TEMPERATURE SENSOR
VEGA TD-11

User Manual

Vega TD-11 is used for measurement air and non-aggressive gases temperature and further transmitting of this data to the LoRaWAN network

Vega TD-11 can act as a security sensor and send extraordinary alarm message by the triggering security input

Document Information

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Product name	Type number
End devices	Vega TD-11

Revision History

Revision	Date	Name	Comments
01	14.09.2017	KEV	Document creation date
02	13.03.2018	KEV	Changes in specification
03	22.01.2019	TII, KEV	Changes in specification, in communication protocol, in device operation logic, in warranty, "Marking" part added
04	24.01.2019	KEV	Inaccuracy in communication protocol fixed – packet type for packets with settings and request of settings
05	10.06.2019	KEV	Settings 80 and 81 corrected

CONTENTS

INTRODUCTION

This manual is designated for Vega TD-11 device (hereinafter – device, converter) manufactured by Vega-Absolute LLC and provides information on powering and activation procedure, control commands and functions of the device.

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

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

1 DESCRIPTION AND OPERATION

The device Vega TD-11 is designed for measurement atmosphere temperature (air and non-aggressive gases) by the external thermistor and further transmitting of this data to the LoRaWAN network.

Also, device can act as a security sensor and send extraordinary alarm message by the triggering security input.

There is a function of temperature range control in the device. During device setting, you may set allowed temperature low and high thresholds. When temperature measurements are out of specified temperature range then extraordinary communication session appears. Data collection periods when measurements in temperature range and out are set independently.

Vega TD-11 may be used in systems where temperature control is required but its directly measurement is difficult. For example, car engine temperatures control and temperature control at the production rooms, stocks.
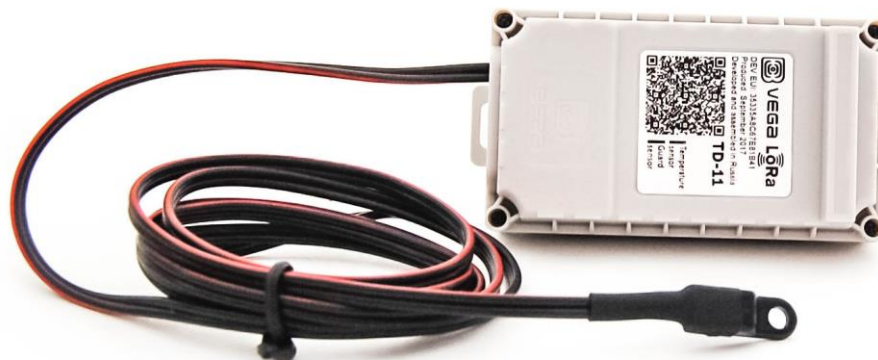
TD-11 is powered by a 3400 mAh built-in battery with service life up to 10 years, provided data transmitted once a day.

> **The device is powered by a non-rechargeable lithium-thionyl chloride (LiSOCl$_2$) battery**
> **Attempts to charge the battery may result in fire**

COMUNICATION AND DATA COLLECTION ALGORITHM

The readings collecting from the thermistor with a configurable period from 5 minutes to 24 hours. The readings stored in the device memory and transmitting during the next communication session with the LoRaWAN network.

Data collection period when measurements are out of specified temperature range set independently and may be equal from 5 minutes to 24 hours.

The adjustable data transfer period can be from 5 minutes to 24 hours. Data transferring in random point in time during set period. At the next communication session, the device starts sending accumulated packets with readings, from the earliest to the latest.

When measurements are out of specified temperature range the communication period still the same if parameter "Immediately send data when temperature is out of range" is not active. If that parameter is active then the alarm message will forming and sending during 2 minutes after the moment of temperature measurements are out of specified range. Every following message, which will form according to the data collection period, also will have sent immediately until the temperature measurements are back in range.

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.

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

FUNCTIONAL

Vega TD-11 temperature sensor is class A device (LoRaWAN classification) and has the following features:

- o Temperature measurement in range of -55... +100 °C
- o Charge measuring of the built-in battery (%)
- o Extra communication in case of security inputs actuation
- o Extra communication in case of tamper sensor actuation
- o Extra communication in case of Hall sensor (1 or 2) actuation
- o Extra communication in case of temperature measurements are out of specified range
- o Two operating modes – Active mode and Storage mode
- o ADR support (Adaptive Data Rate)
- o Sending of confirmed packets (configurable)
- o Ability to configure security input triggering on short, open or both of this cases

- o Ability to set different data collection period for case of temperature measurements are out of specified range
- o Immediately data sending at moment of message forming for case of temperature measurements are out of specified range

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

USB-port	mini-USB, type B
Operating temperatures	-40...+85 °C
Measurement temperatures	-55...+100 °C
Hall sensor sensitivity	5 mT, bipolar
External temperature sensor type	B57861-S 103-F40 10 kOhm
Accuracy of temperature measurement	±0.5 ºC in range -10...+40 ºC ±1 ºC in range -55...+100 ºC

LoRaWAN

|	
AppEui by default	7665676174643131
LoRaWAN class	A
Quantity of LoRa channels	16
Frequency plan	RU868, EU868, IN865, AS923, AU915, KR920, US915, KZ865, custom (EU868 based)
Activation type	ABP or OTAA
Communication period	5, 15, 30 minutes, 1, 6, 12 or 24 hours
Data collection period	5, 15, 30 minutes, 1, 6, 12 or 24 hours
Memory amount for storing packets	200 packets
Antenna type	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	80 000

Case

Housing dimensions	95 x 50 x 45 mm
Ingress protection rating	IP65
Tamper sensor	yes
Mounting	clamp fastening to the support, DIN-rail, wall-mounting

3 OPERATION

CONTACTS

External thermistor connection contacts

Contact pair for connection with the security circuit
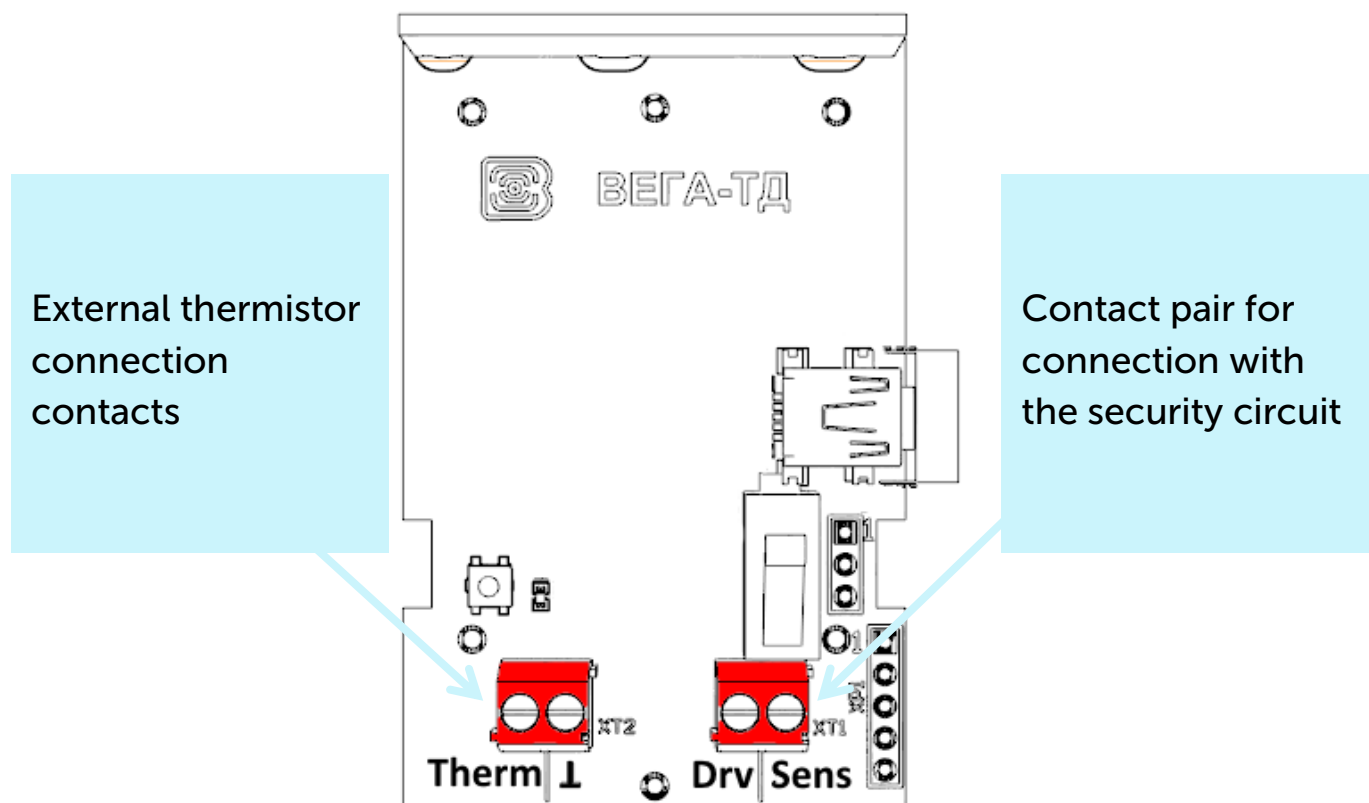
Temperature sensor has a two contact pairs. One pair ("Therm" and " ⊥ " contacts) is for connect to external thermistor, another one is security input ("Drv" and "Sens" contacts).

Security input of the device can be used for connect to circuits with the following types of NO contacts:

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

Polarity is matter only for open-drain circuit. Open drain output must be connected to "Drv" contact and ground to "Sens".

Security input can trigger on short, open or both of these cases. It is configured by the "Vega LoRaWAN Configurator" application (See part 4). Should the security input triggering, the device is activated and sends an alarm message to the network.

When thermistor connecting you should to configure sending data parameters in "Vega LoRaWAN Configurator" application.

DEVICE SENSORS

Two Hall sensors are located on the board bottom. Hall sensor triggers in the presence of magnetic field what allows using temperature sensor for reed switch control. Should the any sensor triggering, the device sends a corresponding message to the LoRaWAN network (see part 5).


DVR2 – Hall sensor 2

DVR1 – Hall sensor 1
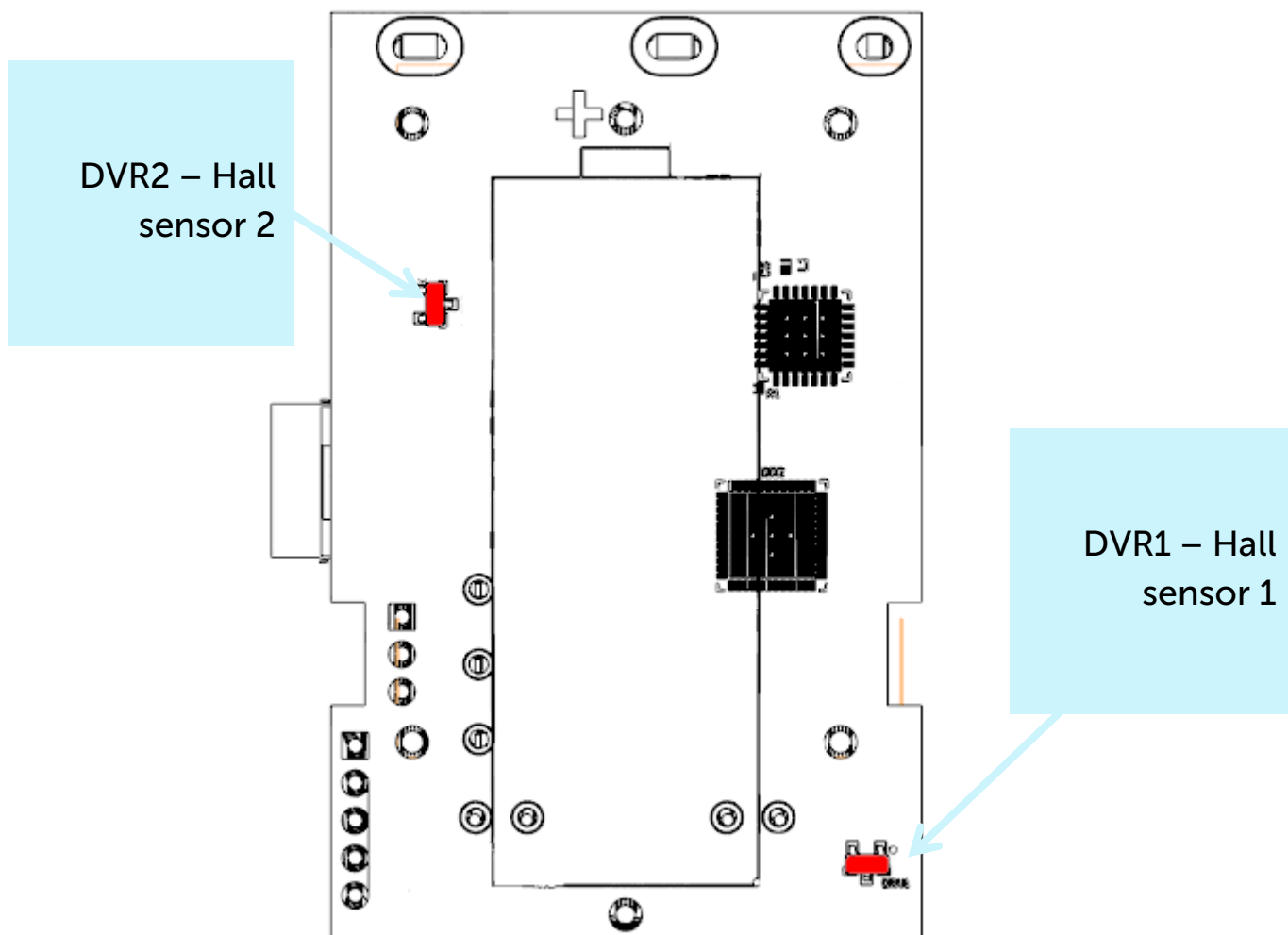
Tamper is located on the board top. Should the tamper triggering, the device sends a corresponding message to the LoRaWAN network.

Tamper
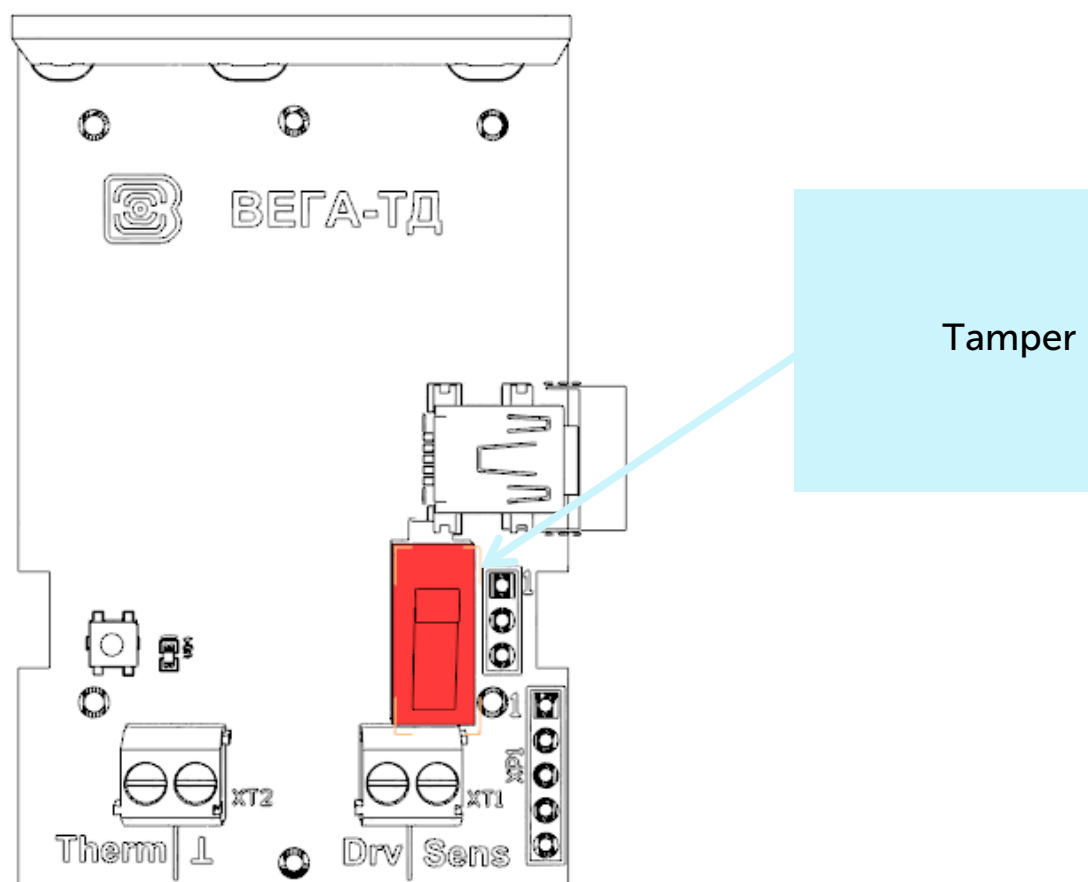
INDICATION

The device has one red LED located on the board. Indication is only used during device activation step in the LoRaWAN network and when operation modes are switch.

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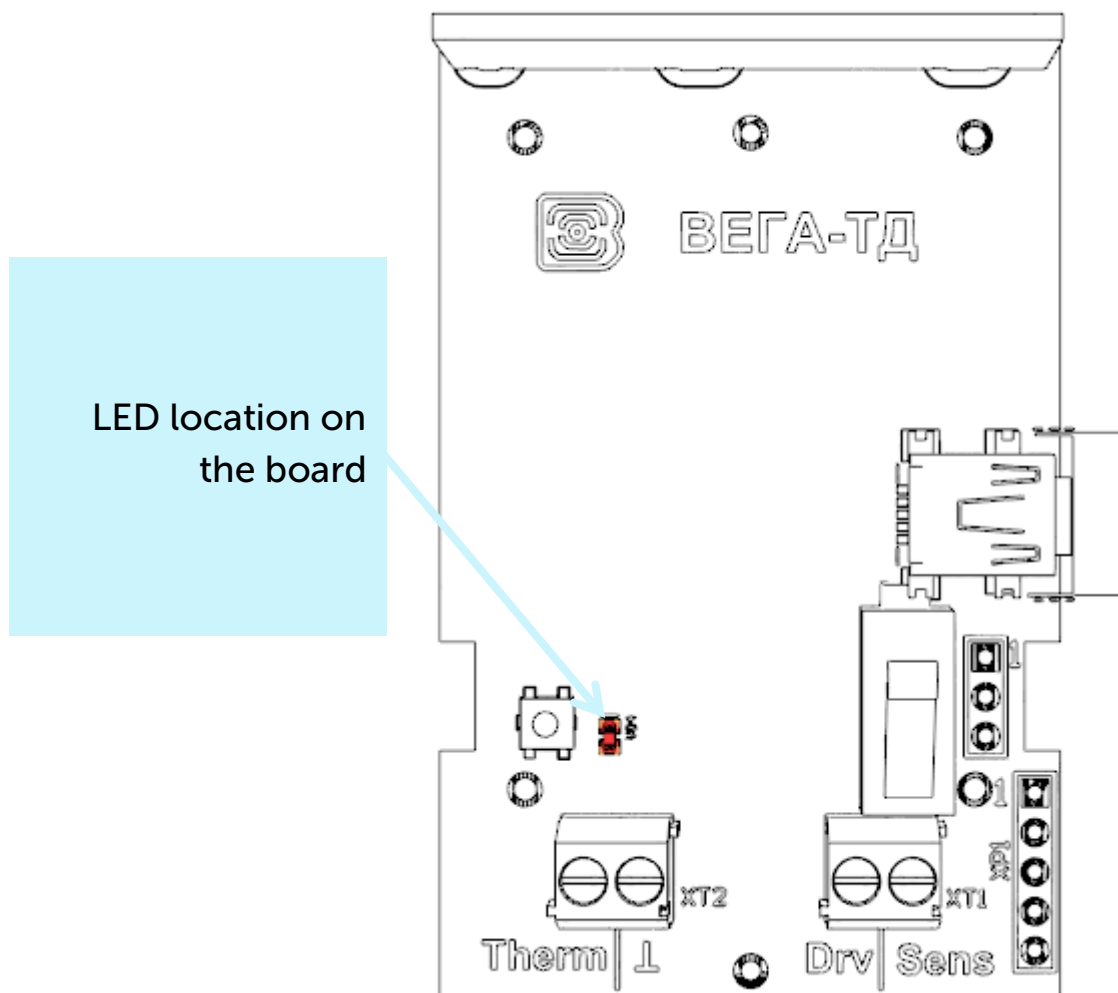
LED signal		Meaning
● ● ●	Series of short flashes	Connection to the network is proceed
▬▬▬▬	One long flash	The device connected to the network and is in active mode
▬▬ ▬▬ ▬▬	Three long flashes	Linking to the network is unsuccessful or the device switched to the «Storage» mode

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

INITIAL STARTUP

Vega TD-11 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 sensor from the "Storage" mode.

The temperature sensor 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 plan. After the activation in the LoRaWAN network is confirmed, the device sends a signal (LED flashing for 5 seconds) and switches to the "Active" mode. If all attempts fail, the device will continue to accumulate data and will attempt to connect to the network every 6 hours.

To transfer the device from the "Active" mode to the "Storage" mode, you can use the long press of the start button (more than 5 seconds).


Press the start button located on the board
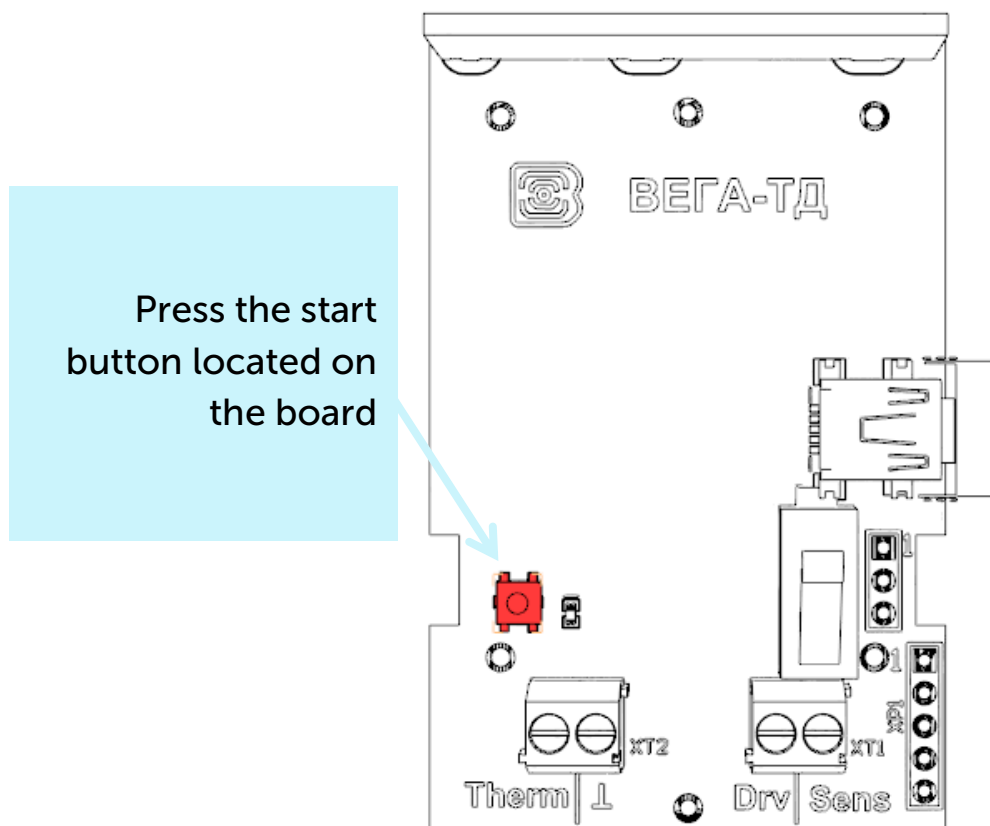
CONNECTING VIA USB

Vega TD-11 adjusted with the "Vega LoRaWAN Configurator" application (See part 4).

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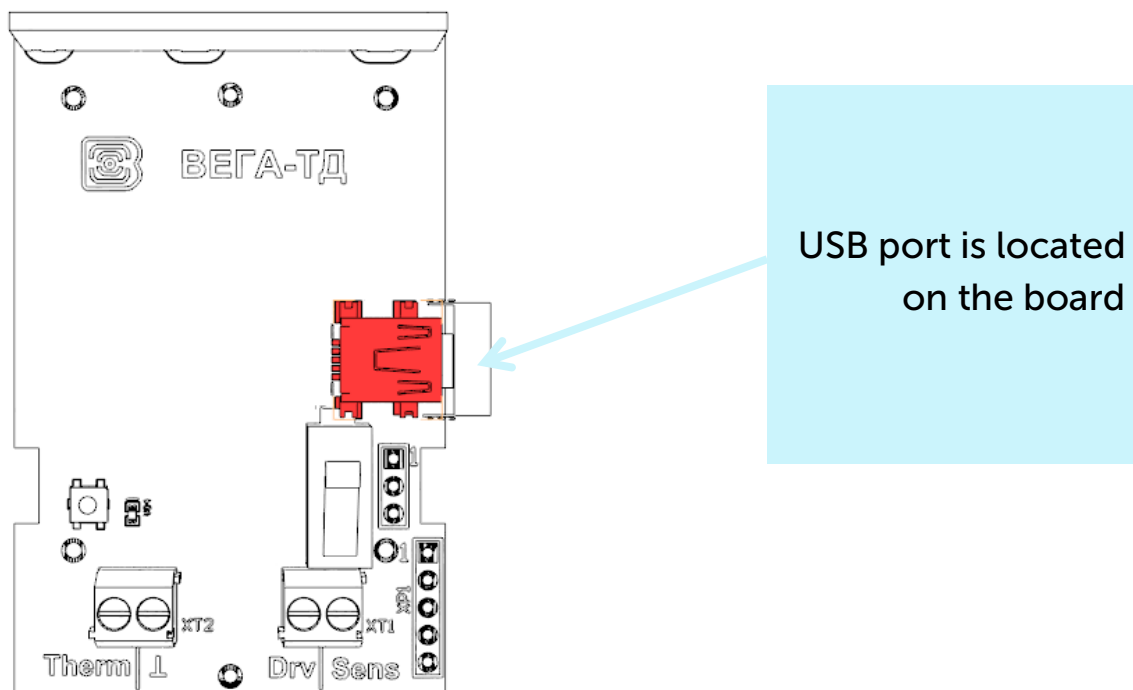
Before connecting the device to the computer for the first time, you must install the driver for the COM port **stsw-stm32102**, which can be downloaded from iotvega.com. After running the executable file **VCP_V1.4.0_Setup.exe**, the installer window will appear:
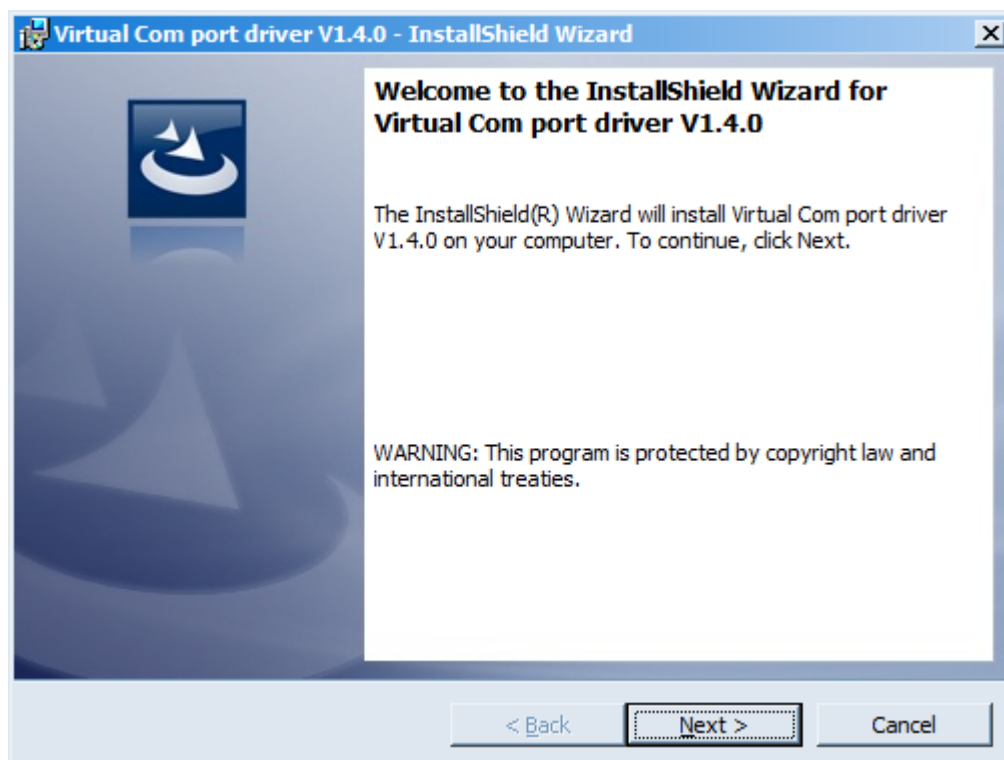
In this window, you need to click **Next**, then **Install**, and then the installation will begin. When the installation is completed successfully, the following screen appears:
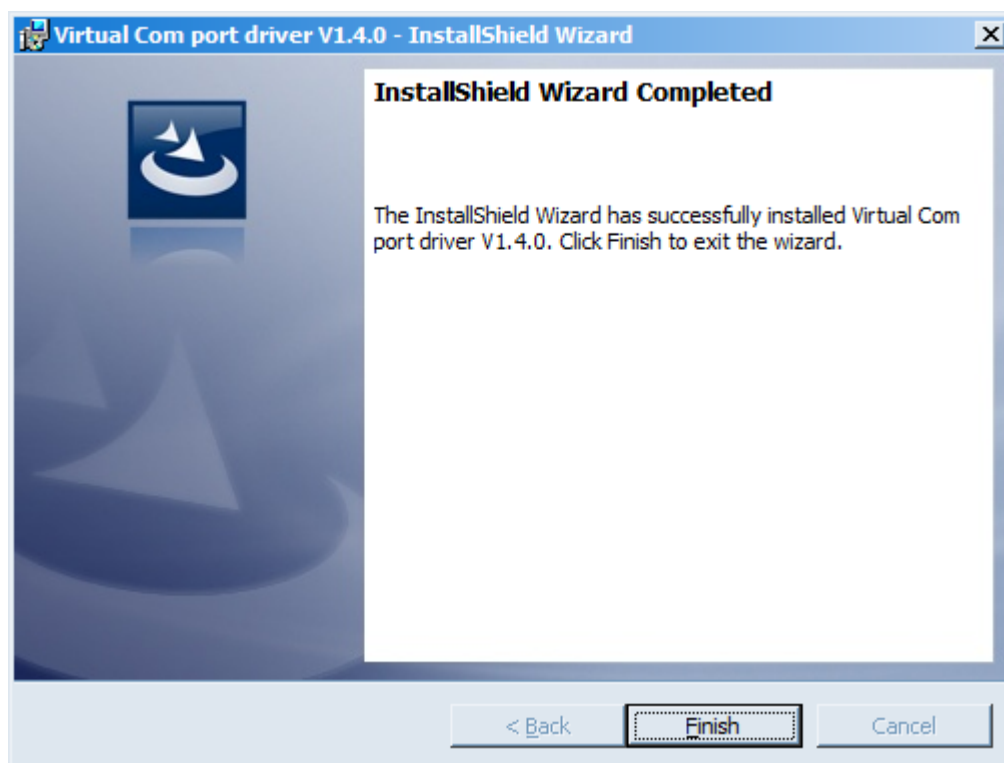
After pressing **Finish** the driver is ready for operation, - it is possible to connect the device via USB.

4 VEGA LORAWAN CONFIGURATOR

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

The configurator has two modes of operation - "Simple" and "Expert". In the "Simple" mode, only basic settings are available. In the "Expert" mode, the basic settings, advanced settings and the ability to check the coverage area of the signal from the gateways are available. Next, the work of the application 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.
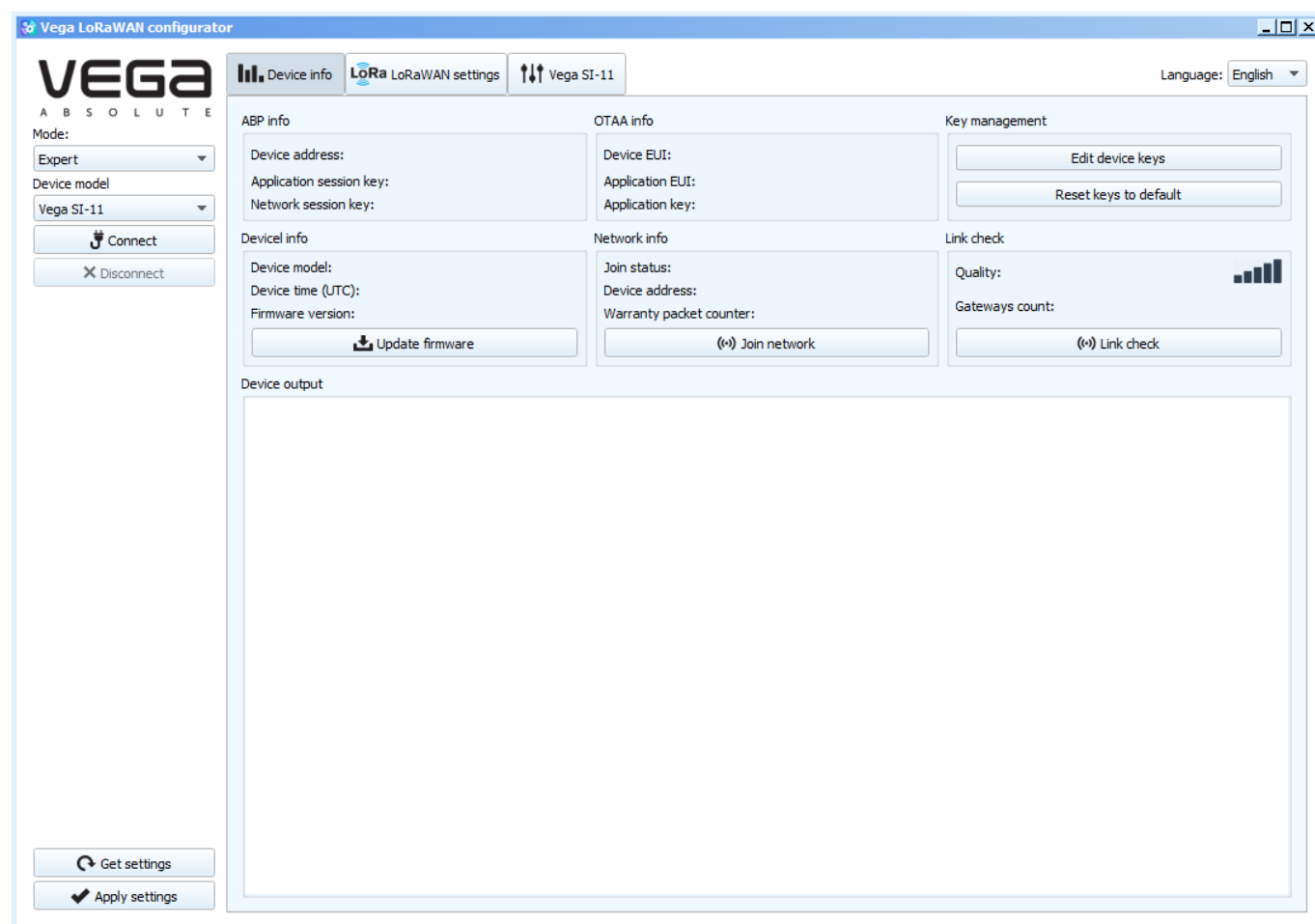
The menu on the left allows you to switch between the "Simple" and "Expert" modes, select the device model, connect to the device or disconnect from it, get and apply settings.

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.
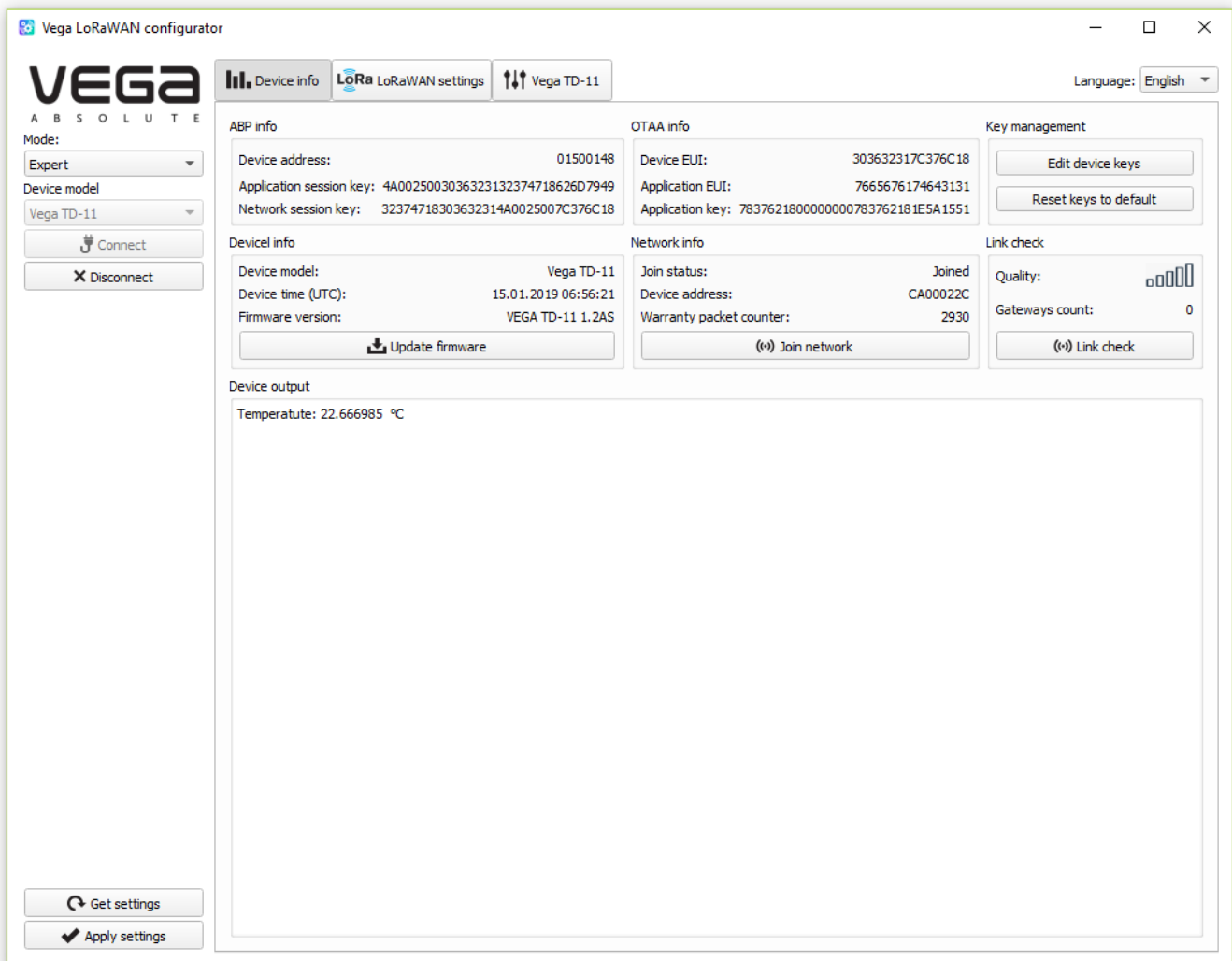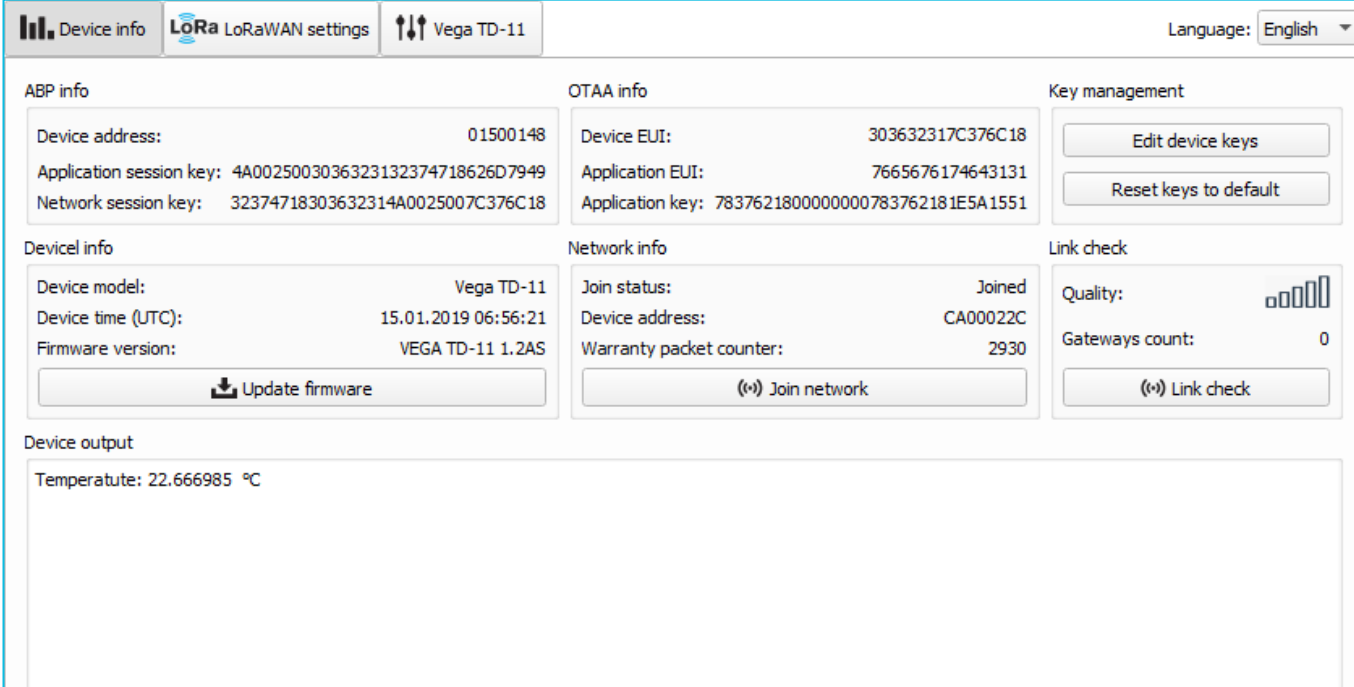

To read the settings from the device, you need to click the "Get settings" button, until this point the application will display the default settings or from the last connected device.

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 status, and the data needed to register the device in the LoRaWAN network.

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

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

Regional info (not displayed in the "Simple" mode) - shows the frequencies of the JOIN channels and the second receiving window. These frequencies can be changed in the "LoRaWAN Settings" tab when selecting a frequency plan.

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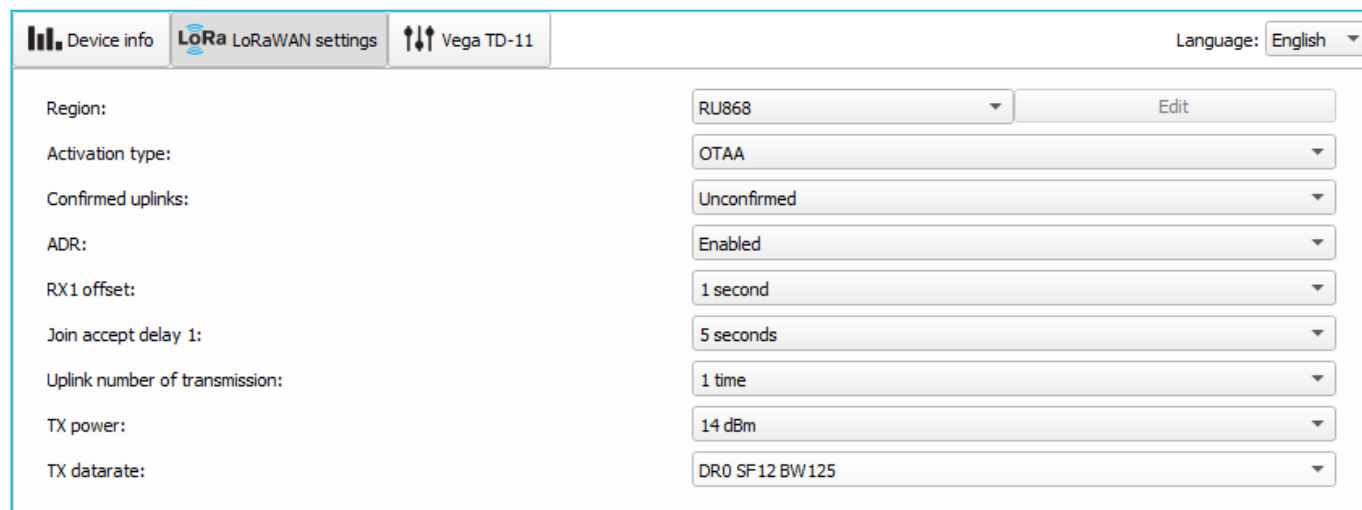
Link check (not displayed in the "Simple" mode) - when pressed, the device sends a special signal to the LoRaWAN network, in response to which the network informs it of the number of gateways that received this signal and the signal quality. This button only works when the device is connected to the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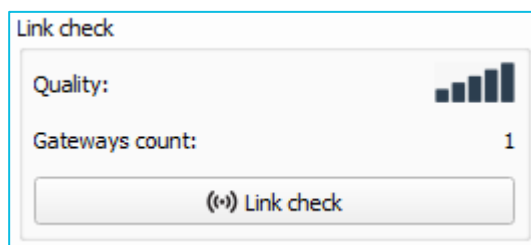
Device output (not displayed in the "Simple" mode) - monitoring the device status, all events in real time are displayed.
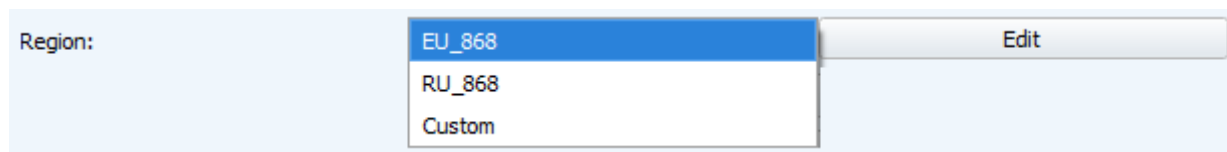
"LORAWAN SETTINGS" TAB

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 plan.

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

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

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 – 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).

> **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.

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.

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

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

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

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

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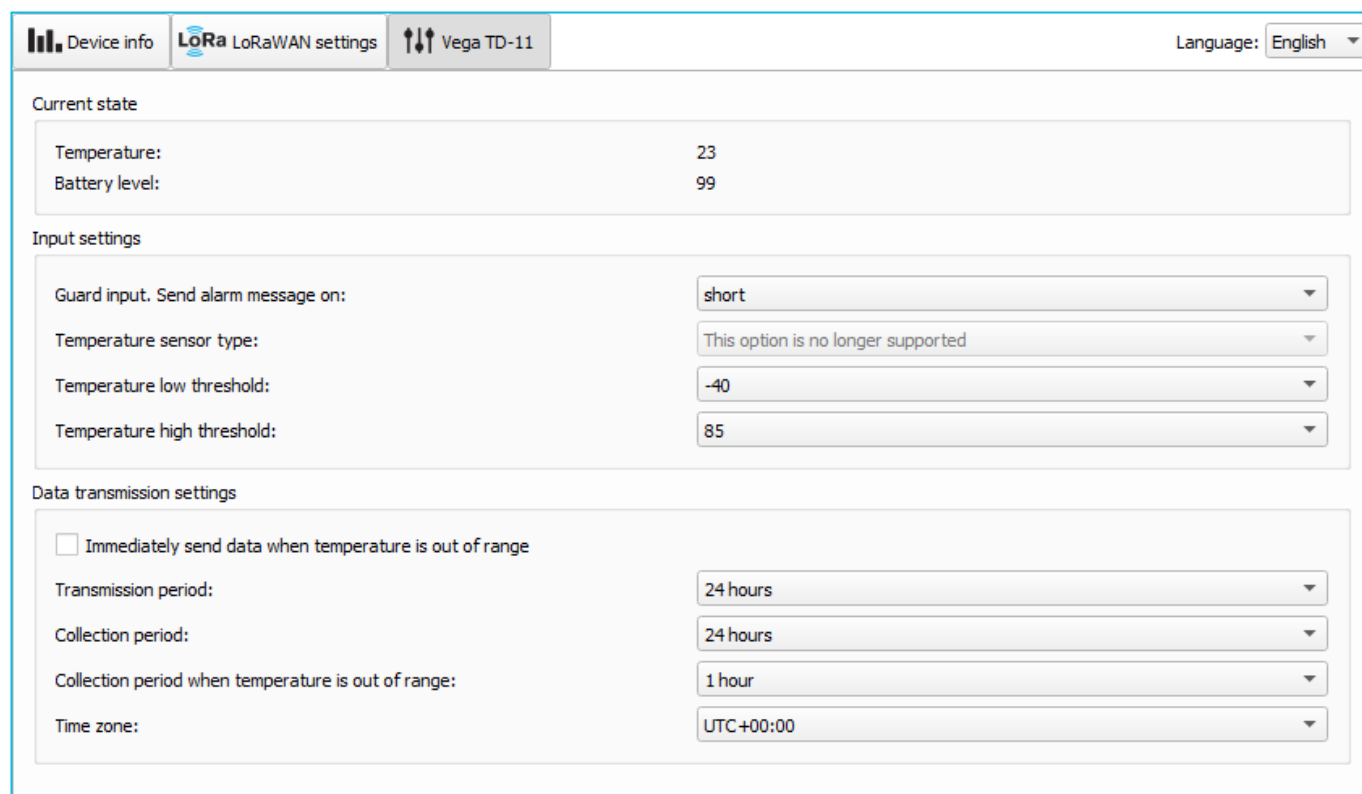
TX power:

2 dBm	
5 dBm	
8 dBm	
11 dBm	
14 dBm	
20 dBm	

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

TX datarate:

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

«VEGA TD-11» TAB

The "Vega TD-11" tab contains the settings of the connected device.

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

Input settings – allows to setting guard input and specify temperature range. Alarm message (see part 5, message 1) can be sent by the short or open security circuit or in both of these cases.

"Temperature low threshold" and "temperature high threshold" parameters allow setting temperature range, when the measurements are out of which the device will switch in alarm mode. Data collection period may be setting independently for that mode in a group of parameters "Data transmission settings".

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 device will be set which.

When measurements are out of specified temperature range the communication period still the same, if parameter "Immediately send data when temperature is out of range" is not active. If that parameter is active then the alarm message will forming and sending at moment of temperature measurements are out of specified range. Every following message, which will form according to the data collection period, also will have sent immediately until the temperature measurements are back in range.

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 5 minutes 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.

Data collection period when measurements are out of specified temperature range set independently and may be equal from 5 minutes to 24 hours.

5 COMMUNICATION PROTOCOL

This part describes the TD-11 data exchange protocol with LoRaWAN network.

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

SENSOR TD-11 TRANSMITS THE FOLLOWING TYPES OF PACKETS

1. Packet with current readings

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 1	uint8_t
1 byte	Battery level, %	uint8_t
1 byte	Overlimits ("0" – no overlimits, "1" – there is overlimit)	uint8_t
4 bytes	Time of sending readings (unixtime UTC)	uint32_t
1 byte	Current temperature in °C multiplied by 10	int16_t
1 byte	Temperature low threshold	int8_t
1 byte	Temperature high threshold	int8_t
1 byte	Reason of sending message	uint8_t
1 byte	TD-11 inputs/outputs state	uint8_t

> If thermistor is not connected to the TD-11 (contacts «Therm» and «⊥»), in the «Temperature» field will be sent an -1000 value for breakage or fault indication. In case of thermistor short circuit will be sent an -1270 value

"Inputs state" bit field decoding

Bits	Field description	Value
0 bit	Security input state	"0" – short, "1" – open
1 bit	Tamper state	"0" – case not open, "1" – case open
2 bit	Hall sensor 1 state	"0" – sensor triggered, "1" – sensor not triggered
3 bit	Hall sensor 2 state	"0" – sensor triggered, "1" – sensor not triggered
4...7 bits	not used	

"Reason of sending message" field codes

Code	Value
0x00	Sending packet by the time
0x01	By the security input triggering
0x02	By the tamper triggering
0x03	By the Hall sensor 1 triggering
0x04	By the Hall sensor 2 triggering
0x05	Temperature measurements are out of specified range

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

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

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

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

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

VEGA TD-11 SENSOR RECEIVES PACKETS OF THE FOLLOWING TYPES

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

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

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

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

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

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

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

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

Table of ID of TD-11 parameters and these possible values

ID of parameter	Description	Data length	Possible values
4	Confirmed uplinks	1 byte	1 – confirmed 2 – unconfirmed
5	Adaptive data rate	1 byte	1 – on 2 – off
8	Uplinks number of transmission	1 byte	from 1 to 15
16	Communication period	1 byte	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours

			5 – 5 minutes 6 – 15 minutes 7 – 30 minutes
38	Guard input, Send alarm message	1 byte	1 – on short 2 – on open 3 – short and open
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
78	Data collection period when temperature is out of range	1 byte	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours 5 – 5 minutes 6 – 15 minutes 7 – 30 minutes
79	Immediately send data when temperature is out of range	1 byte	0 – off 1 – on
80	Temperature low threshold	1 byte	from -55 to +100
81	Temperature high threshold	1 byte	from -55 to +100

6 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega TD-11 shall be stored in the original packaging in heated room at temperatures +5°C to +40°C and relative humidity less than 85%.

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

7 CONTENT OF THE PACKAGE

Vega TD-11 device is delivered complete with:

Temperature sensor Vega TD-11 – 1 pc.

External thermistor – 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:

- power supplies of devices sending more than 80,000 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.

vega-absolute.ru

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