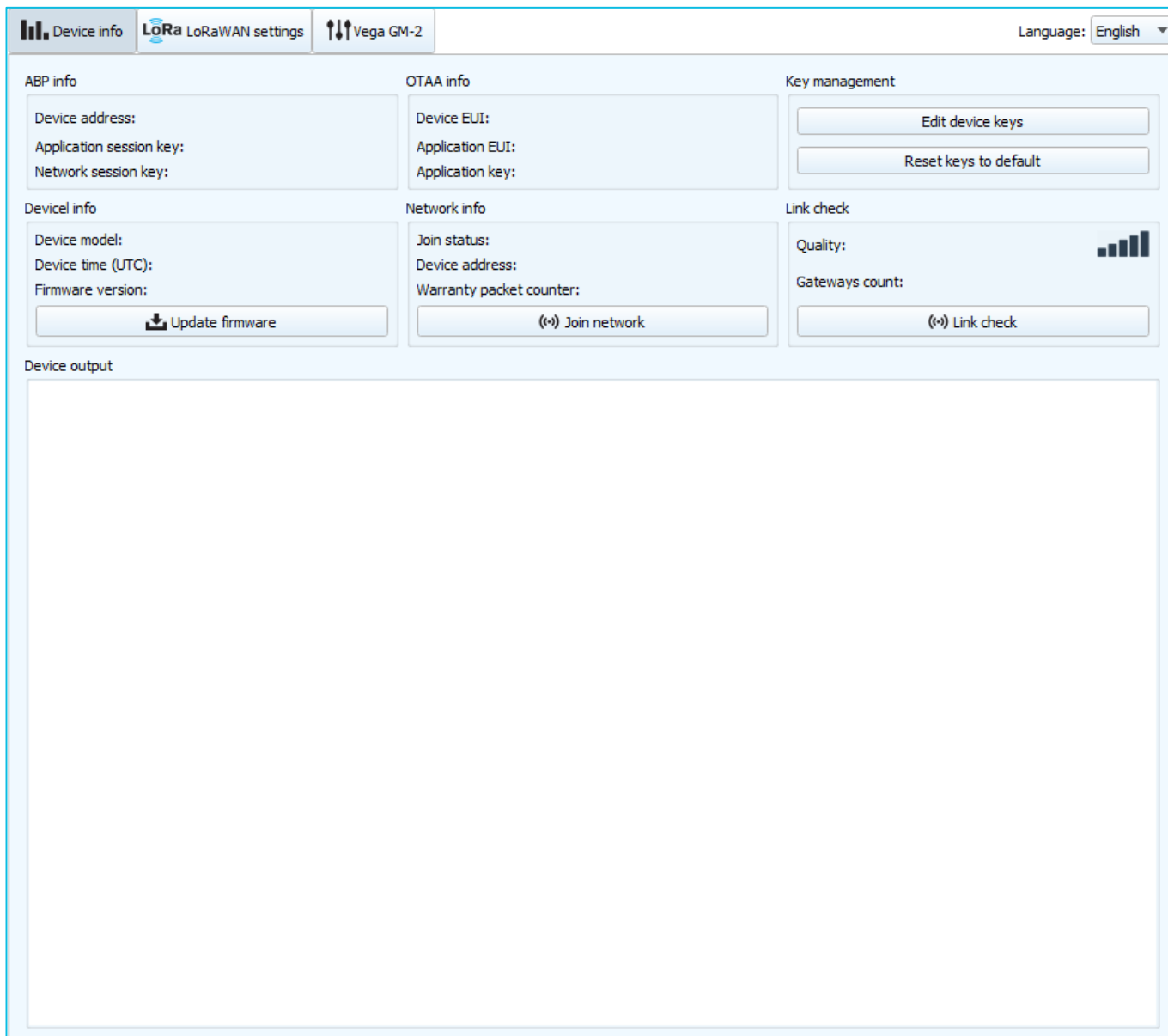


To read the settings from the device, you need to click the "Get settings" button, until this point the application will display the default settings or from the last connected device.

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 also the data needed to register the device in the LoRaWAN network.



The screenshot shows the "Device info" tab selected. The interface includes a language dropdown set to "English". The main content area is divided into several sections:

- ABP info:** Fields for Device address, Application session key, and Network session key.
- OTAA info:** Fields for Device EUI, Application EUI, and Application key.
- Key management:** Buttons for "Edit device keys" and "Reset keys to default".
- Device info:** Fields for Device model, Device time (UTC), and Firmware version, with an "Update firmware" button.
- Network info:** Fields for Join status, Device address, and Warranty packet counter, with a "Join network" button.
- Link check:** Fields for Quality (with a signal strength indicator) and Gateways count, with a "Link check" button.
- Device output:** A large empty text area for logs.

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 also reset the keys back to the factory settings.

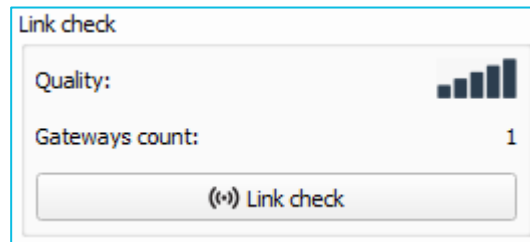
Device info - the configurator reads information about the device model, its firmware and automatically corrects the device's time when connected to it.

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 downloaded 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.

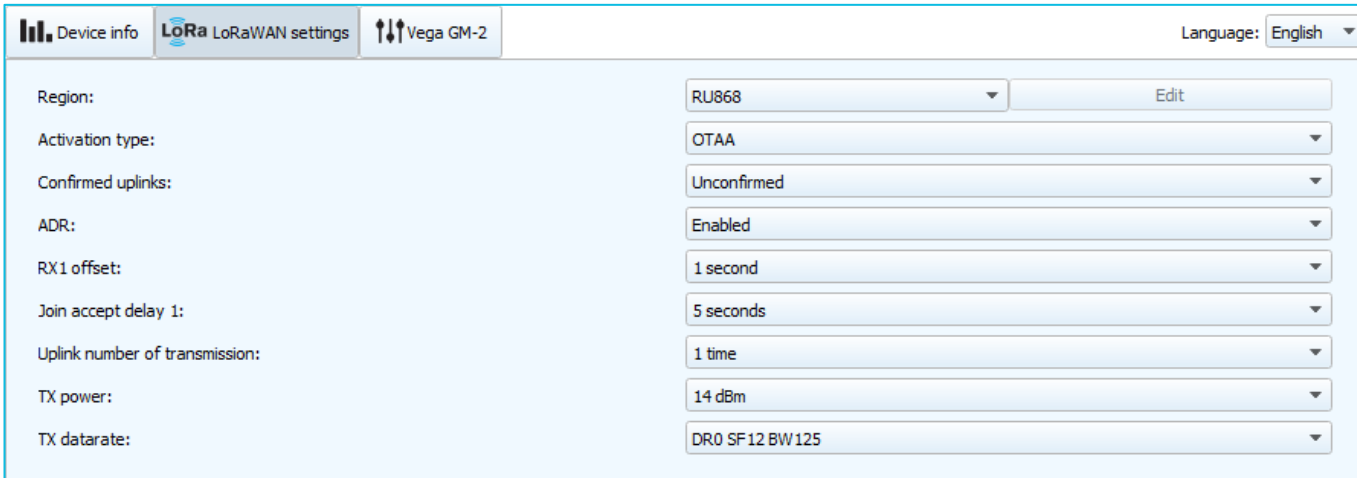
Link check (not displayed in the "Simple" mode) - when pressed, the device sends a special signal to the LoRaWAN network, in response to which the network informs it of the number of gateways that received this signal and the signal quality. This button only works when the device is connected to the network.



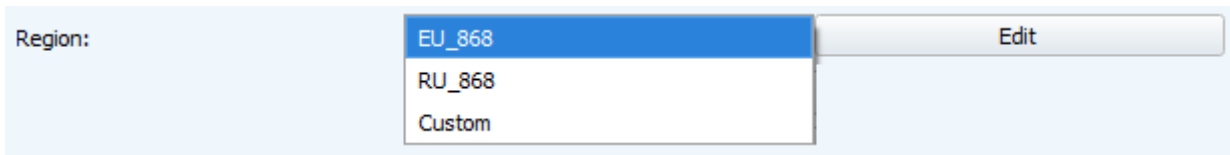
Device output (not displayed in the "Simple" mode) - monitoring the device status, all events in real time are displayed.

"LORAWAN SETTINGS" TAB

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



Region - allows you to select RU-868, EU-868 or specify a custom frequency band.



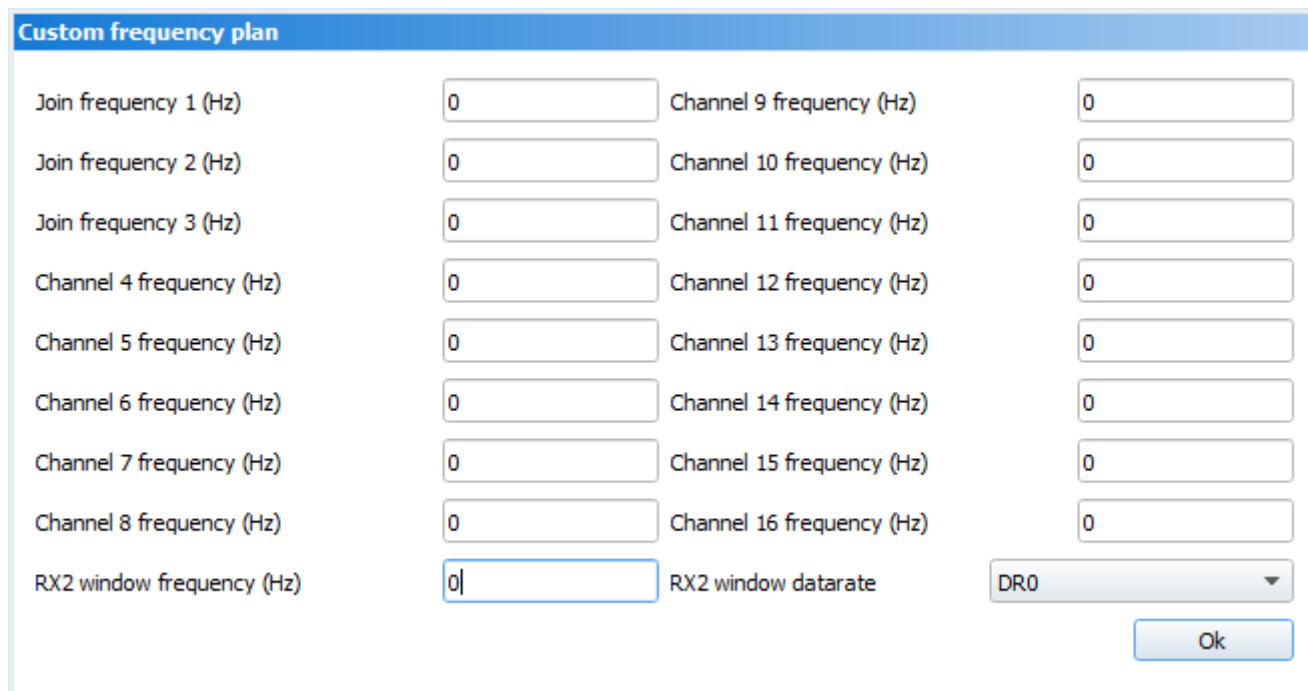
The modem supports the following frequency bands:

Frequency band 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	MultiSF 125 kHz
Custom	Set with «Vega LoRaWAN Configurator» application		

In the EU_868 and RU_868 frequency bands, only those channels are active by default on which send requests for connection to the network (join channels). The remaining channels that the device should use can be transferred by the LoRaWAN network server during the device activation procedure (only OTAA).

¹ By default, the device supports two frequency bands and the custom, but it is possible to order firmware for other frequency bands: IN865, AS923, AU915, KR920, US915, KZ865

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:



The dialog box titled "Custom frequency plan" contains the following fields:

Join frequency 1 (Hz)	<input type="text" value="0"/>	Channel 9 frequency (Hz)	<input type="text" value="0"/>
Join frequency 2 (Hz)	<input type="text" value="0"/>	Channel 10 frequency (Hz)	<input type="text" value="0"/>
Join frequency 3 (Hz)	<input type="text" value="0"/>	Channel 11 frequency (Hz)	<input type="text" value="0"/>
Channel 4 frequency (Hz)	<input type="text" value="0"/>	Channel 12 frequency (Hz)	<input type="text" value="0"/>
Channel 5 frequency (Hz)	<input type="text" value="0"/>	Channel 13 frequency (Hz)	<input type="text" value="0"/>
Channel 6 frequency (Hz)	<input type="text" value="0"/>	Channel 14 frequency (Hz)	<input type="text" value="0"/>
Channel 7 frequency (Hz)	<input type="text" value="0"/>	Channel 15 frequency (Hz)	<input type="text" value="0"/>
Channel 8 frequency (Hz)	<input type="text" value="0"/>	Channel 16 frequency (Hz)	<input type="text" value="0"/>
RX2 window frequency (Hz)	<input type="text" value="0"/>	RX2 window datarate	<input type="text" value="DR0"/>

An "Ok" button is located at the bottom right.

This frequency band 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 band will be considered empty

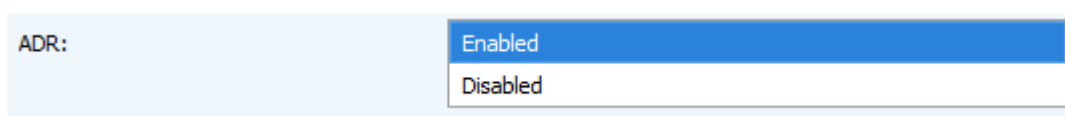
Activation type – allows to set up ABP or OTAA device activation method.

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 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.



The ADR dropdown menu is open, showing two options: "Enabled" (highlighted in blue) and "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. 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.

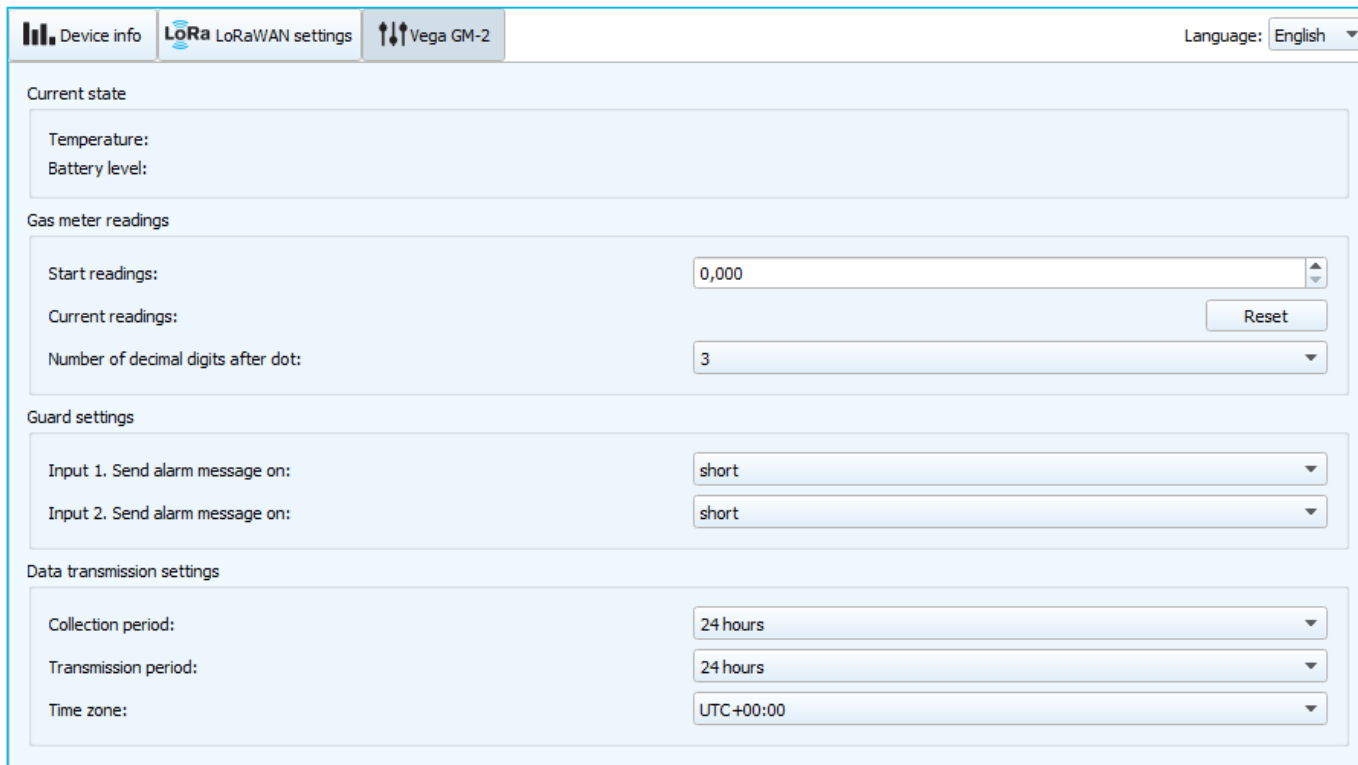
TX power:	2 dBm
	5 dBm
	8 dBm
	11 dBm
	14 dBm
	20 dBm

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 GM-2" TAB

The "Vega GM-2" tab contains the settings of the connected device.



The screenshot shows the "Vega GM-2" settings tab in a web interface. At the top, there are three tabs: "Device info", "LoRa LoRaWAN settings", and "Vega GM-2". The "Vega GM-2" tab is selected. In the top right corner, there is a language dropdown menu set to "English".

The settings are organized into four sections:

- Current state:** Displays "Temperature:" and "Battery level:".
- Gas meter readings:** Includes "Start readings:" with a text input field containing "0,000", "Current readings:" with a "Reset" button, and "Number of decimal digits after dot:" with a dropdown menu set to "3".
- Guard settings:** Includes "Input 1. Send alarm message on:" and "Input 2. Send alarm message on:", both with dropdown menus set to "short".
- Data transmission settings:** Includes "Collection period:", "Transmission period:", and "Time zone:", all with dropdown menus. "Collection period" and "Transmission period" are set to "24 hours", and "Time zone" is set to "UTC+00:00".

Current state – displays the current parameters of the device - the temperature and the battery level.

Gas meter readings – displays the current readings and allows you to set the initial value of the gas meter to be connected so that when collecting and transmitting the readings, their absolute value displayed on the modem is transmitted, as well as the number of decimal places. The number of digits after the decimal point must be aligned with the analogous parameter of the meter on the front panel. The "Reset" button resets the modem of the readings accumulated by the modem since it was connected.



The "Number of decimal places" parameter must clearly meet the same meter parameter for the correct collection of readings

Guard settings – allows to setting up the condition of triggering the security input – on short, on open, or both of these cases. The maximum possible frequency of sending alarm packets - every 10 seconds.

Data transmission settings – a group of parameters that allows you to configure the collection and transmission periods, and the time zone for the internal clock of the modem will be set which. The readings are read from the connected device at 00.00 on the internal clock of the device if the data collection period is set to 24 hours, at 00.00 and at 12.00, if the period

is 12 hours and so on. All readings are stored in the device memory until the next communication session. The data transfer period can be adjusted from 1 to 24 hours. Data transfer is carried out by a random time at the selected period. At the next communication session, the device starts sending accumulated packets with readings, from the earliest to the latest. With the "Confirmed uplinks" option turned off, the device just sends all accumulated packets to the network in order from the earliest to the latest thus clearing the queue for sending packets in memory. If the "Confirmed uplinks" option is enabled, the device will send the next packet only after receiving a confirmation of the delivery of the previous one. If such confirmation is not received after the fulfilled in the settings number of re-requests, device completes the communication session until the next according to the schedule. In this case, the device continues to collect data according to the data collection period and store it in memory. Non-transmitted packets remain in the modem memory until the next communication session.

5 COMMUNICATION PROTOCOL

This part describes the GM-2 communication protocol with LoRaWAN network.

VEGA GM-2 MODEM TRANSMITS THE FOLLOWING TYPES OF PACKETS



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

1. Packet with current readings, sent regularly

Size in bytes	Field description
1 байт	Battery charge, %
4 байта	Time of the readings at that packet (unixtime UTC)
1 байт	Temperature, °C
1 байт	Reason of packet transmission: 0 – by the time, 1 – by the input 1 alarm, 2 – by the input 2 alarm, 3 – by the output 1 state changing, 4 – by the output 2 state changing 5 – by the external magnetic influence 6 – by the tamper
1 байт	Input 1 state (1 – closed, 0 – unclosed)
1 байт	Input 2 state (1 – closed, 0 – unclosed)
1 байт	Output 1 state (1 – on, 0 – off)
1 байт	Output 2 state (1 – on, 0 – off)
1 байт	External magnetic influence (1 – present, 0 - absent)
1 байт	Tamper (1 – open, 0 - close)
4 байта	Meter readings at moment of packet sending (cub.m. * 100)
4 байта	Initial meter readings at moment of modem installing (cub.m * 100)

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

- 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.

When taking readings, the time zone specified in the settings is taken into account.

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.

VEGA GM-2 MODEM RECEIVES PACKETS OF THE FOLLOWING TYPES

1. Outputs control request – send by application on LoRaWAN port 2

Size in bytes	Field description
1 byte	Output number
1 byte	Output state (1 – on, 0 - off)
2 bytes	The value in seconds for which you need to set the output in specified state. If that value is equal to zero then the specified state will set forever.

Upon receiving this package, the modem will set the specified output to the specified state for a specified time, or forever.

2. 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

6 STORAGE AND TRANSPORTATION REQUIREMENTS

LoRaWAN modem Vega GM-2 shall be stored in the original packaging in heated room at temperatures +5°C to +40°C and relative humidity less than 85%.

The modem 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 modem is delivered complete with:

LoRaWAN modem Vega GM-2 – 1 pc.

Factory certificate – 1 pc.

8 WARRANTY

The warranty period for the device is 5 years from the date of sale or 60,000 packages sent by the device, whichever comes first.

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:

- devices that sent more than 60,000 packets;
- 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.



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