



LORAWAN MODEM FOR ELSTER GAS METER VEGA GM-2

User manual

LoRaWAN modem GM-2 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 plan RU-868 is changed, some typos are fixed
04	28.05.2019	KEV	Communication protocol changed, setting via 'air' described, specification changed, " Marking " part added

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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

DEVICE DESCRIPTION

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 device is powered by a non-rechargeable lithium-thionyl chloride (LiSOCl₂) battery
Attempts to charge the battery may result in fire**

COMUNICATION AND DATA COLLECTION ALGORITHM

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.

With the "Confirmed uplinks" option turned on, the device will send the next packet only after receiving a confirmation of the delivery of the previous one. If such confirmation has not received after the fulfilled in the settings uplink number of transmissions, device completes the communication session until the next one 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 device 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 non-transmitted messages 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.

FUNCTIONAL

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 (%)

MARKING

Device marked with sticker that contain the next information:

- Device model;
- DevEUI;
- Month and year of manufacture;
- 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:

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

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

AppEui by default	76656761474D2D32
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	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
Transmitter power by default	25 mW (configurable)
Maximum transmitter power	100 mW

Power

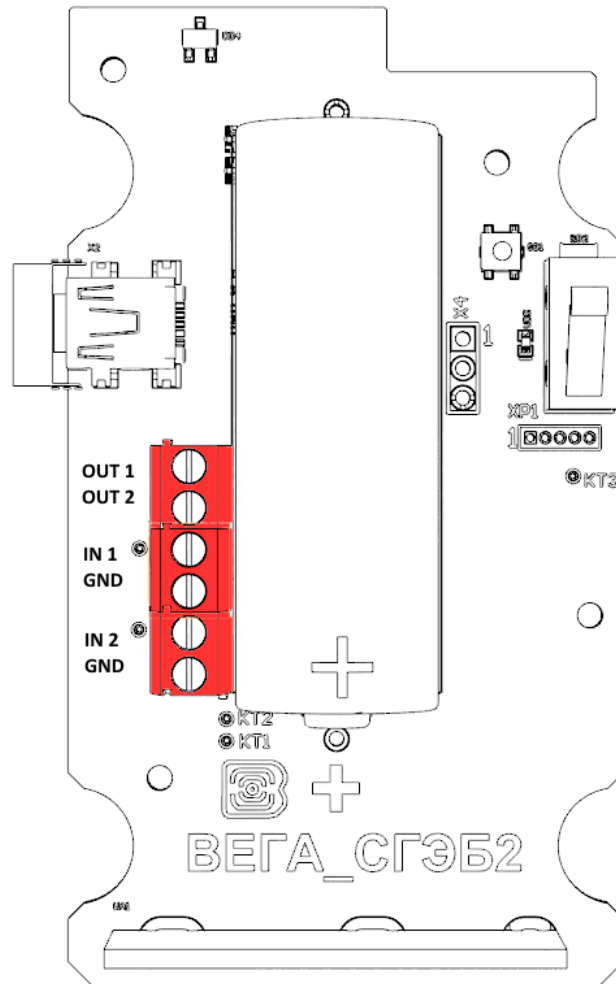
Built-in battery	3400 mAh
Warranty number of packets sent by the device, not less	60 000

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

3 OPERATION

CONTACTS



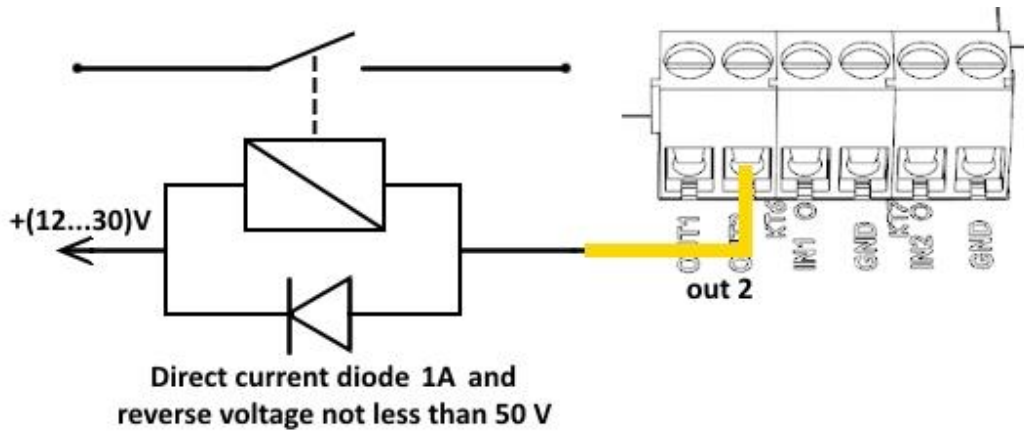
LoRaWAN modem has 2 security inputs. The device monitors its closure or opening, depending on the settings in the "Vega LoRaWAN Configurator" application. In the case of a security input triggering, the device is activated and sends an alarm message to the network.

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



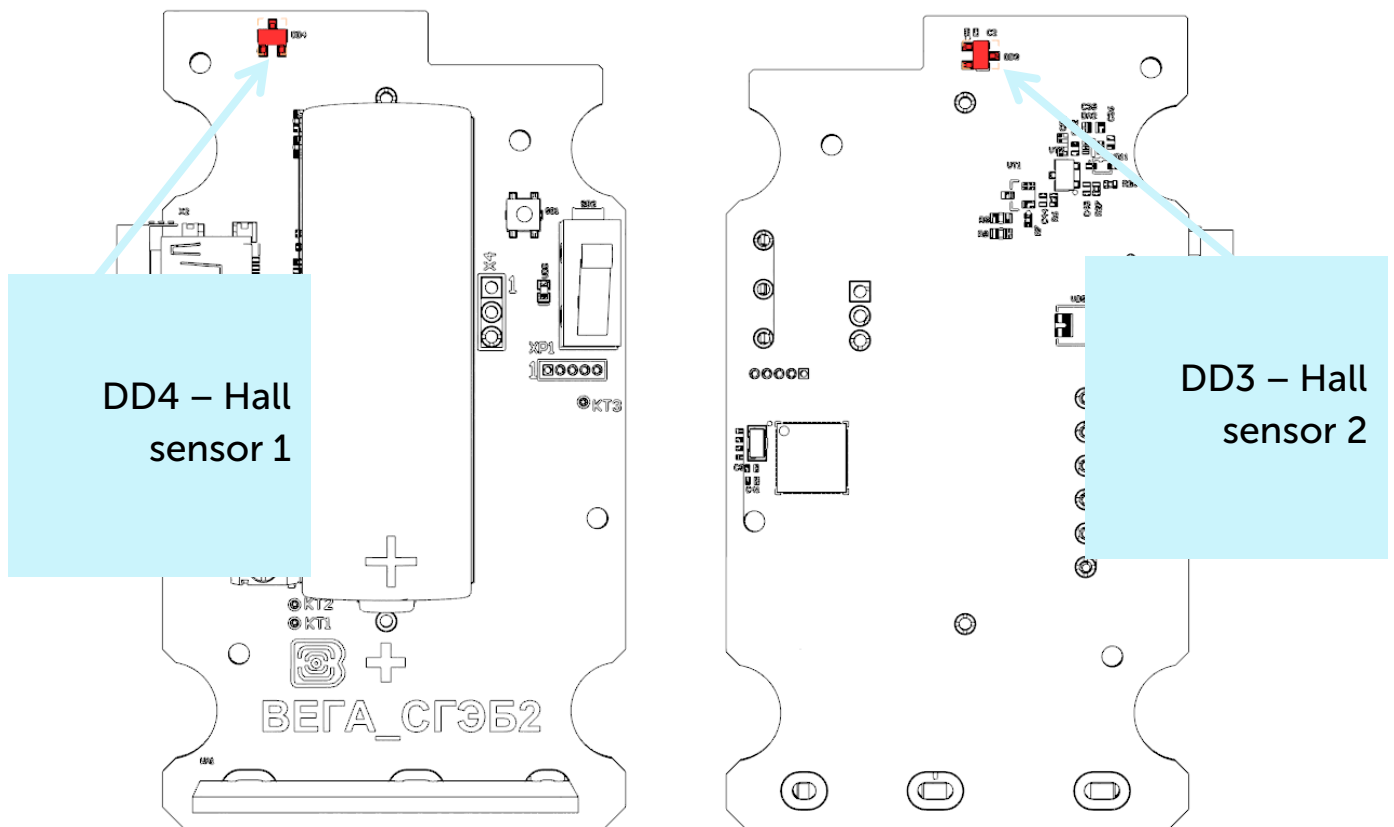
Permissible load for each digital output is 2 A

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

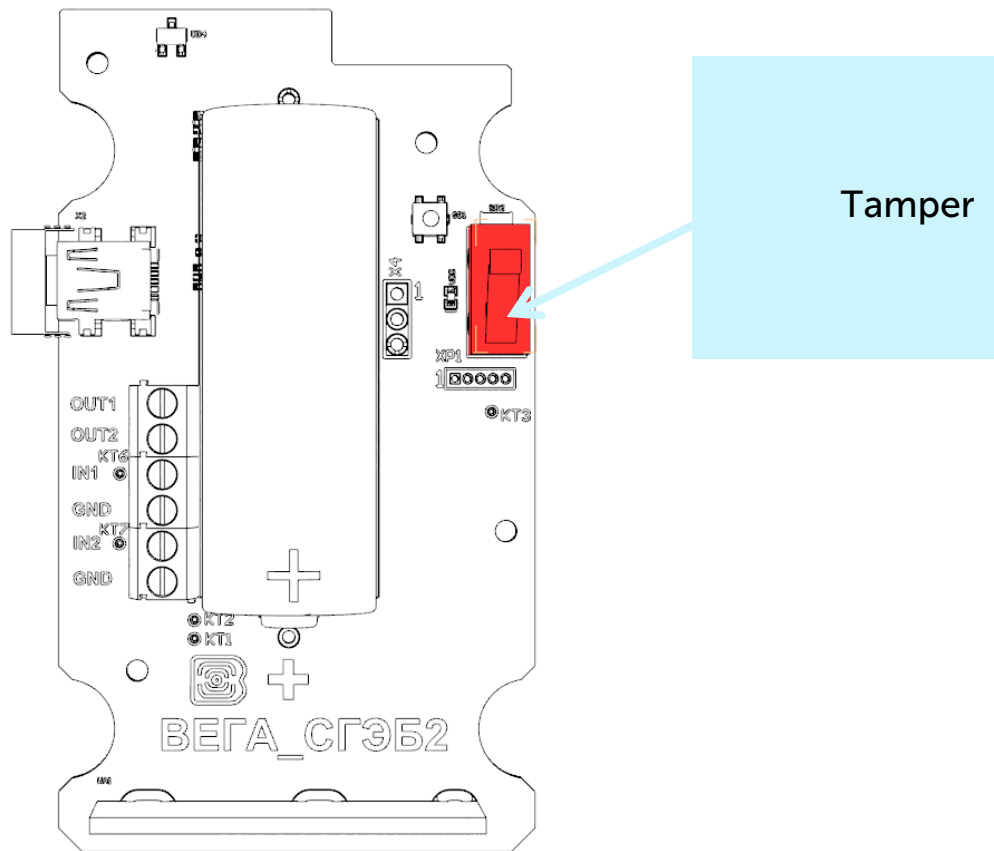


DEVICE'S SENSORS

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.

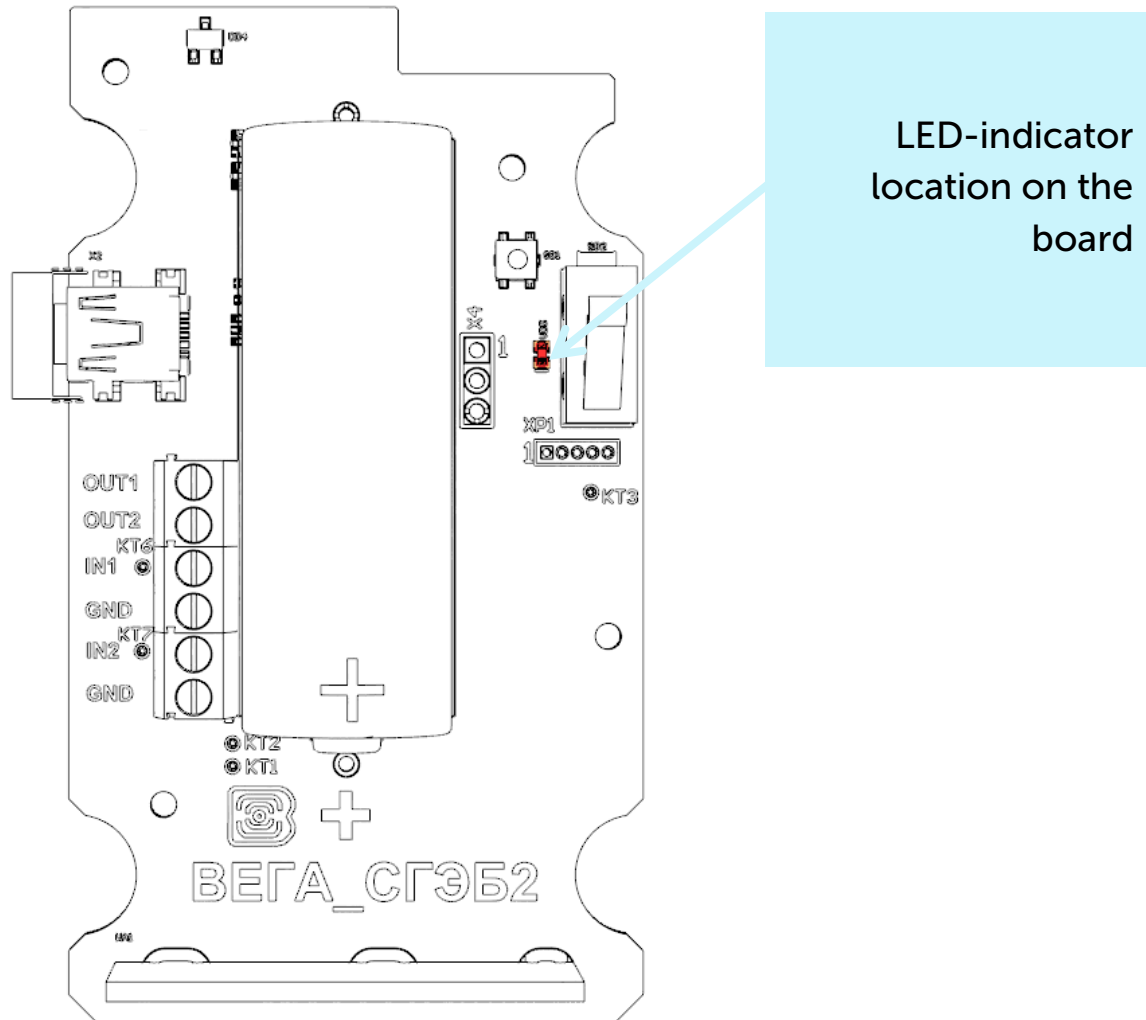





On the upper side of the board there is a tamper. When the Hall sensor 1 and / or tamper are triggered, a packet with the corresponding message is sent to the LoRaWAN network.



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	Linking to the network is unsuccessful or 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

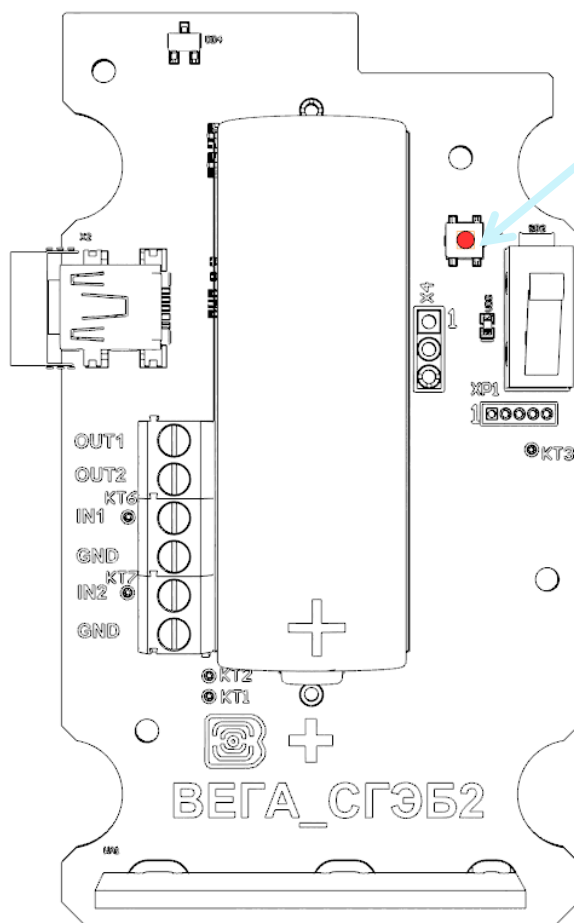
LoRaWAN modem GM-2 is constantly on but can operate in a special "Storage" mode, designed for storage and transportation. The device does not regularly transmit data to the network in this mode. Before use switch the modem from the «Storage» mode.

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 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 modem will continue to accumulate data and will attempt to connect to the network every 6 hours.

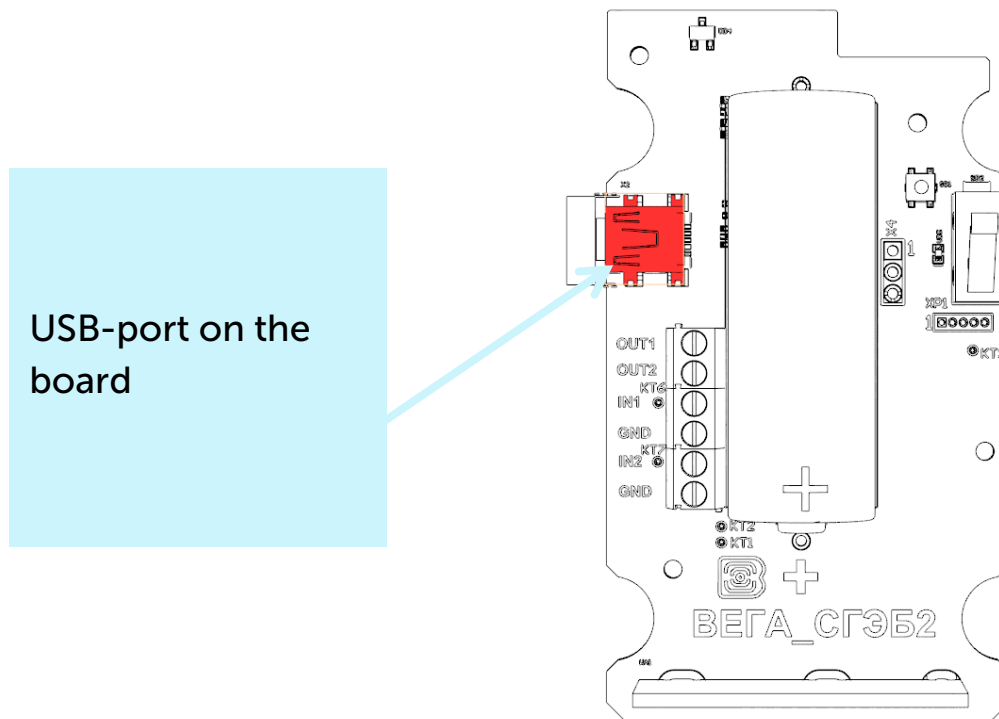
Hold the start button pressed (min. 5 seconds) to switch the device from the "Active" mode back to the "Storage" mode.



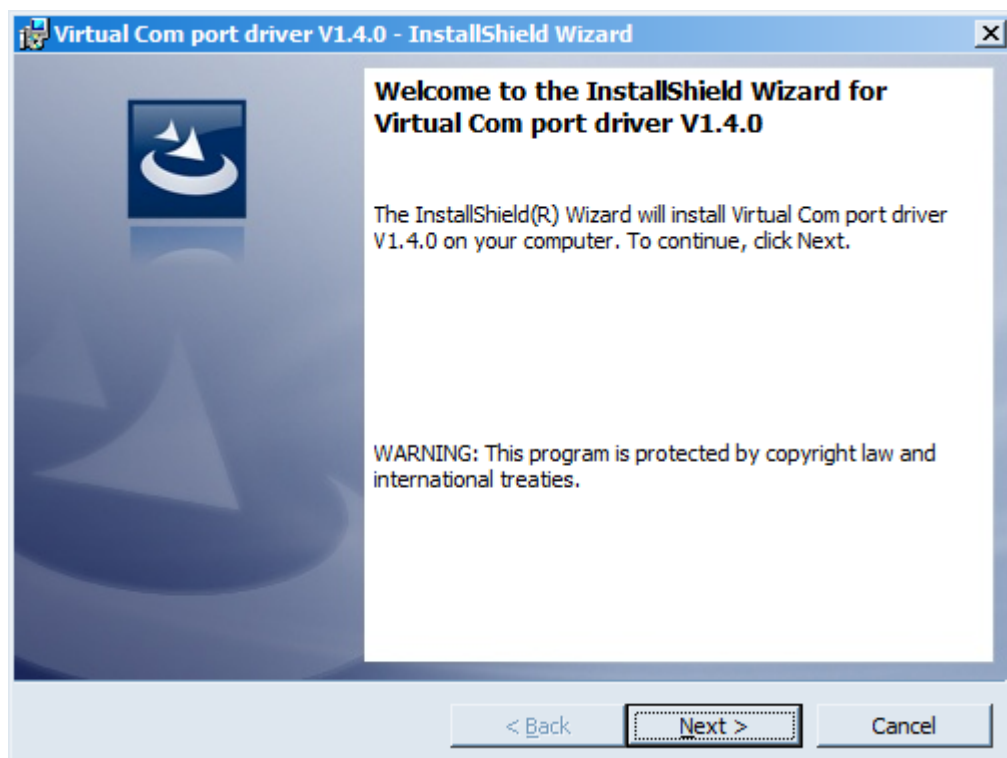
Hold the start
button located on
the board

CONNECTING VIA USB

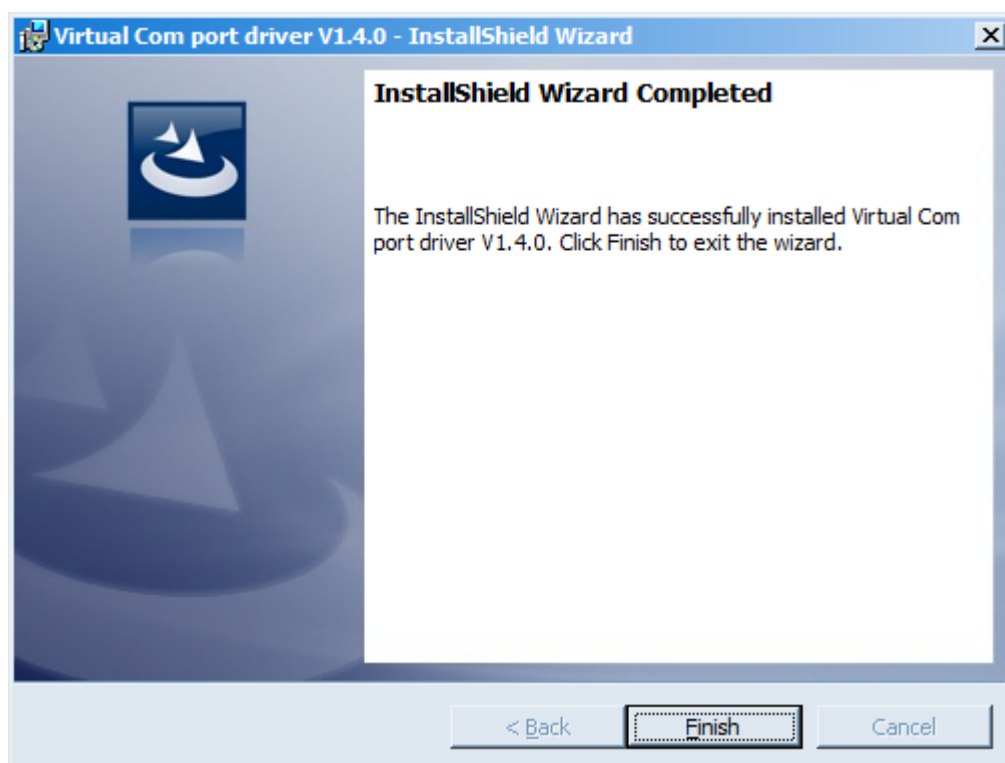
The modem can be adjusted with the "Vega LoRaWAN Configurator" application (See part 4).



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.

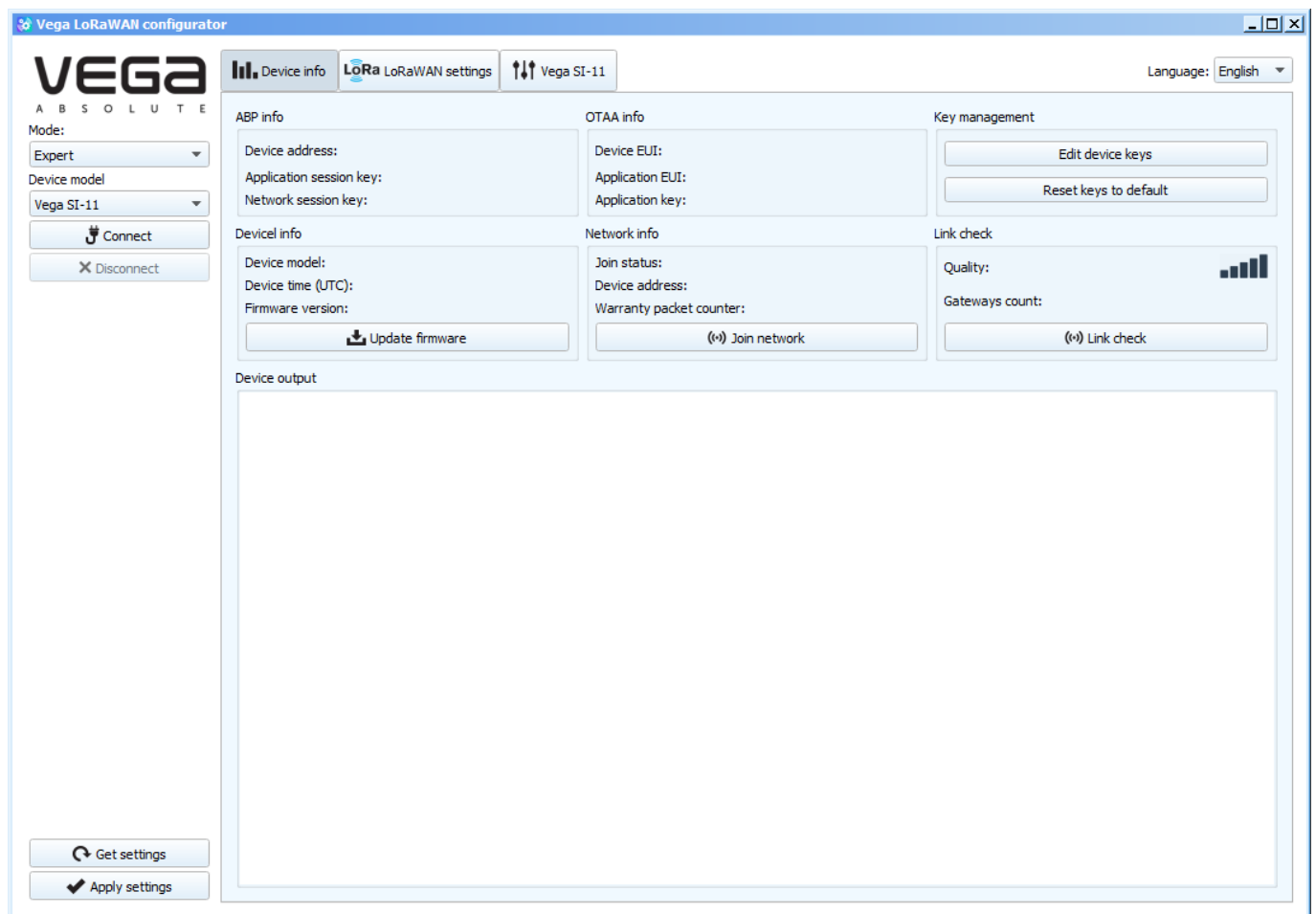
4 VEGA LORAWAN CONFIGURATOR

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.

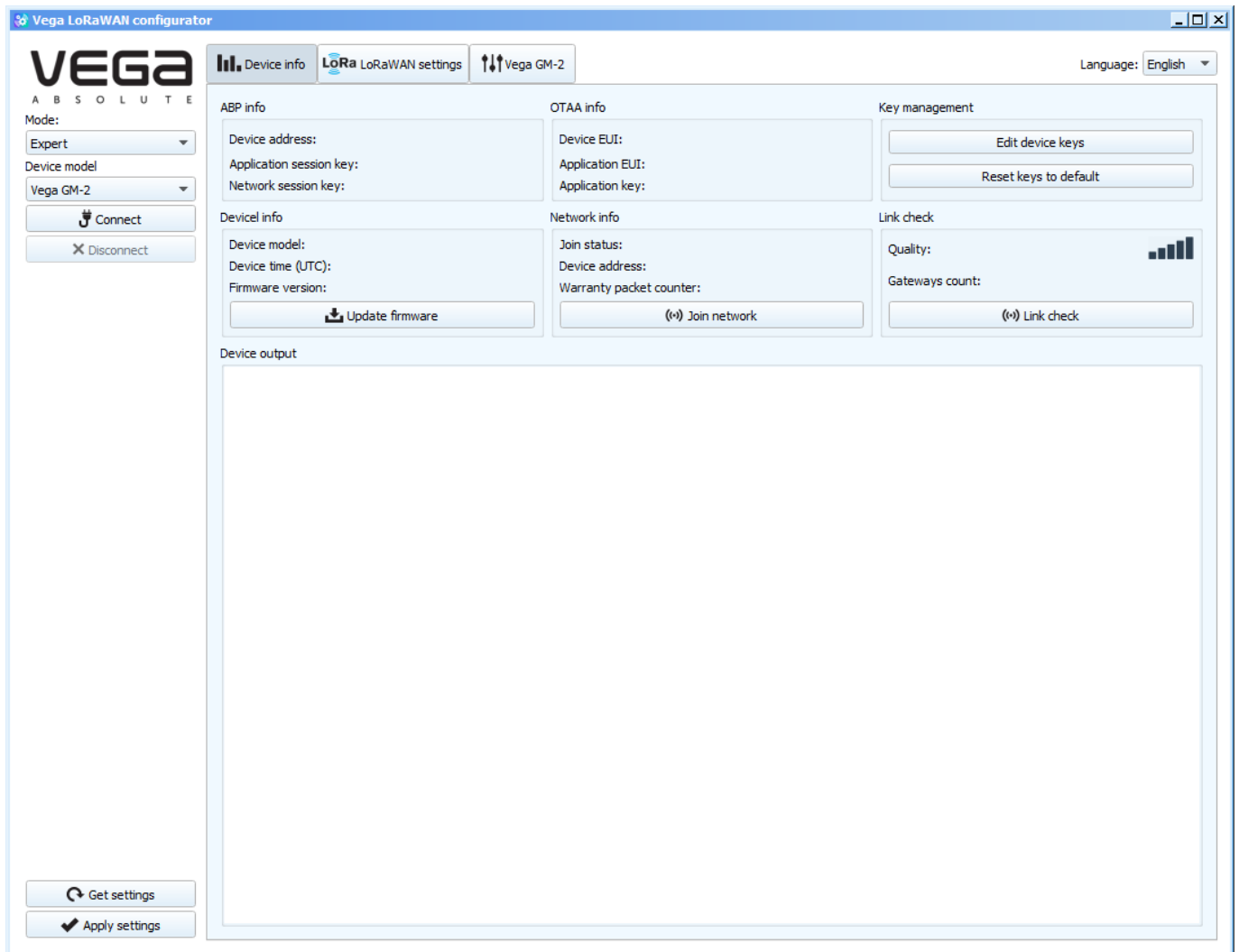
The language selection menu is in the upper right corner.

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.

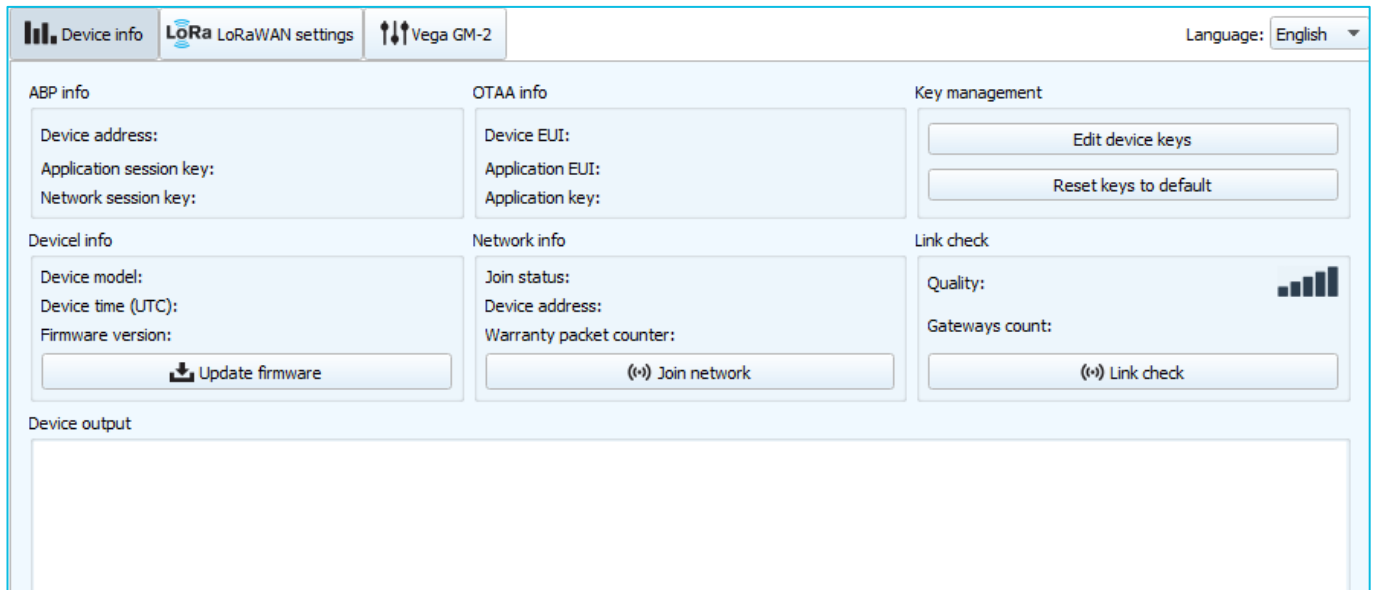


To read the settings from the device, you need to click the "Get settings" button, until this point the application will display the default settings or from the last connected device.

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.



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.

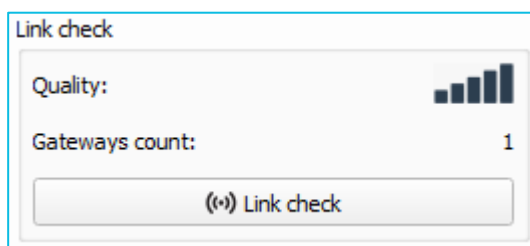
Update firmware - allows you to select the firmware file from your computer's hard drive and load it into the device. The device will automatically disconnect from the configurator when the download is complete. The current version of the device firmware can be downloaded from iotvega.com.

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 occur.

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

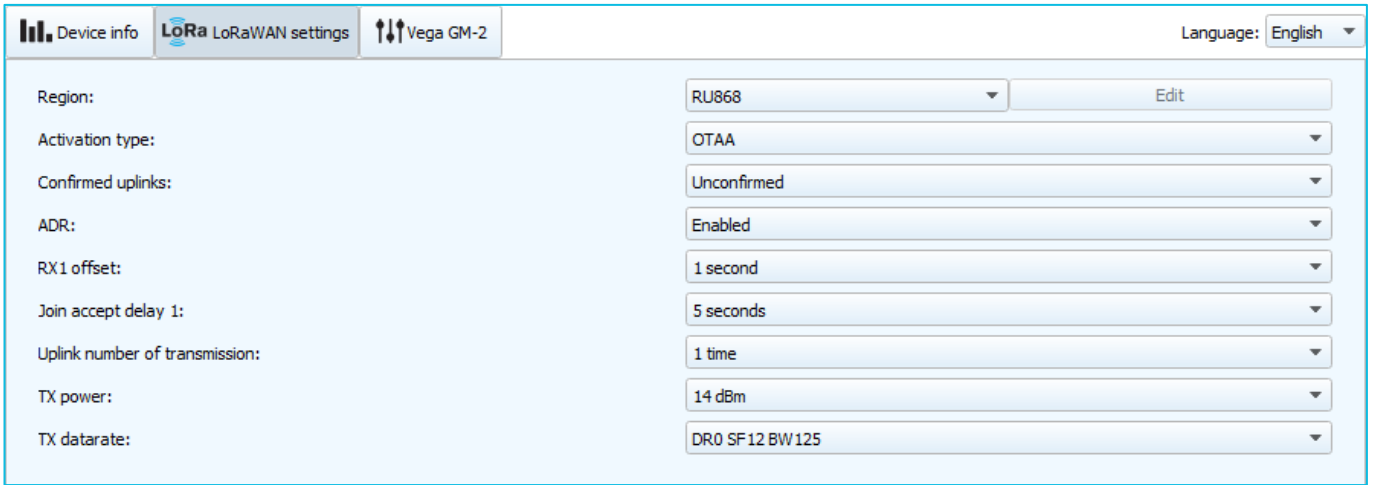
number of gateways that received this signal and the signal quality. This button only works when the device is connected to the network.



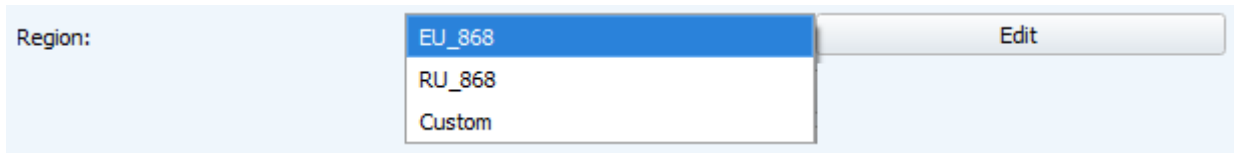
Device output (not displayed in the "Simple" mode) - monitoring the device status, all events in real time are displayed.

"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.



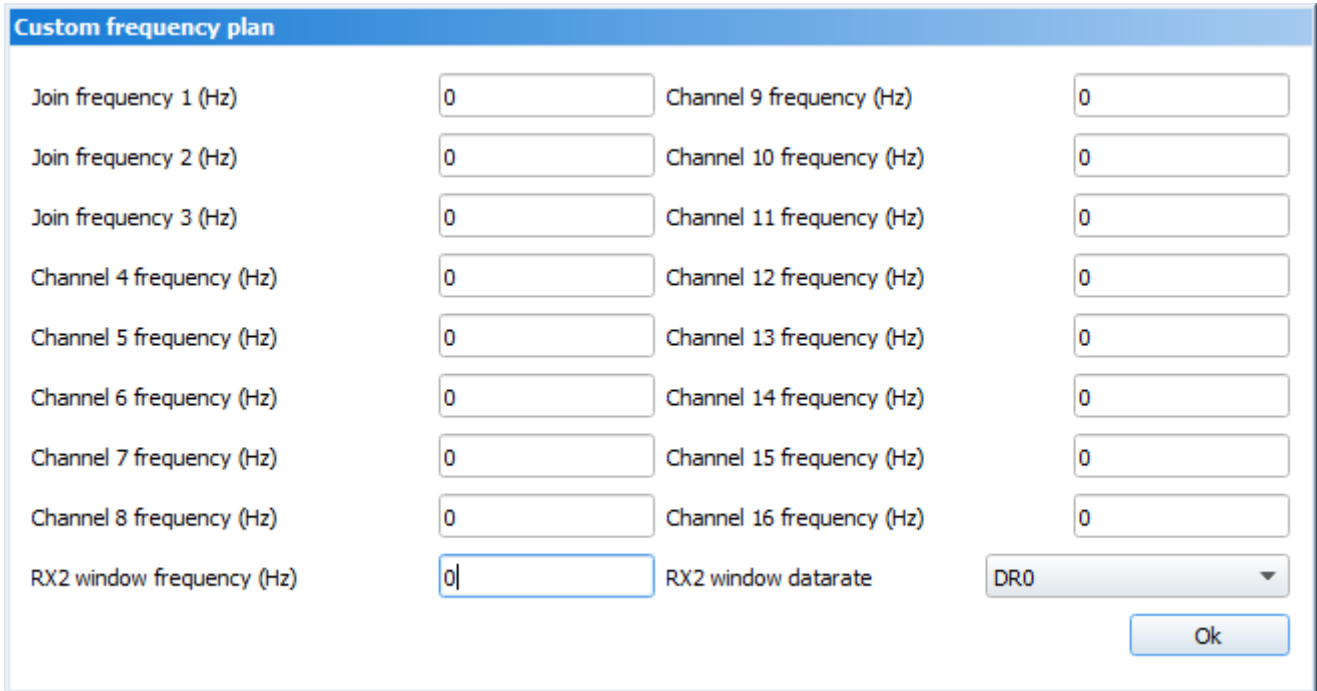
The modem supports the following frequency plans:

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

In the EU_868 and RU_868 frequency plans, 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).

¹ By default, the device supports two frequency plans and the custom, but it is possible to order firmware for other frequency plans: 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:



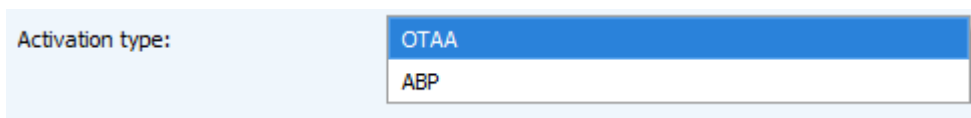
Custom frequency plan			
Join frequency 1 (Hz)	<input type="text" value="0"/>	Channel 9 frequency (Hz)	<input type="text" value="0"/>
Join frequency 2 (Hz)	<input type="text" value="0"/>	Channel 10 frequency (Hz)	<input type="text" value="0"/>
Join frequency 3 (Hz)	<input type="text" value="0"/>	Channel 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"/>

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

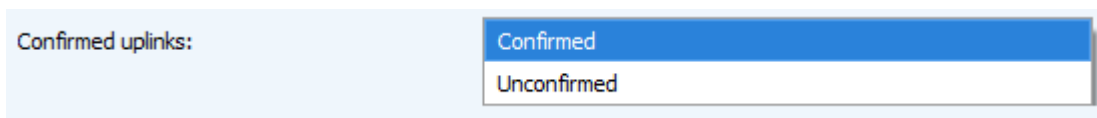


The first three channels and the second receiving window parameters are mandatory. Without these parameters the custom frequency plan will be considered empty

Activation type – 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 server side. The higher the quality of the

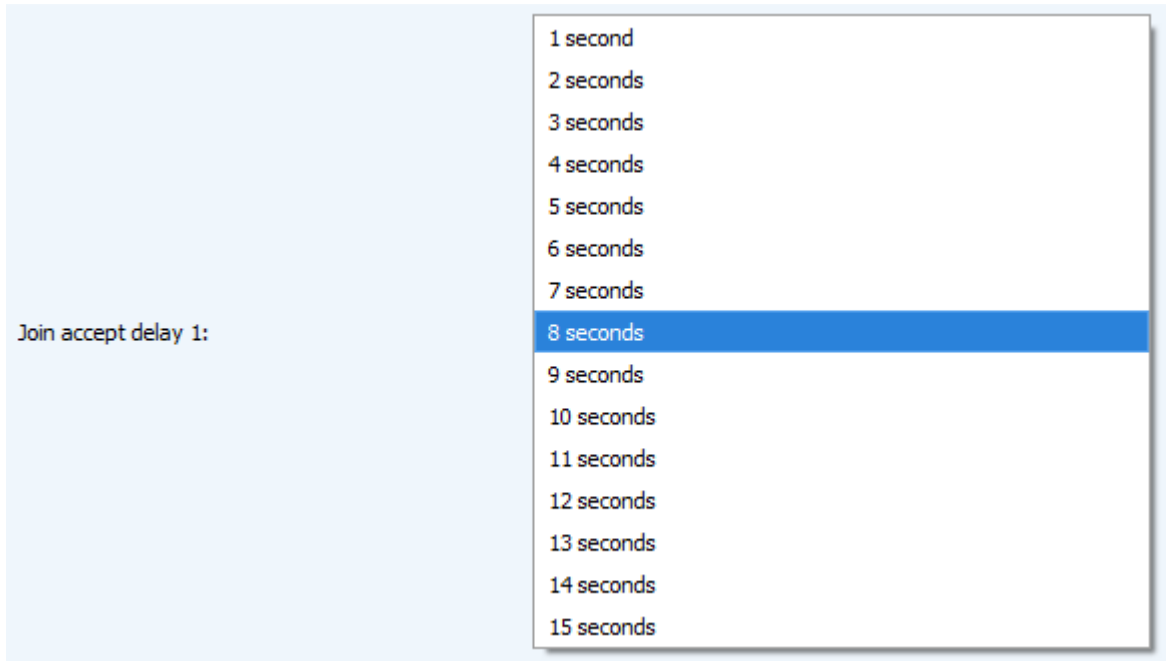
signal received by the network, the higher the speed will be installed on the device. This option is recommended only on permanently installed devices.

ADR:	Enabled
	Disabled

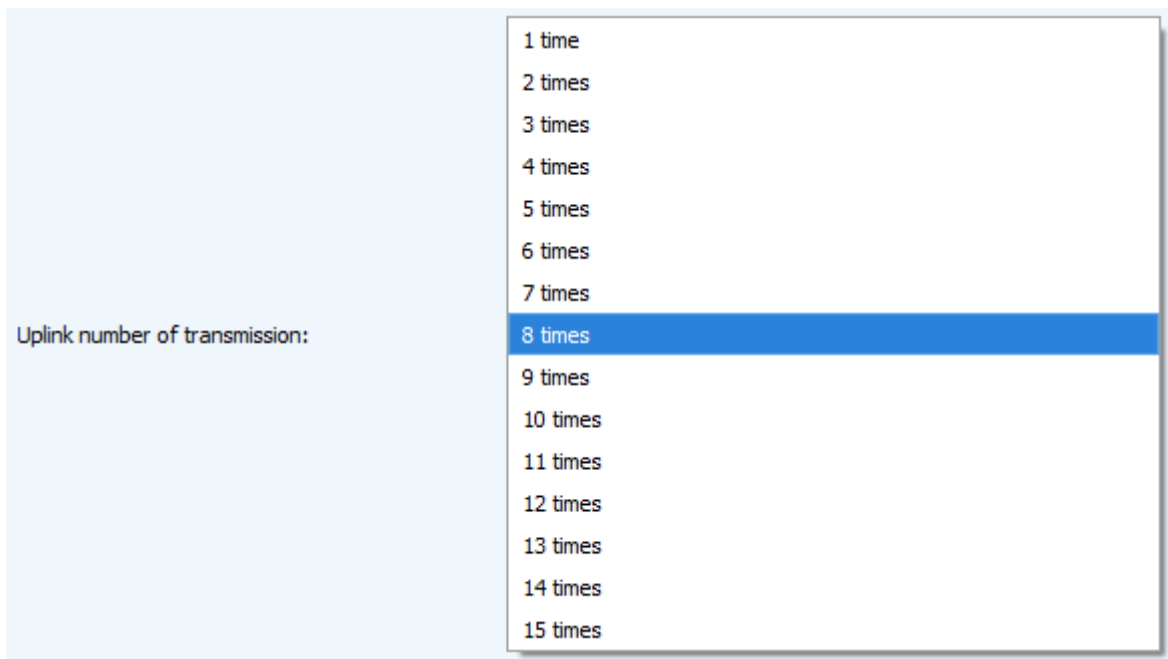
RX1 offset (not displayed in the "Simple" mode) – specifies the time between end of packet transmission and first receiving window opening. The second receiving window always opens after 1 second after the first.

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.



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.



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

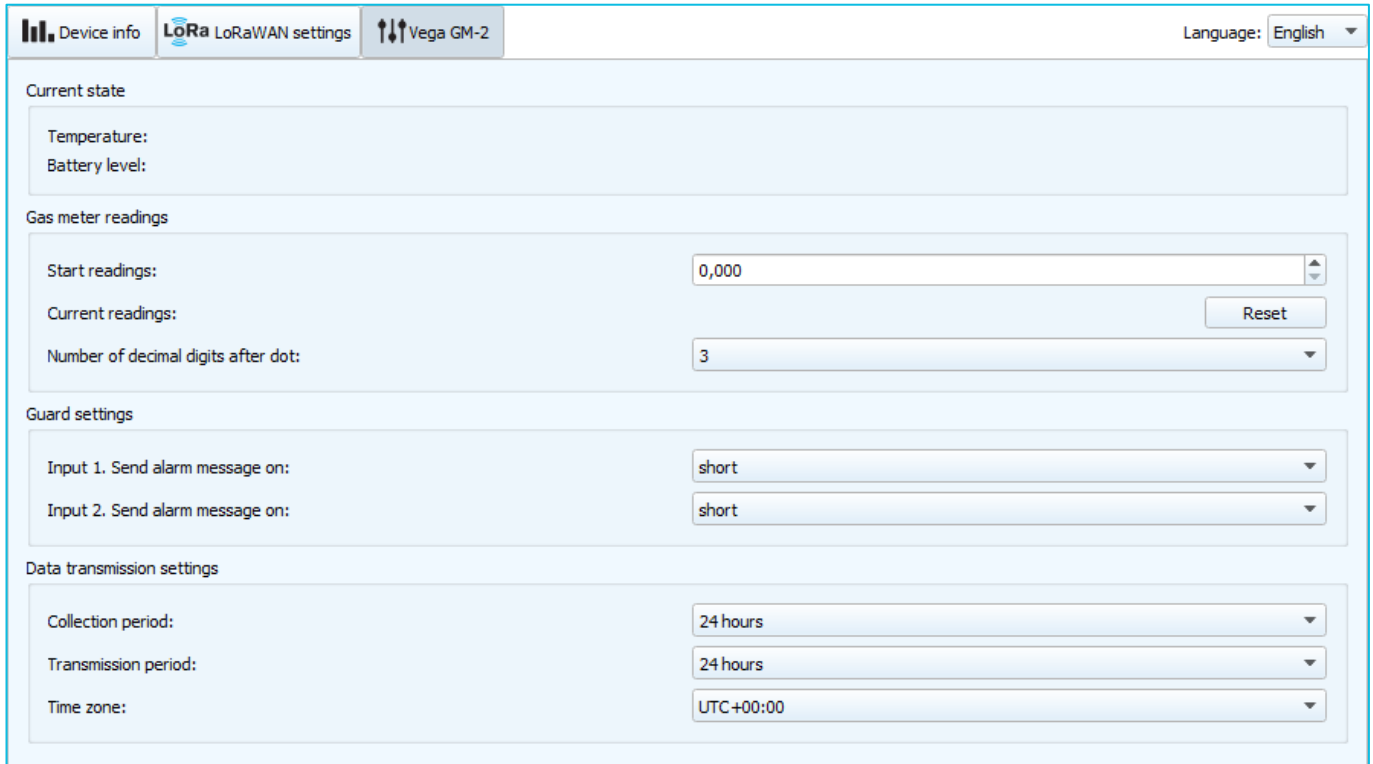
TX datarate (not displayed in the "Simple" mode) – the device transmission datarate at which it will transfer packets to the LoRaWAN network. This speed can be changed by the network server if the ADR algorithm is enabled.

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 active. In the top right corner, there is a "Language: English" dropdown menu. The main content area is divided into four sections:

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

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 1 second.

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 on, the device will send the next packet only after receiving a confirmation of the delivery of the previous one. If such confirmation have not received after the fulfilled in the settings uplink number of transmission, device completes the communication session until the next one 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 device 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 non-transmitted messages in the device memory.

5 COMMUNICATION PROTOCOL

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



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

VEGA GM-2 MODEM TRANSMITS THE FOLLOWING TYPES OF PACKETS

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.

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 == 1	
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 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

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

Size in bytes	Field description
1 byte	Packet type, this packet = 0

Answering that packet the device sent the packet with settings.

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

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 1	
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 GM-2 parameters and these possible values

ID of parameter	Description	Data length	Possible values
4	Confirmed uplinks	1 byte	1 – confirmed 2 – unconfirmed
8	Uplinks number of transmissions	1 byte	from 1 to 15
12	Input 1 mode	1 byte	1 – pulse 2 – security
13	Input 2 mode	1 byte	1 – pulse 2 – security
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
55	Time zone, in minutes	2 bytes	from -720 to 840
56	Start readings	4 bytes	Readings in a cubic meters multiplied by 1000

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.

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 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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