VEGA
ABSOLUTE

LoRaWAN Device

VEGA SI-13

User manual

Document Information	
Title	LoRaWAN Device Vega SI-13
Document type	Manual – Translation from Russian
Document number	V02-SI13-01
Revision and date	12 - 06 July 2020

This document applies to the following products:

Product line	Product name
End devices	Vega SI-13-232
	Vega SI-13-485

Revision History

Revision	Date	Name	Comments
01	23.03.2017	KEV	Document creation date
02	14.04.2017	KEV	Photos were added, minor edits
03	10.05.2017	KEV	New photos of the appearance
04	29.05.2017	PKP	A little change at the communication protocol
05	21.06.2017	KEV	Technical characteristics were changed
06	05.09.2017	KEV	Part "Vega LoRaWAN Configurator" was added, and some additions at the communication protocol
07	23.10.2017	KEV	Minor edits
08	04.05.2018	KEV	Edits concerning the field of application with meters with pulse outputs, minor edits, new illustrations in the "Operation" part
09	21.12.2018	KEV	"Transparent mode operation" and "Marking" parts added, device AppEui added in specification
10	21.05.2019	KEV	Typo in communication protocol fixed in bit field decoding table – bits 6 and 7
11	14.08.2019	KEV	Typo on the 28th page in the '5' packet description
12	06.07.2020	KEV	Scheduled revision of the document, minor changes

CONTENTS

INTRODUCTION

This manual is designated for Vega SI-13-232 and Vega SI-13-485 converters (hereinafter – the converter) manufactured by Vega-Absolute OOO and provides information on powering and activation procedure, control commands and functions of the converter.

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

> **To provide the stable radio between the gateway and the end device it is recommend avoiding the device installation in the places which are barriers for the radio signal getting through like a reinforced floors and walls, a basement, an underground facilities and wells, a metal case etc.**
> **The necessary stage for the network deploying including a big quantity of end devices is a radio planning work with nature experiments**

Vega-Absolute OOO reserves the right to make changes to the manual related to the improvement of equipment and software, as well as to eliminate typos and inaccuracies, without prior notice.

1 DESCRIPTION AND OPERATION

DEVICE DESCRIPTION

Vega SI-13 has two design options, varying by data exchange interface:

- o Vega SI-13-232 with RS-232 interface;
- o Vega SI-13 -485 with RS-485 interface.

Vega SI-13 converter is designed for counting of pulses incoming to 2 independent inputs, further accumulating and transmitting of this information via the LoRaWAN protocol to the gateway through wireless communication within 860-1000 MHz frequency band.

In addition, Vega SI-13 can be used as a security device - all inputs can be configured as security inputs.

The converter can be used for any utilities' meters and industrial equipment with RS-232 and RS-485 interfaces or pulse outputs, including water-, electricity-, and heat meters. Vega SI-13 can work as a wireless modem or query some meters' models.

> **Equipment with NAMUR pulse output is not supported**

De-bouncing logics with 5 msec time constant is integrated in the converter. The pulse counting is carried out for frequencies up to 200 Hz.

The converter is powered by an 8...36 V external power supply.

FUNCTIONAL

Vega SI-13 converter is class C device (LoRaWAN classification) and has the following features:

- o Operation as LoRaWAN <-> RS-232 or LoRaWAN <-> RS-485 wireless modem
- o Query of some meters' models
- o ADR support (Adaptive Data Rate)
- o Sending of confirmed packets (configurable)
- o Inputs can be switched to «security» mode for connection to external leakage and safety sensors, etc.
- o Communication in case of security inputs actuation
- o Temperature measurement

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	
Double-contact digital inputs	up to 2
Maximum input frequency	200 Hz
Security inputs	up to 2
Interface	RS-232 or RS-485
USB-port	yes
Operating temperatures	-40...+85 °C
Built-in temperature sensor	yes
LoRaWAN	
AppEui by default	7665676173693133
LoRaWAN class	C
Quantity of LoRaWAN channels	16
Frequency band	EU-868, RU-868, custom
Activation type	ABP or OTAA
Communication period	1, 6, 12 or 24 hours
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	
External power supply	8...36 V
Case	
Housing dimensions	95 x 50 x 45 mm
Ingress protection rating	IP65
Mounting	clamp fastening to the support, DIN-rail, wall-mounting

3 OPERATION

CONTACTS
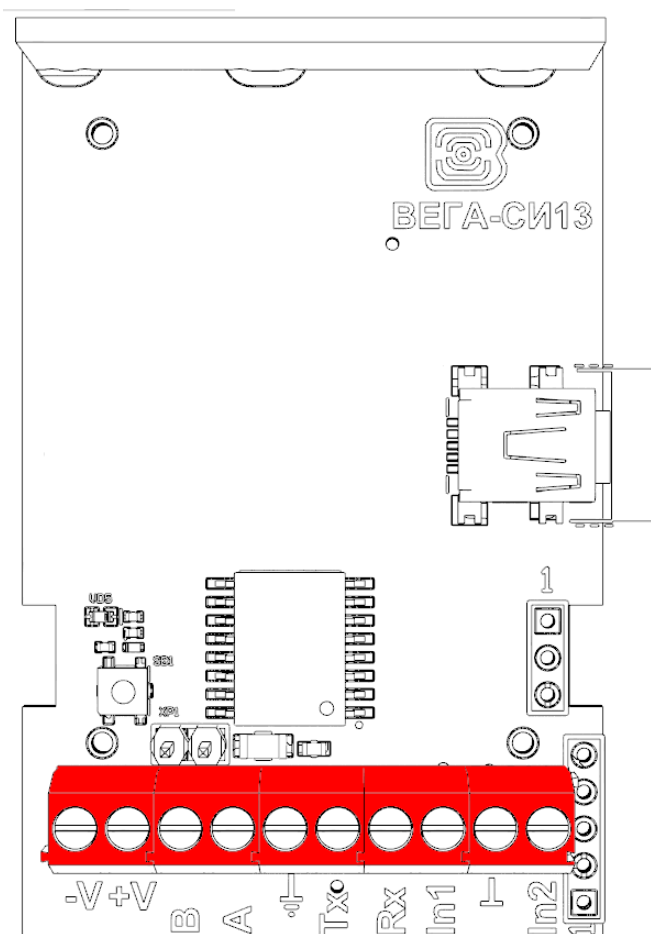
The converter has 10 contacts, see table below:

Contact	Description
-V	Power -
+V	Power +
B	RS-485 B
A	RS-485 A
Tx	RS-232 TX
Rx	RS-232 RX
$\perp$, $\perp$	Signal ground
In1, In2	Pulse inputs 1 and 2

Ground "⏚" contact is used for connecting of RS-232 or RS-485; ground "⊥" is used for connecting of pulse inputs 1 and 2.

The converter pulse inputs are used to connect circuits with the following types of NO contacts:

- reed switch (Herkon);
- mechanical pushbutton;
- open-collector output.

**Equipment with NAMUR pulse output is not supported**

Any input can be configured for work in the "Security" mode with special software when connected to the converter via USB. In this case, the device does not count pulses at the "Security" input, but only monitors its closure. Should the "Security" input close, the device is activated and sends an alarm message to the network.

When connecting a radio modem to external devices, consider the internal circuitry of its pulse inputs shown below.
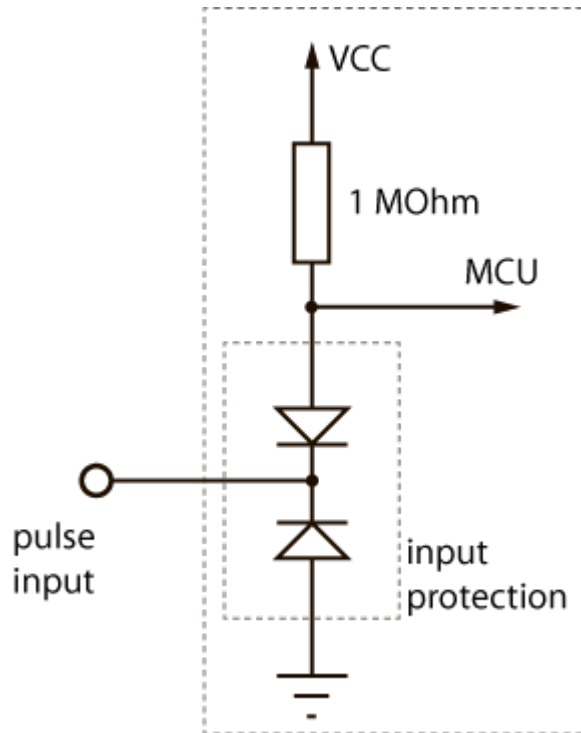
INDICATION

There is one red LED on the terminal board. The indication is only used when the device is activated in the LoRaWAN network.
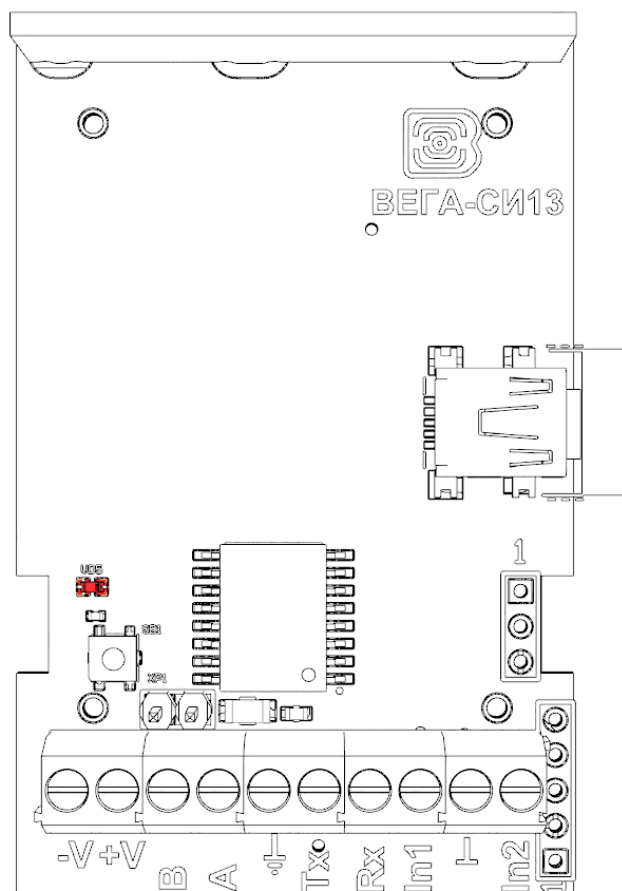
LED signal		Meaning
●●●	Series of short flashings	Linking to the network
▬▬▬▬	One long flashing	The device connected to the network and is in active mode
▬▬ ▬▬ ▬▬	Three long flashings	Linking to the network is unsuccessful or the device switched to the «Storage» mode

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

INITIAL STARTUP

VEGA SI-13 supports two activation methods in the LoRaWAN network - ABP and OTAA. Select one of the methods using "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 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 converter switches to the "Storage" mode.

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

> **When switching to the "Storage" mode, all readings from the pulse inputs accumulated in the device memory are reset**
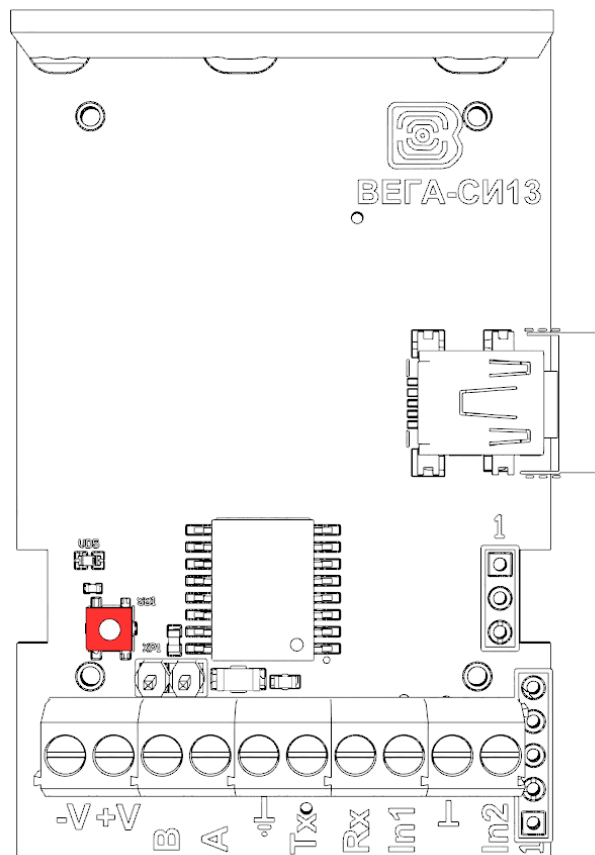
TRANSPARENT MODE OPERATION

For enable using converter in conjunction with various software systems dispatching of meters and industrial equipment, there is an ability to operating in a transparent mode. In this mode, the converter operates as a simple communication channel between the LoRaWAN network server and connected external device. SI-13 can receive data from the LoRaWAN network for external devices and transfer them to the RS-232/RS-485 interface without any processing. If the external device responds to the request, the converter sends the received data back to the network, also without processing, as one or more packets.

Thus, in transparent mode, the converter does not form a request and does not process the response from the metering device. The duty to form requests and analyze the responses lies entirely on the external application that works with SI-13 through the LoRaWAN network.

To provide device operation in the transparent mode it is necessary to install "LoRa2TCP" application downloading on the iotvega.com. There is a manual about initial setting of the transparent mode on the device page.

CONNECTING VIA USB

The converter 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:
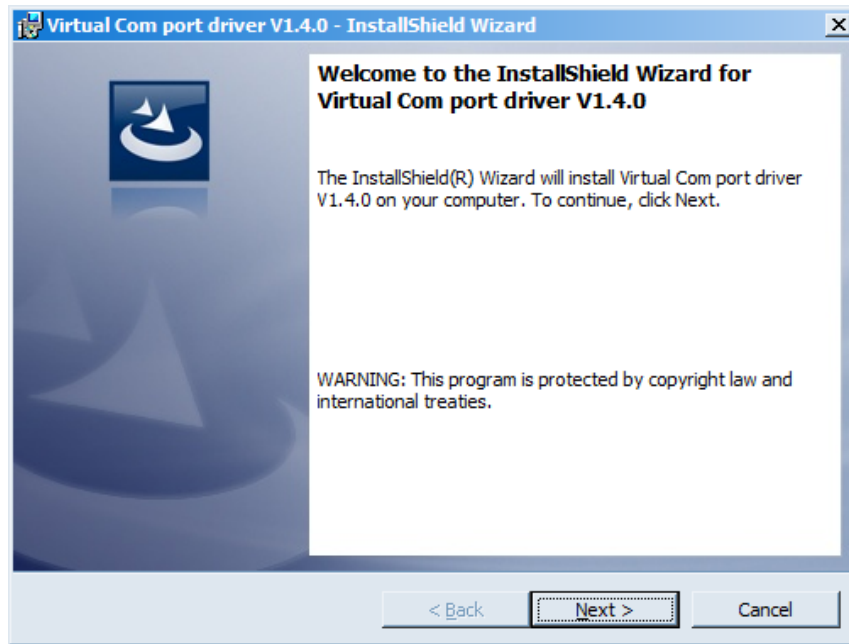
In this window, you need to click **Next**, then **Install**, and then the installation will begin. When the installation is completed successfully, the following screen appears:
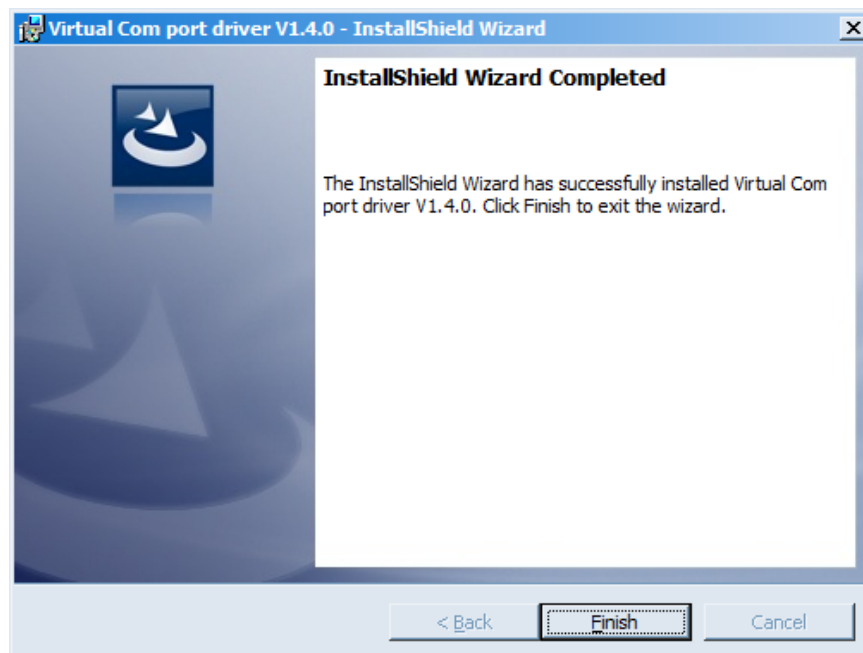
After pressing **Finish** the driver is ready for operation, - it is possible to connect the converter via USB.

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.
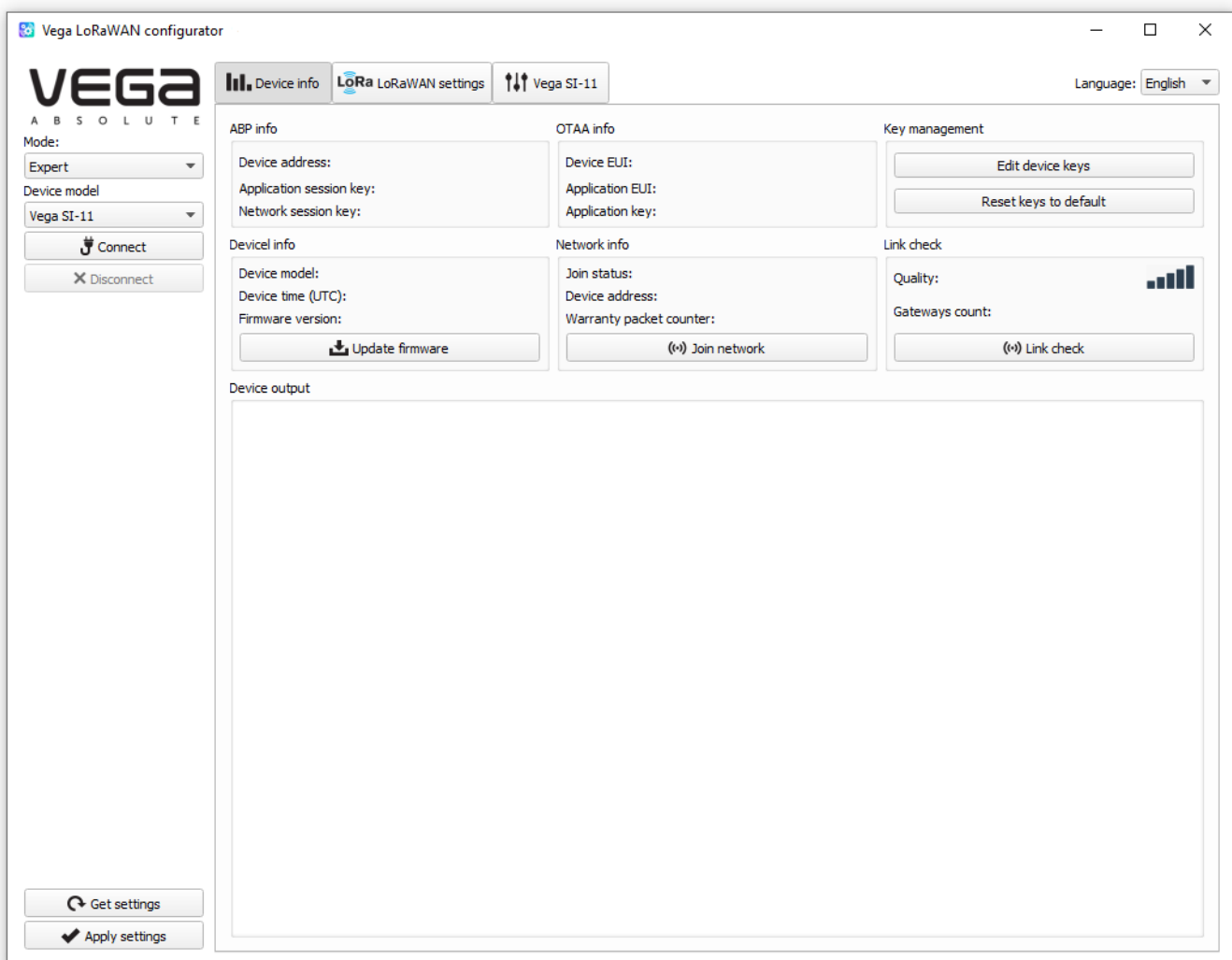
The menu on the left allows you to switch between the "Simple" and "Expert" modes, select the device model, connect to the device, or disconnect from it, get, and apply settings.

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.
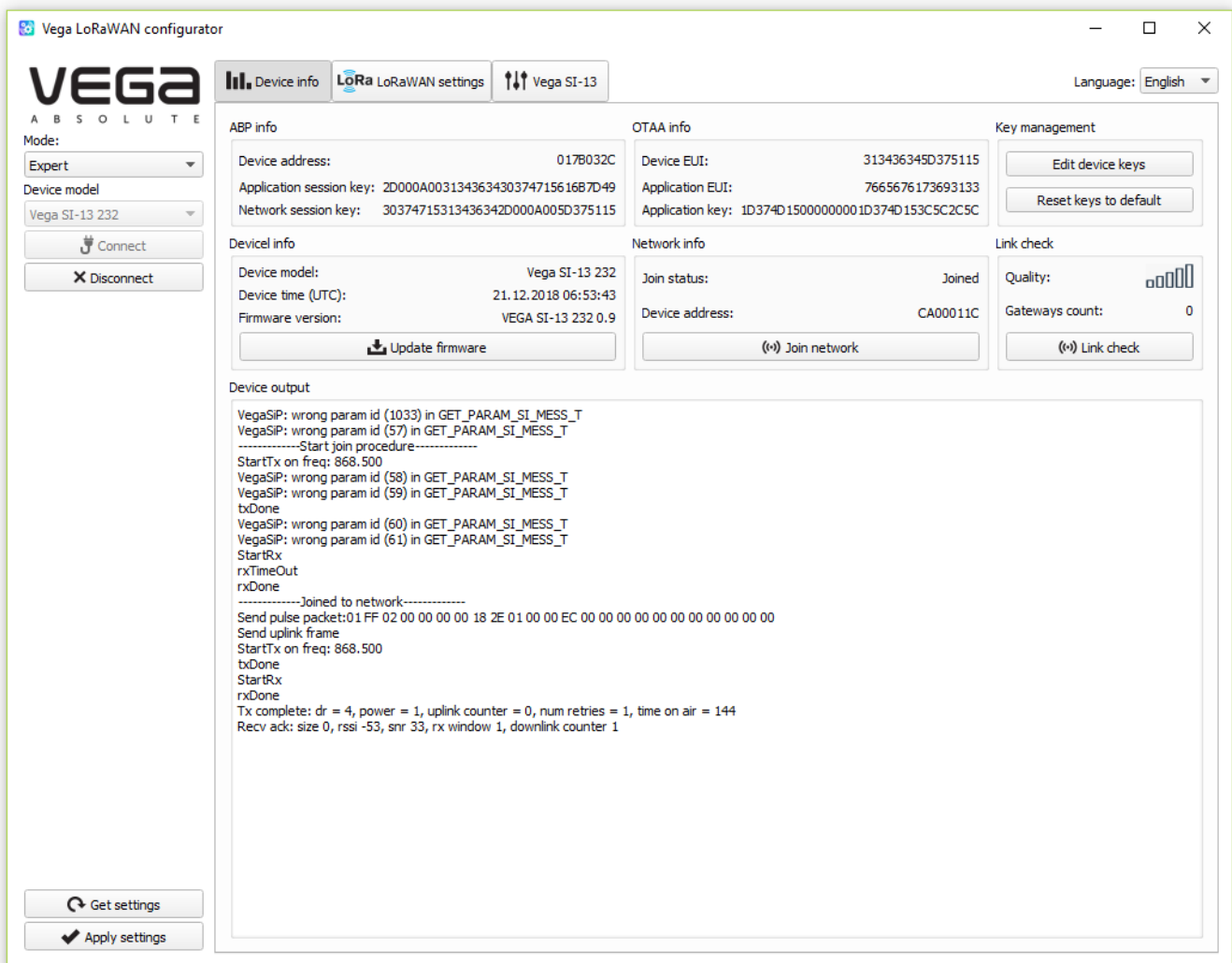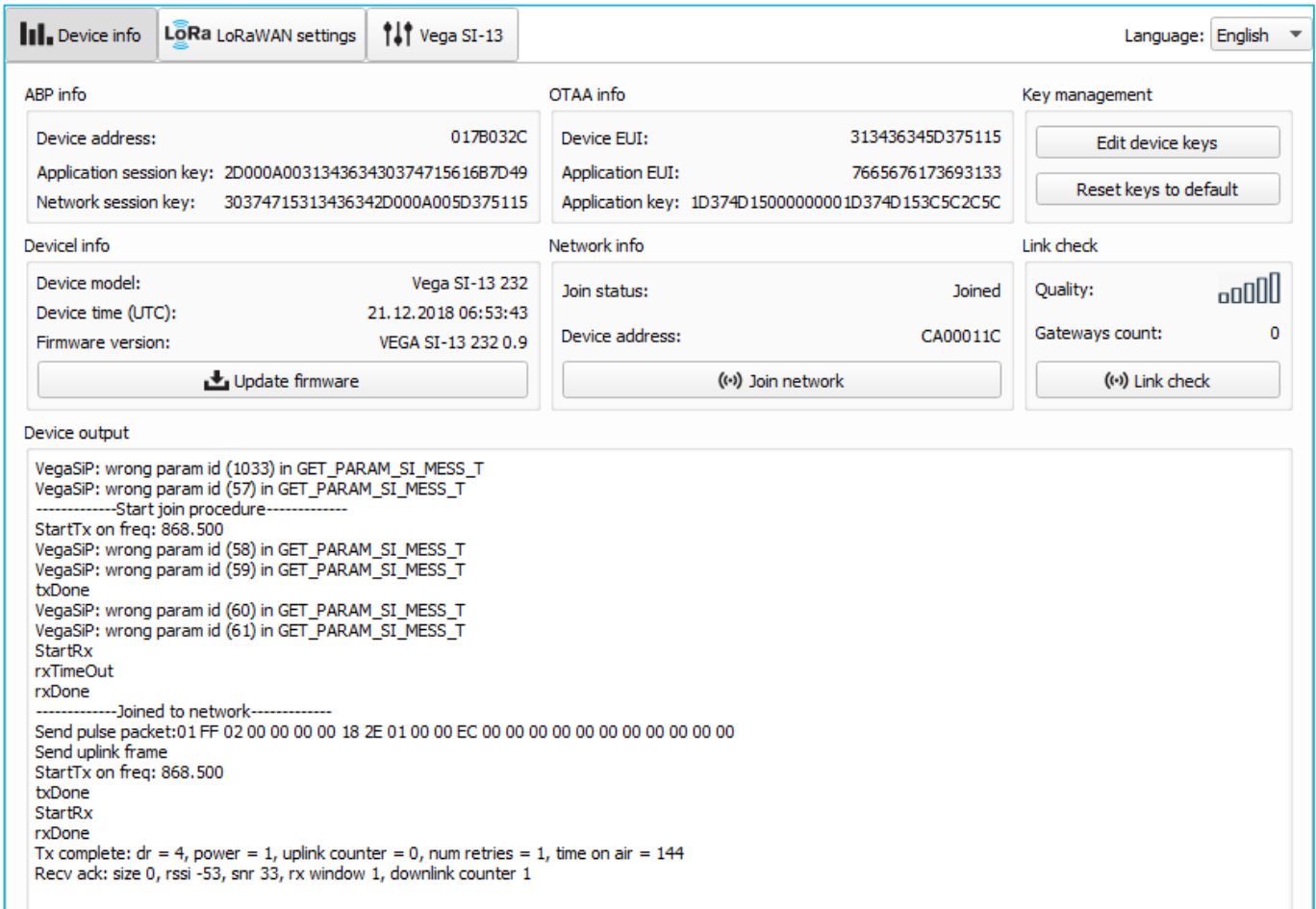

To read the settings from the device, you need to click the "Get settings" button, until this point the application will display the default settings or from the last connected device.

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 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 connecting 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.
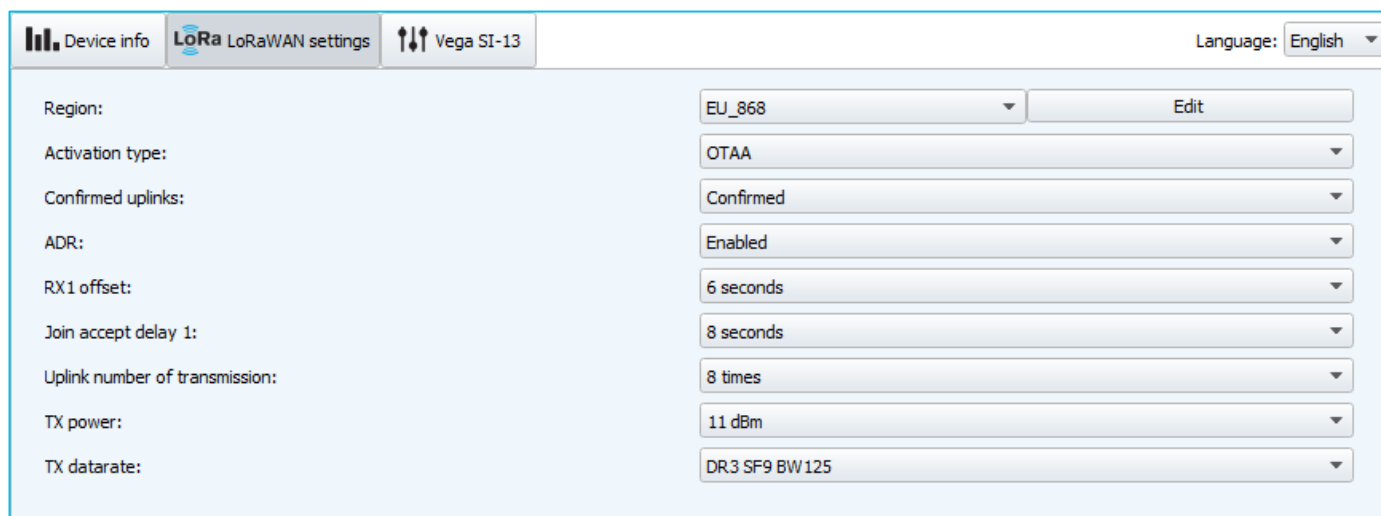
Link check (not displayed in the "Simple" mode) - when pressed, the device sends a special signal to the LoRaWAN network, in response to which the network informs it of the number of gateways that received this signal and the signal quality. This button only works when the device is connected to the network.
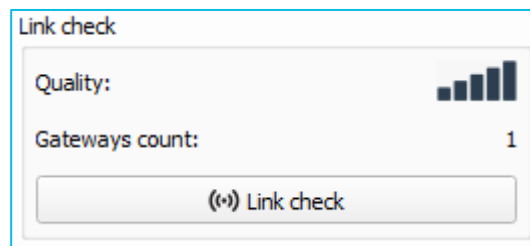
Device output (not displayed in the "Simple" mode) - monitoring the device status, all events in real time are displayed.
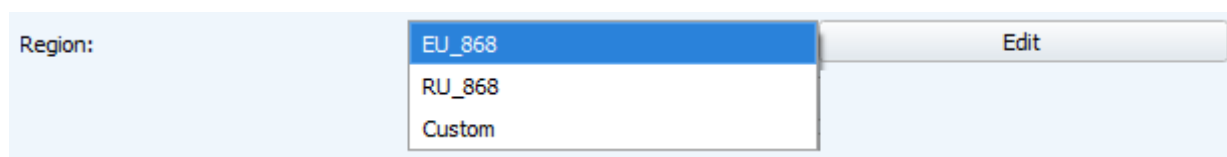
"LORAWAN SETTINGS" TAB

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.
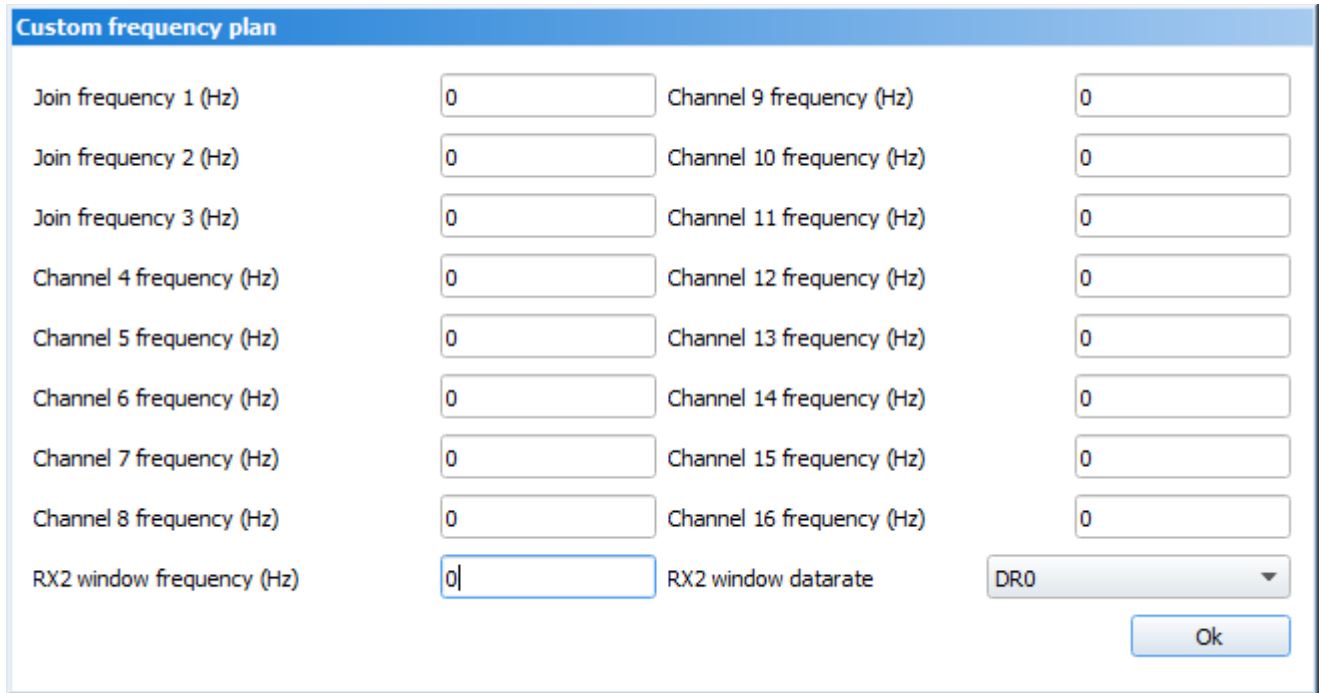

The converter supports the following frequency bands:

Frequency band	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	864.5	MultiSF 125 kHz
	2	864.7	MultiSF 125 kHz
	3	864.9	MultiSF 125 kHz
	RX2	869.05	SF12 125 kHz
Custom	Set with «Vega LoRaWAN Configurator» application		

In the EU_868 and RU_868 frequency bands, only 3 channels are active by default. The device sends requests for connection to the network on this "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).

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:
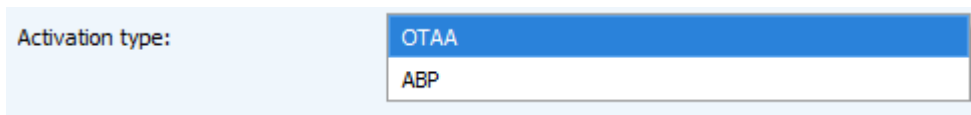

This frequency band allows you to set up to 16 channels, as well as the frequency and speed of the second receiving window.
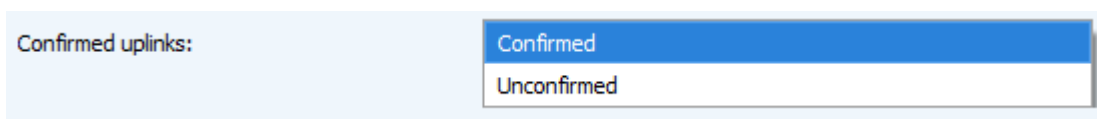
> **The first three channels and the second receiving window parameters are mandatory. Without these parameters the custom frequency band will be considered empty**

Activation type – selecting 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).

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.

| ADR: | Enabled |
| | Disabled |

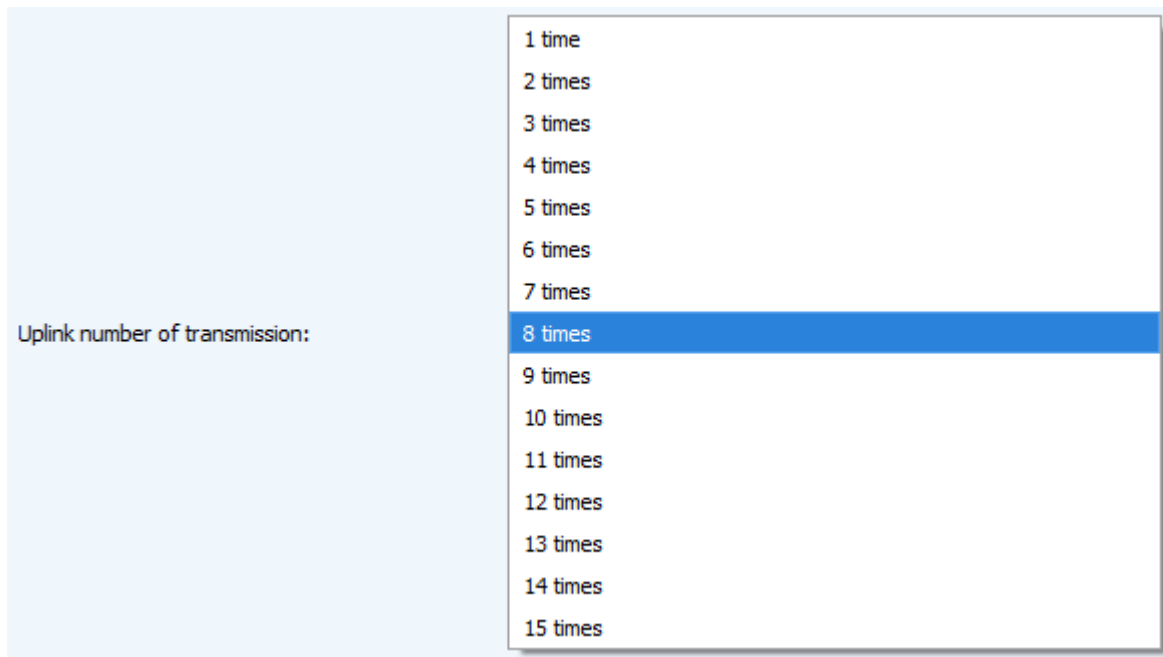**RX1 offset** (not displayed in the "Simple" mode) – specifies the time between end of packet transmission and first receiving window opening. The second receiving window always opens after 1 second after the first.

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. 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

ADR:

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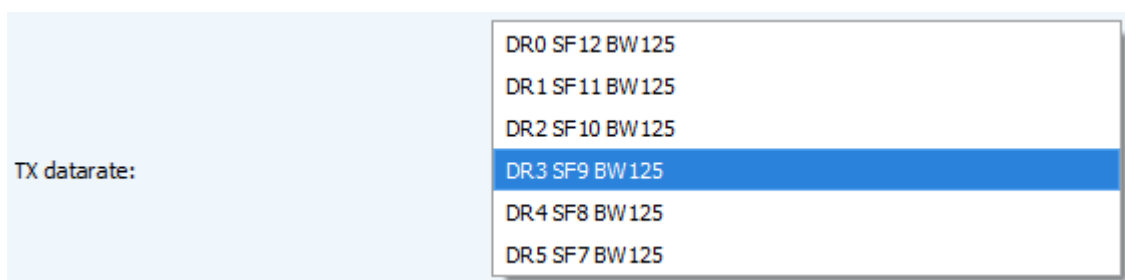
Uplink number of transmission:	1 time
	2 times
	3 times
	4 times
	5 times
	6 times
	7 times
	8 times
	9 times
	10 times
	11 times
	12 times
	13 times
	14 times
	15 times

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.

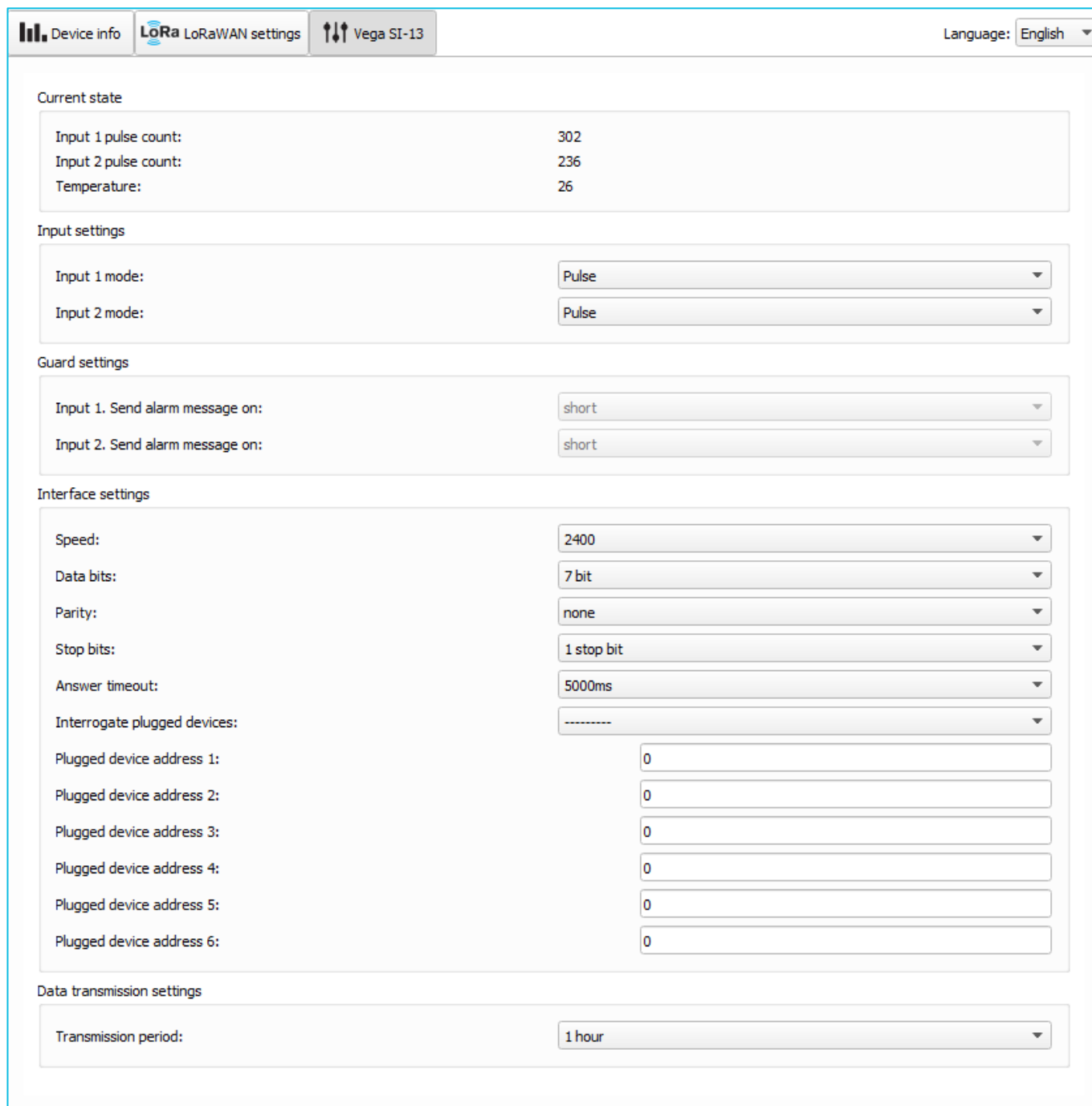| TX power:	2 dBm
	5 dBm
	8 dBm
	11 dBm
	14 dBm
	20 dBm
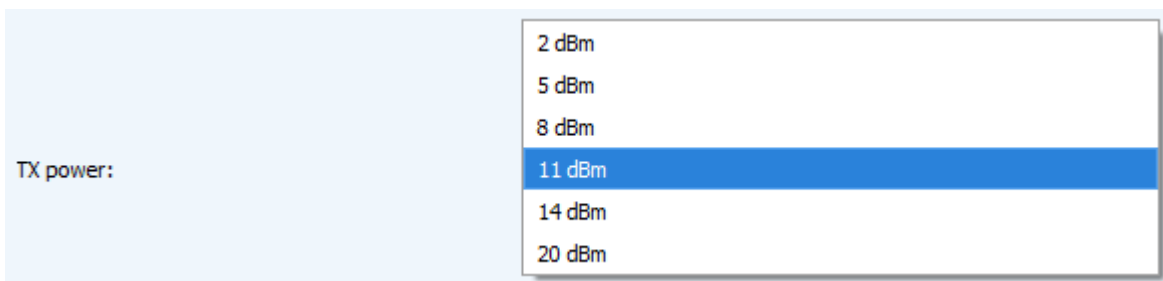
TX datarate (not displayed in the "Simple" mode) – the device transmission datarate at which it will transfer packets to the LoRaWAN network. This speed can be changed by the network server if the ADR algorithm is enabled.

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

"VEGA SI-13" TAB

The "Vega SI-13" tab contains the settings of the connected device.

Current state – displays the current parameters of the device - the number of counted pulses at the inputs and the temperature.

To reset the collected readings from device memory, it is necessary to put the device in the "Storage" mode by pressing the button on the board for a long time (more than 5 seconds) (see section "Initial startup").

Input settings – allow you to change the operation of the pulse inputs from the counting of pulses to the security mode and back. When transferring the input to the security

mode, the device will send an alarm packet to the network (See part 5, packet 2) whenever this input is closed. The maximum possible frequency of sending alarm packets is one per 10 seconds.

Guard settings – allows setting up the work of security inputs, namely, what kind of security input state changing is reason to send an alarm message: short, open, or both of them.

Interface settings – RS-232 or RS-485 interface settings depending on the type of the connected device.

Data transmission settings – the transmission period which the packet with the current readings is transmit (See part 5, packet 1).

5 COMMUNICATION PROTOCOL

This part describes the SI-13 data exchange protocol with LoRaWAN network. SI-13 uses the LoRaWAN port 2 for uplink and downlink messages.

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

VEGA SI-13 CONVERTER TRANSMITS THE FOLLOWING TYPES OF PACKETS

1. Packet with current readings, sent regularly

Size in bytes	Field description	Data type
1 byte	Packet type, this packet = 1	uint8
1 byte	*Reserve*	-
1 byte	Values of basic settings (bit field)	uint8
4 bytes	*Reserve*	-
1 byte	Temperature, °C	int8
4 bytes	Input 1 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	Input 2 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	*Reserve*	-
4 bytes	*Reserve*	-

"Values of basic settings" bit field decoding

Bits	Field description
0 bit	Activation type: 0 - OTAA, 1 – ABP
1 bit	Query for packet confirmation: 0 – off, 1 – on
2,3 bits	Communication period: |3==0 |2==0| - 1 hour |3==0 |2==1| - 6 hours |3==1 |2==0| - 12 hours |3==1 |2==1 | - 24 hours
4 bits	First input type: 0 – pulse, 1 - security
5 bits	Second input type: 0 – pulse, 1 - security
6 bits	*Reserve*
7 bits	*Reserve*

2. «Alarm» packet sent in case of security input closure

Size in bytes	Field description	Data type
1 byte	Packet type, this packet = 2	uint8
1 byte	*Reserve*	-
1 byte	Values of basic settings (bit field)	uint8
1 byte	Input No, where the alarm is detected (1 or 2)	uint8
4 bytes	Input 1 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	Input 2 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	*Reserve*	-
4 bytes	*Reserve*	-

3. Data packet from an external device, received via RS-232 or RS-485 interface

Size in bytes	Field description	Data type
1 byte	Packet type, this packet = 3	uint8
2 bytes	Total data size received via interface	uint16
1 byte	Data size in this packet	uint8
1 byte	Packet ordinal number	uint8
1 byte	Total quantity of packets	uint8
Array	Data	-

The LoRa data transfer technology limits the maximum packet size, depending on the speed of packet transmission. If the readings log cannot be sent in one packet, it is divided into several packets, which are sent in series until the entire requested log is sent. Records in the log packet are arranged from the newest to the oldest.

4. Packet with current readings from connected meter Mercury 206, sent regularly or on request

Size in bytes	Field description	Data type
1 byte	Packet type, this packet = 4	uint8
4 bytes	Meter address	uint32
1 byte	Result (1 – success, 0 – fail)	uint8
4 bytes	Reading rate 1	uint32
4 bytes	Reading rate 2	uint32
4 bytes	Reading rate 3	uint32
4 bytes	Reading rate 4	uint32

5. Packet with the confirmation of the execution of the command

Size in bytes	Описание поля	Data type
1 byte	Packet type, this packet = 5	uint8
1 bytes	Command code which must be confirm	uint8
1 byte	Result of the execution (1 – success, 0 - fail)	uint8

VEGA SI-13 CONVERTER RECEIVES PACKETS OF THE FOLLOWING TYPES

1. Data sending to RS-232 or RS-485 interface

Size in bytes	Field description	Data type
1 byte	Packet type, this packet = 4	uint8
array	data	-

Upon receiving this packet, SI-13 will transfer the data contained therein to the RS-232 / RS-485 interface (depending on the model). In the event that the external device connected via the interface answers within the timeout specified in the SI-13 settings, the response will be transmitted to the LoRaWAN network.

The LoRa data transfer technology limits the maximum packet size, depending on the speed of the device operation. The packet size sent to the device shall not exceed 51 bytes.

If the larger packet is required, the external application is to query the network server if the current speed of the device operation allows sending larger packets. The table below shows the maximum packet sizes for different speeds

Data rate	Spread factor	Maximum packet size
DR0	SF12	51 bytes
DR1	SF11	51 bytes
DR2	SF10	51 bytes
DR3	SF9	115 bytes
DR4	SF8	222 bytes
DR5	SF7	222 bytes

2. Command to change the RS232 / RS485 interface settings

Size in bytes	Field description	Data type
1 byte	Packet type, this packet = 5	uint8
4 bytes	Interface speed. May be equal to values 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	uint32
1 byte	Number of data bits, may be equal to 7 or 8	uint8
1 byte	Parity. 0 – none, 1 – even, 2 – odd	uint8
1 byte	Number of stop bits. May be equal to 1 or 2.	uint8
2 bytes	Response timeout. May be equal to 100, 500, 1000, 3000, 5000	uint16

When a packet of this type is received, the device will send a packet confirming the execution of the command.

3. Command for an extraordinary survey of the connected meter

Size in bytes	Field description	Data type
1 byte	Packet type, this packet = 6	uint8
1 byte	Meter type. May be equal to: 1 – Single-phase electric meter Mercury 20X series	uint8
4 bytes	Meter address	uint32

After receiving this command, SI-13 will poll the meter with the specified address. Based on the results of the survey, a packet will be sent with the current readings of the connected meter.

6 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega SI-13 converter shall be stored in the original packaging in heated room at temperatures +5°C to +40°C and relative humidity less than 85%.

The converter 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 converter is delivered complete with:

1. Vega SI-13-232 converter – 1 pc.

Screw – 4 pcs.

Factory certificate – 1 pc.

2. Vega SI-13-485 converter – 1 pc.

Screw – 4 pcs.

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 undertakes to comply with the terms and conditions of transportation, storage and operation specified in this user manual.

Warranty does not apply to:

- 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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