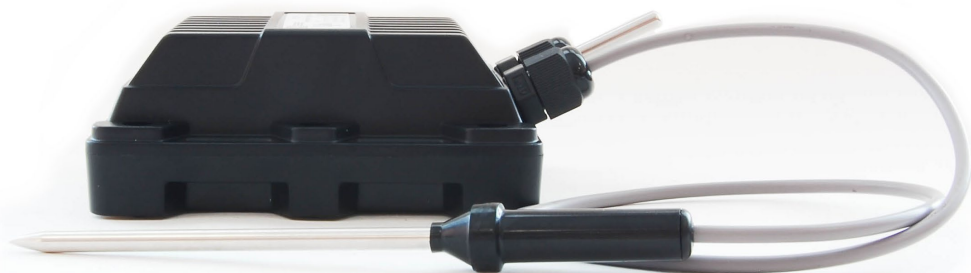




# TEMPERATURE LOGGER

# VEGA TL-11

## User Manual



**Document Information**

Title	Vega TL-11 temperature logger
Document type	Manual - Translation from Russian
Document number	V02-TL11-01
Revision and date	02 – 09 April 2020

This document applies to the following products:

Product name	Type number
End devices	Vega TL-11

**Revision History**

Revision	Date	Name	Comments
01	09.08.2019	KEV	Document creation date
02	09.04.2020	KEV	Minor changes

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## INTRODUCTION

This manual is designated for Vega TL-11 device (hereinafter – device, logger) manufactured by Vega-Absolute OOO 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.



**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

Logger designed for a long autonomic collection and storing of a data about controlled environment (air, non-aggressive gases, liquids, bulk materials, food). Temperature is measuring through two thermistors: external probe connecting to the logger and built-in external temperature sensor. The device archives temperature measurements with the time check at the device memory and then transmits that archived data in the LoRaWAN network when there is a stable radio connection.

The device may operate autonomically and collect temperature readings during a month while the data collection period is 30 minutes.

Logger Vega TL-11 may be used in systems where it's needed to control the temperature through the long time without ability to operatively transmit data to the network, for example, when transporting perishable goods or when it's needed to control the transportation conditions. In transit the device puts product temperature values to the memory and when it's come to the destination the device will transmit saved data to the LoRaWAN network.

TL-11 is powered by a 6400 mAh built-in battery with service life up to 10 years, provided data transmitted once a day.

### 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.

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, also adjustable via LoRaWAN.

## FUNCTIONAL

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

- Temperature measurement in range of -55... +100 °C
- Charge measuring of the built-in battery (%)
- Two operating modes – Active mode and Storage mode
- ADR support (Adaptive Data Rate)
- Sending of confirmed packets (configurable)
- Extra communication in case of tamper sensor actuation

## 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

USB-port	micro-USB, type B
Operating temperatures	-40...+85 °C
Measurement temperatures	-55...+100 °C
Accuracy of temperature measurement	±0.5 °C in range -10...+40 °C ±1 °C in range -55...+100 °C

### LoRaWAN

AppEui by default	30326761544C3131
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	1300 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	6400 mAh
Warranty number of packets sent by the device, not less	80 000

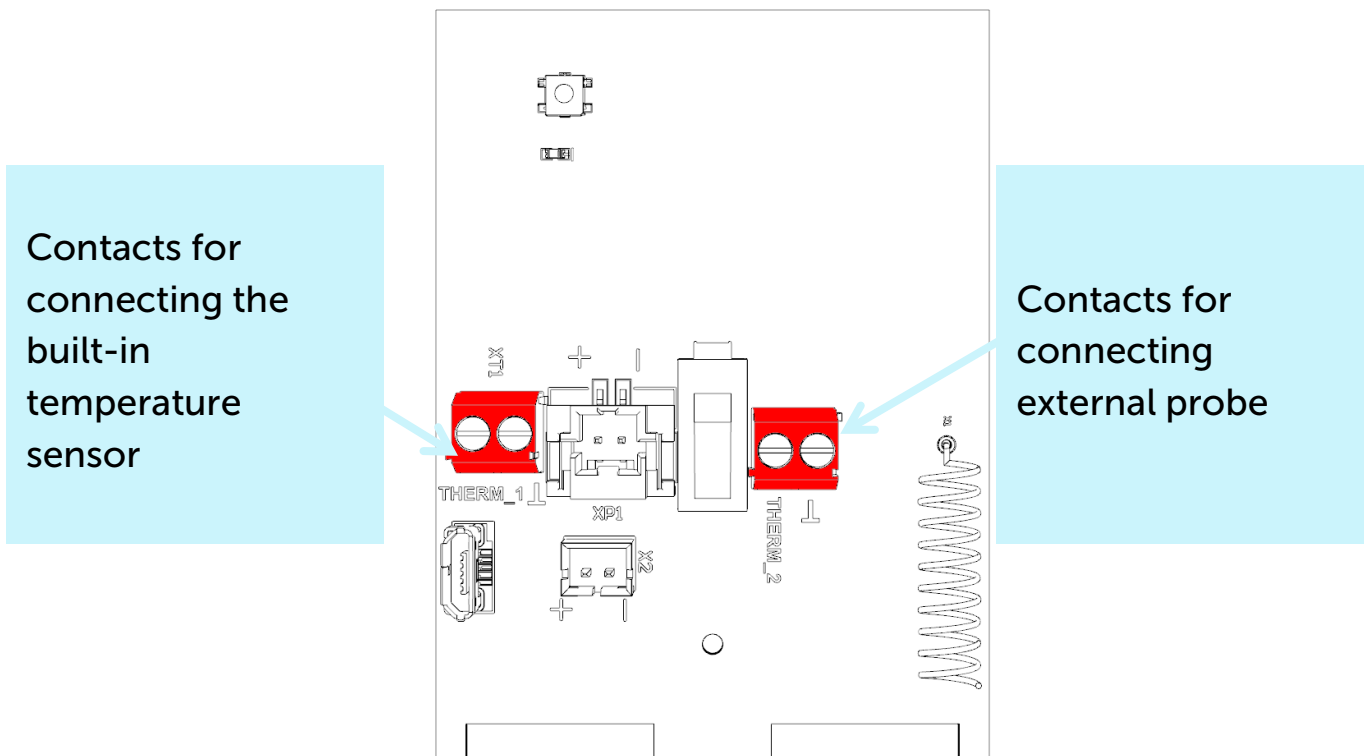
### Case

Housing dimensions	95 x 75 x 40 mm
Ingress protection rating	IP67
Tamper sensor	yes
Mounting	clamp fastening to the support



### 3 OPERATION

#### CONTACTS

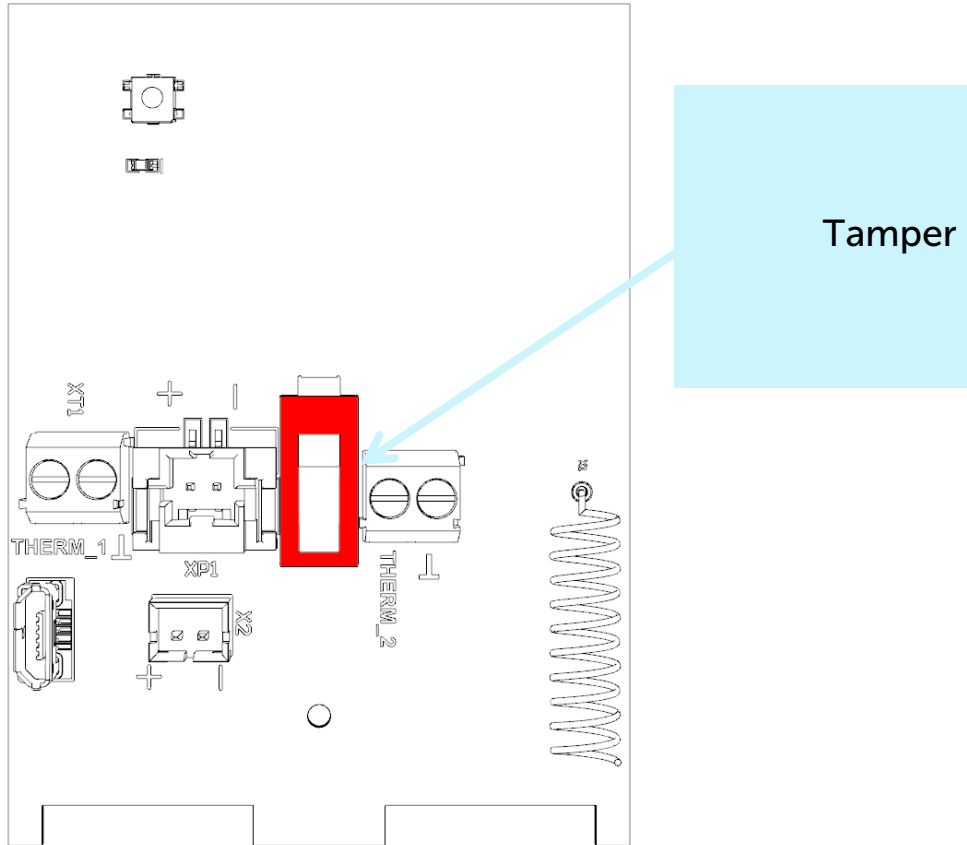


Temperature logger has a two contact pairs. One pair ("Therm1" and "T" contacts) is for connect to built-in thermistor, another one is for external probe ("Therm2" and "T" contacts).

You should configure sending data parameters in "Vega LoRaWAN Configurator" application.

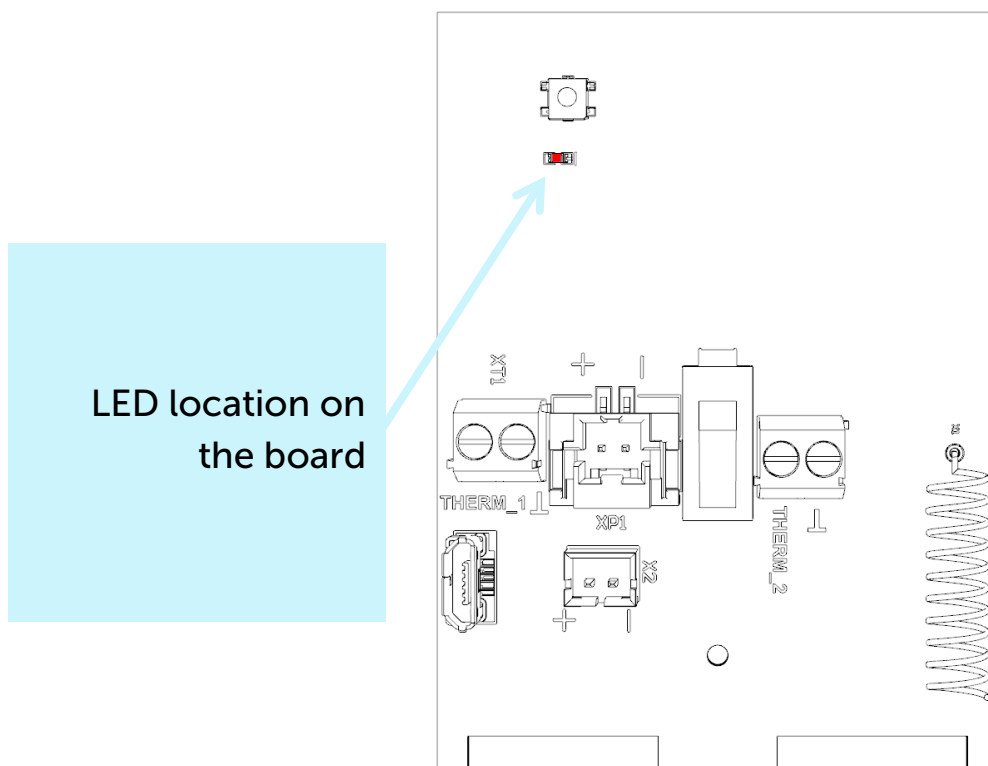
## DEVICE SENSORS

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



## 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 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

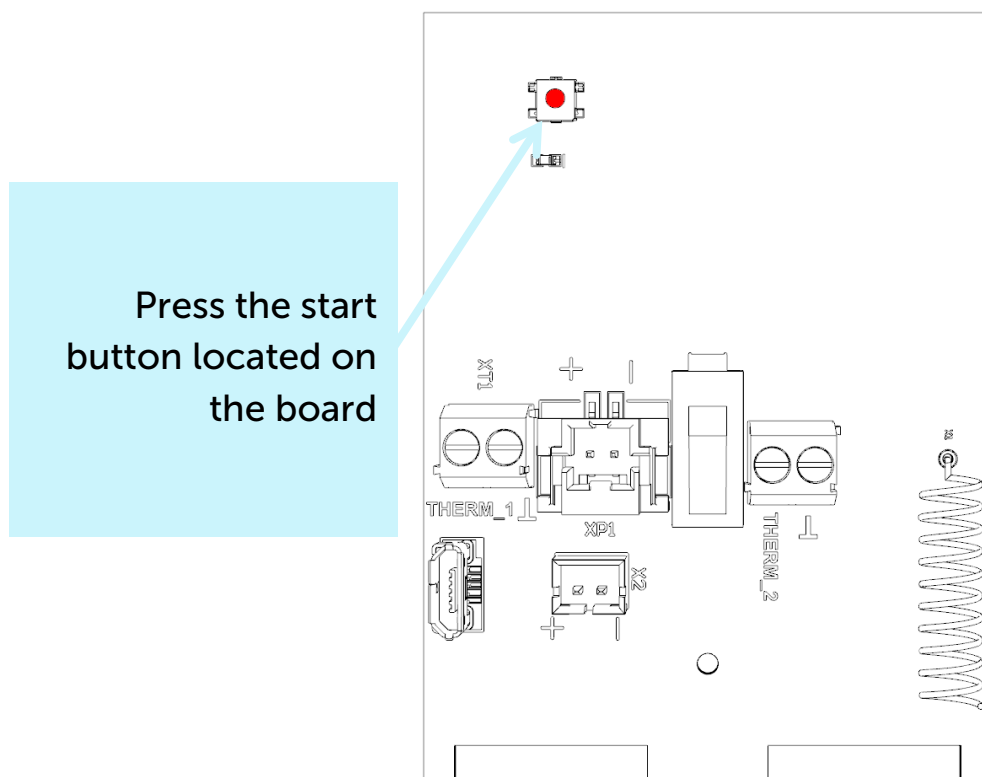
Vega TL-11 is constantly ON, but can operate in a special "Storage" mode, designed for storage and transportation. The device does not regularly transmit data to the network in this mode. Before use switch the device from the "Storage" mode by the button pressing.

The temperature logger 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.

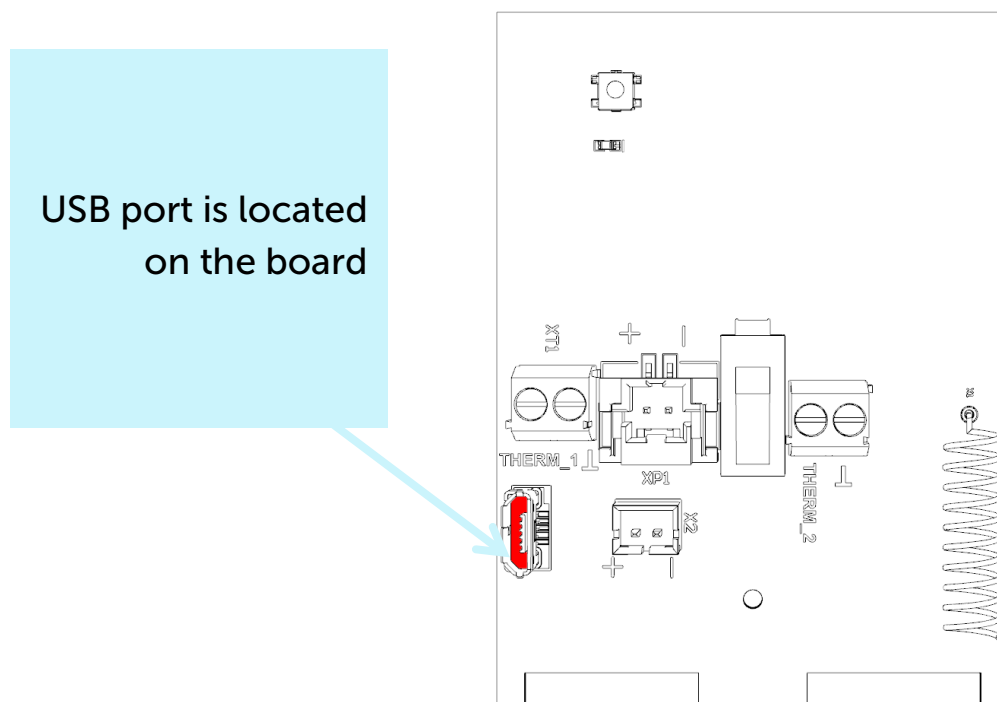
**2. OTAA.** After pressing the start button, the device makes three attempts to connect to the network within the set frequency plan. After the activation in the LoRaWAN network is confirmed, the device sends a signal (LED flashing for 5 seconds) and switches to the "Active" mode. If all attempts fail, 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).

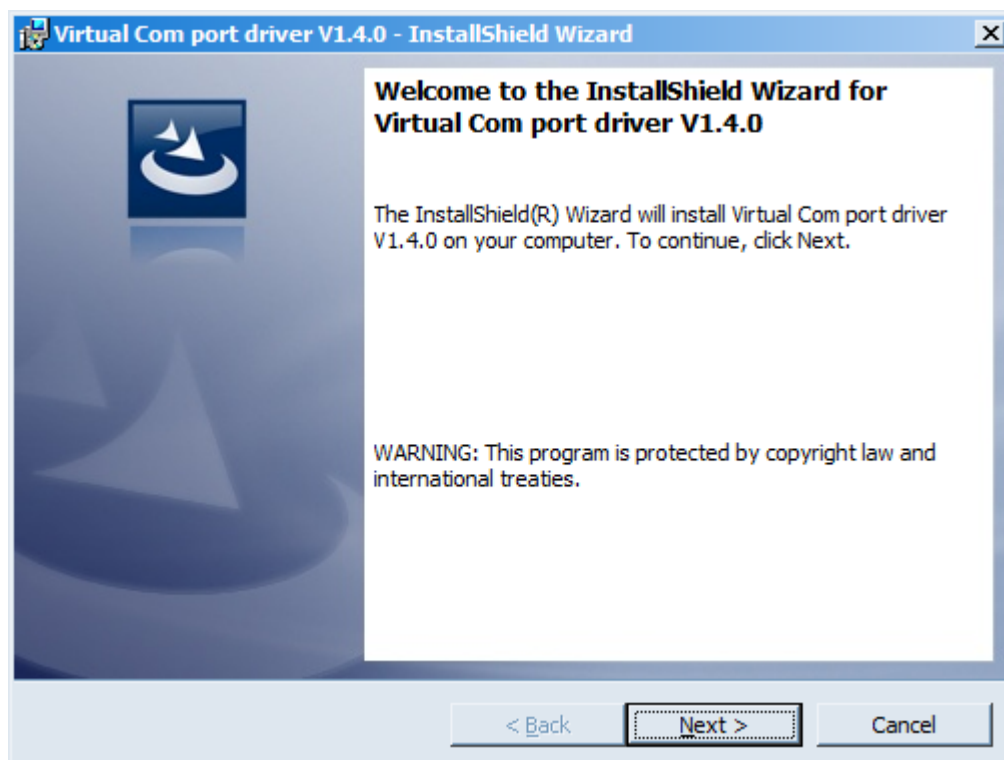


## CONNECTING VIA USB

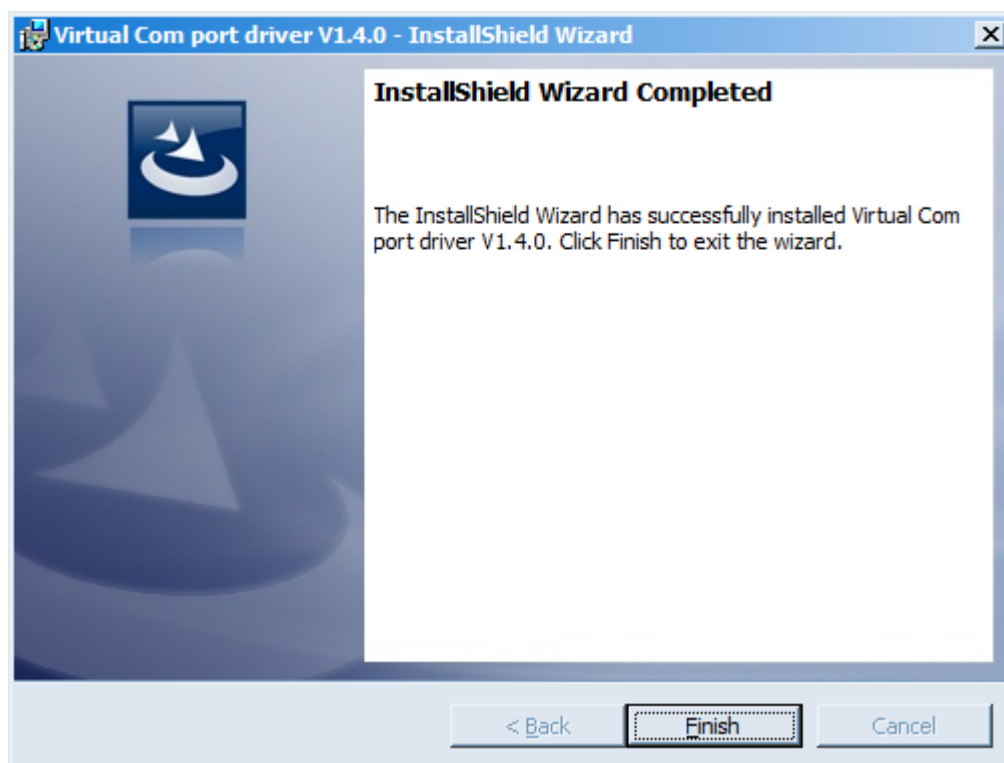
Vega TL-11 adjusted with the "Vega LoRaWAN Configurator" application (See part 4).



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](http://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.

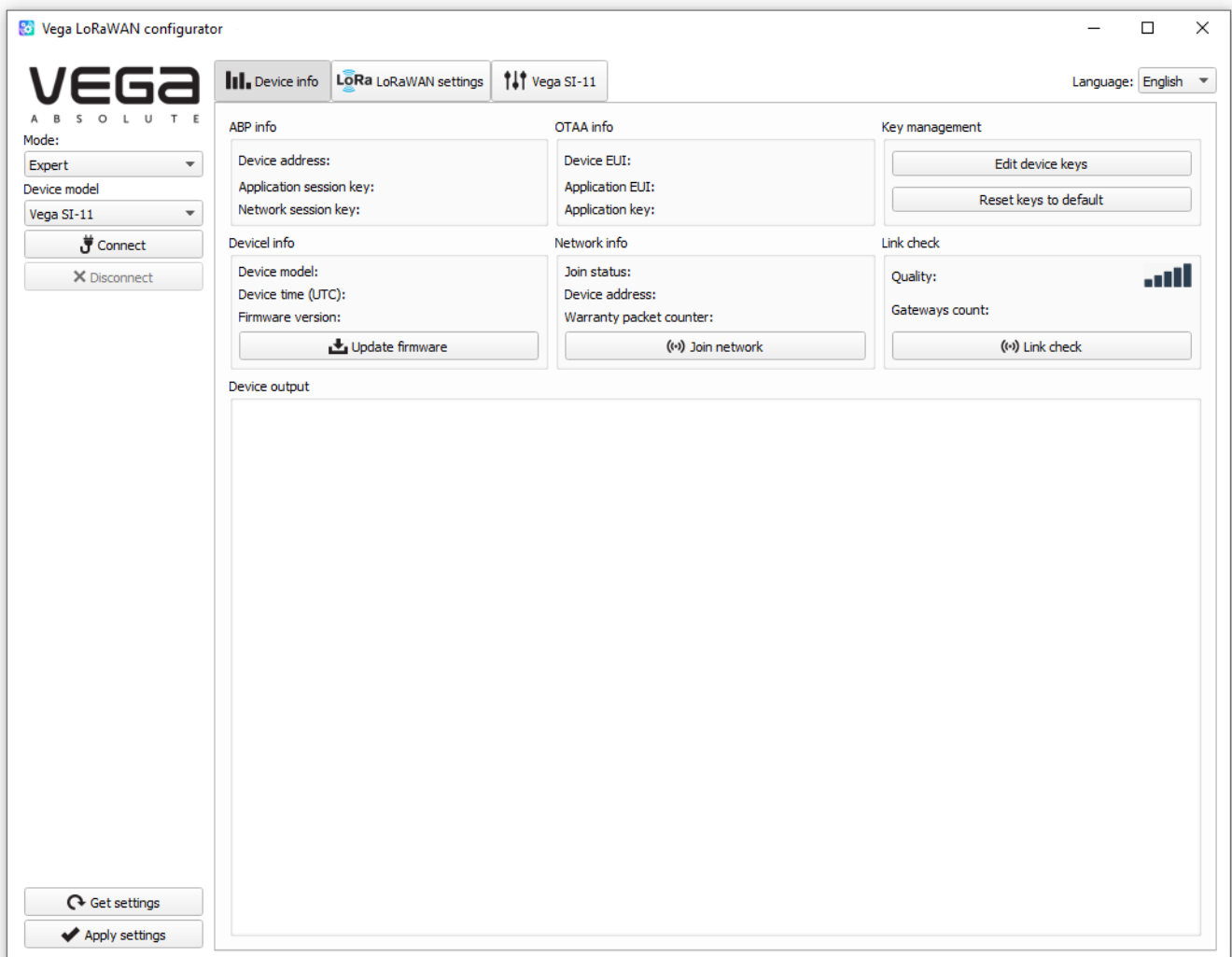
## 4 VEGA LORAWAN CONFIGURATOR

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.

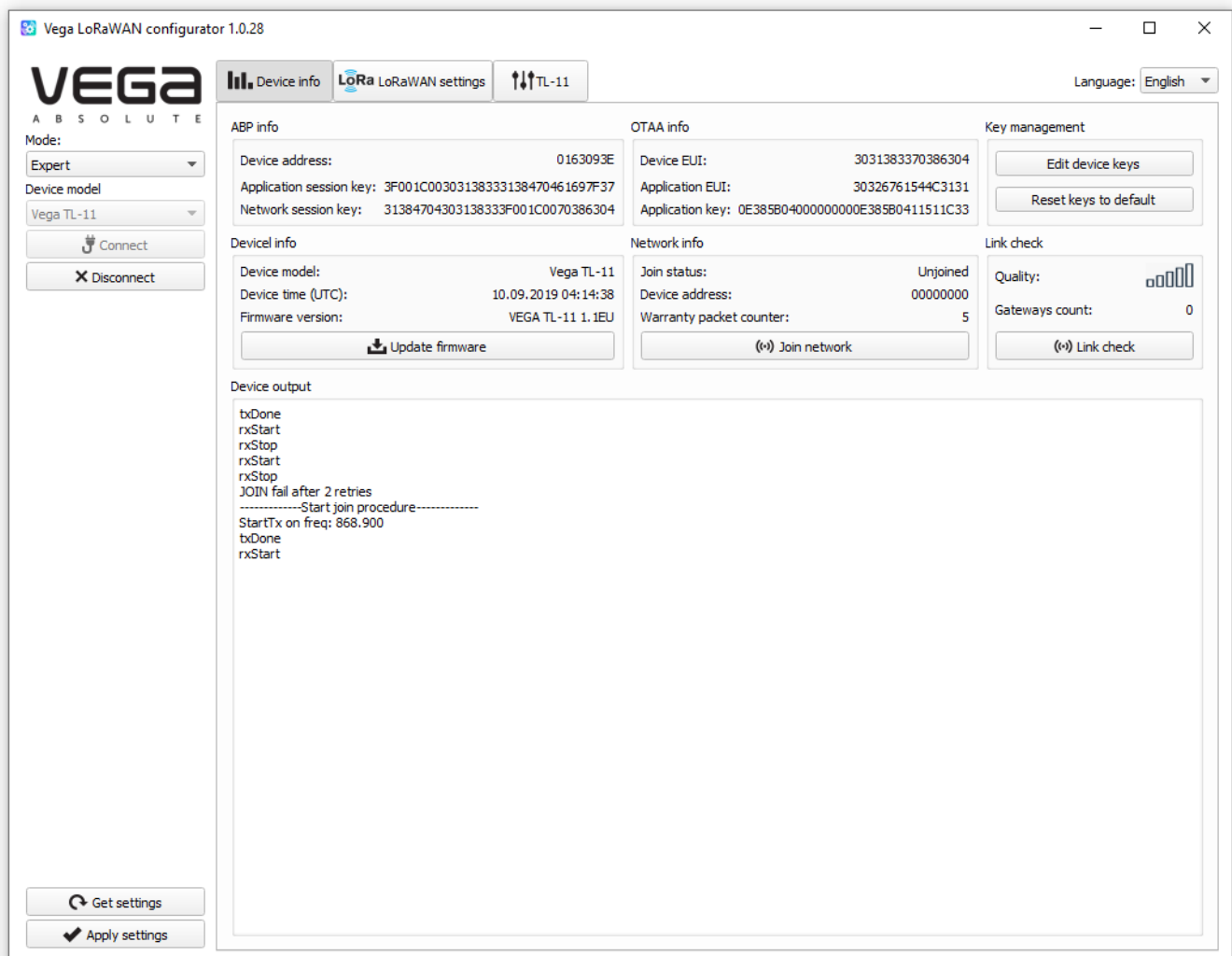
The language selection menu is in the upper right corner.

## 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.



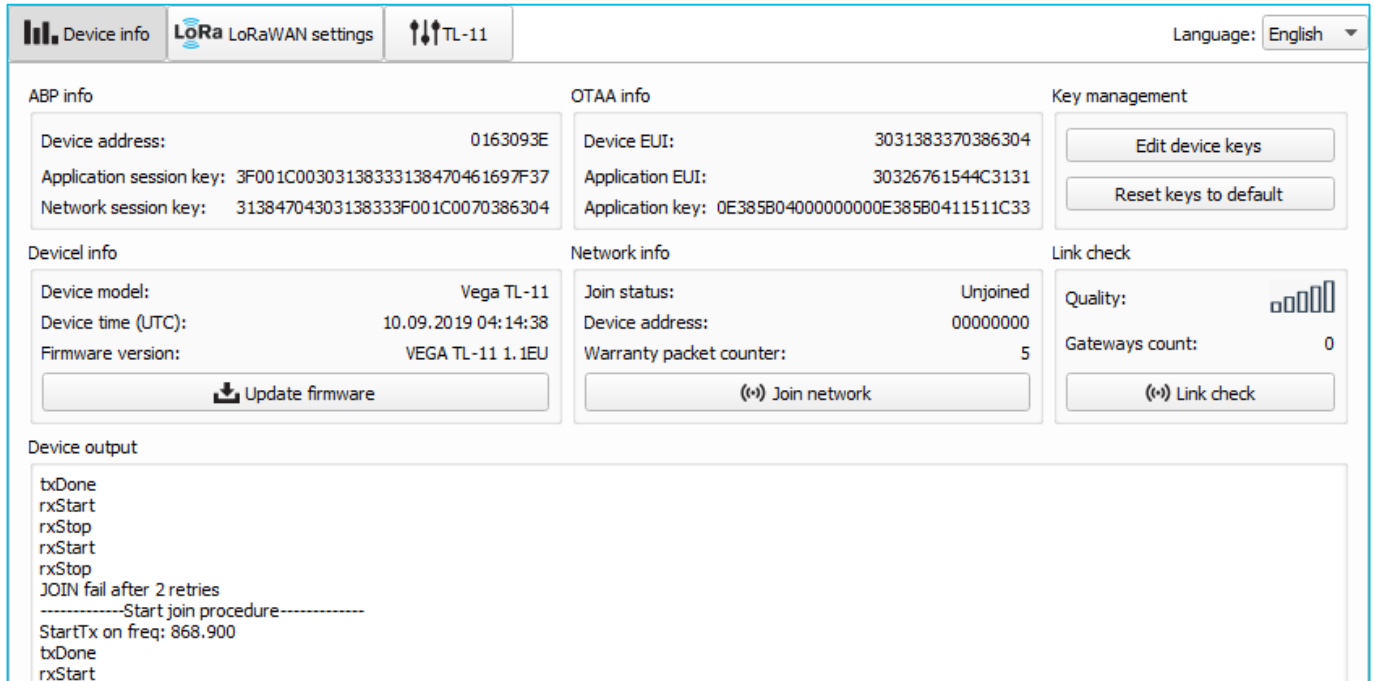
To read the settings from the device, you need to click the "Get settings" button, until this point the application will display the default settings or from the last connected device.



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.



The screenshot shows the 'Device info' tab with the following data:

ABP info	OTAA info	Key management
Device address: 0163093E	Device EUI: 3031383370386304	<button>Edit device keys</button>
Application session key: 3F001C00303138333138470461697F37	Application EUI: 30326761544C3131	<button>Reset keys to default</button>
Network session key: 31384704303138333F001C0070386304	Application key: 0E385B04000000000E385B0411511C33	

Device info	Network info	Link check
Device model: Vega TL-11	Join status: Unjoined	Quality: 
Device time (UTC): 10.09.2019 04:14:38	Device address: 00000000	Gateways count: 0
Firmware version: VEGA TL-11 1.1EU	Warranty packet counter: 5	<button>Link check</button>
<button>Update firmware</button>	<button>Join network</button>	

**Device output**

```

txDone
rxStart
rxStop
rxStart
rxStop
rxStop
JOIN fail after 2 retries
-----Start join procedure-----
StartTx on freq: 868.900
txDone
rxStart
  
```

**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.

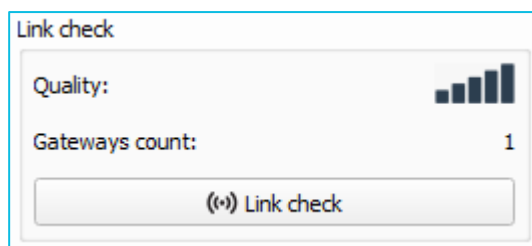
**Device info** - the configurator reads information about the device model, its firmware and automatically corrects the device's time when connected to it.

**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](http://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.

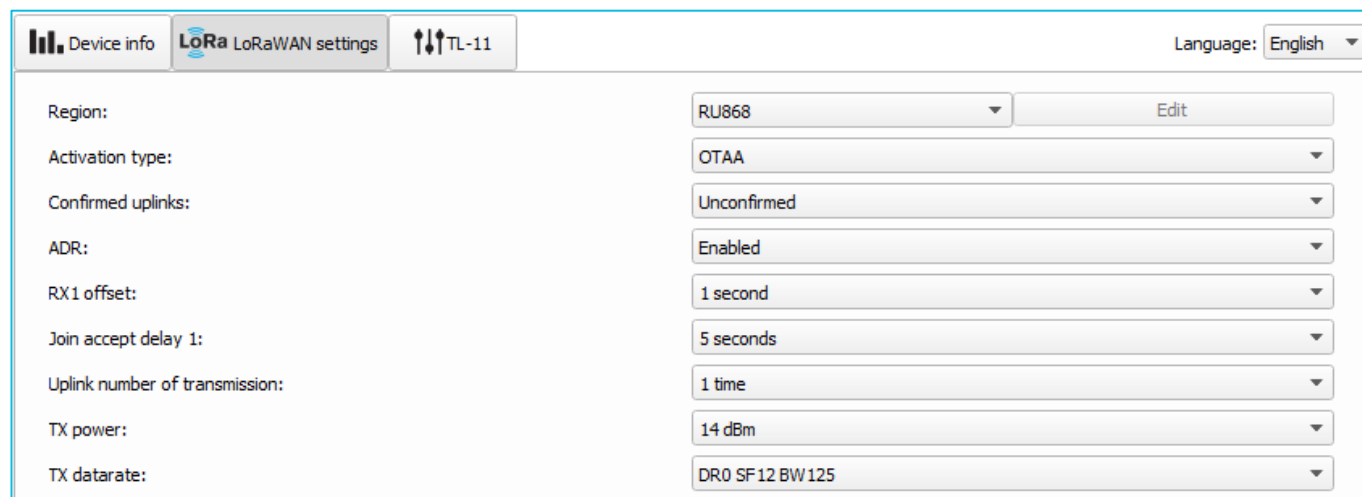
**Link check** (not displayed in the "Simple" mode) - when pressed, the device sends a special signal to the LoRaWAN network, in response to which the network informs it of the number of gateways that received this signal and the signal quality. This button only works when the device is connected to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



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

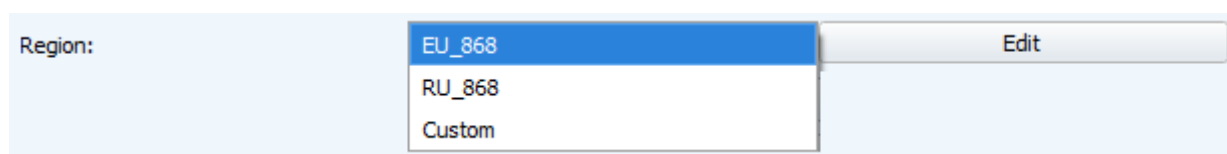
## "LORAWAN SETTINGS" TAB

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



Parameter	Value	Action
Region:	RU868	Edit
Activation type:	OTAA	
Confirmed uplinks:	Unconfirmed	
ADR:	Enabled	
RX1 offset:	1 second	
Join accept delay 1:	5 seconds	
Uplink number of transmission:	1 time	
TX power:	14 dBm	
TX datarate:	DR0 SF12 BW125	

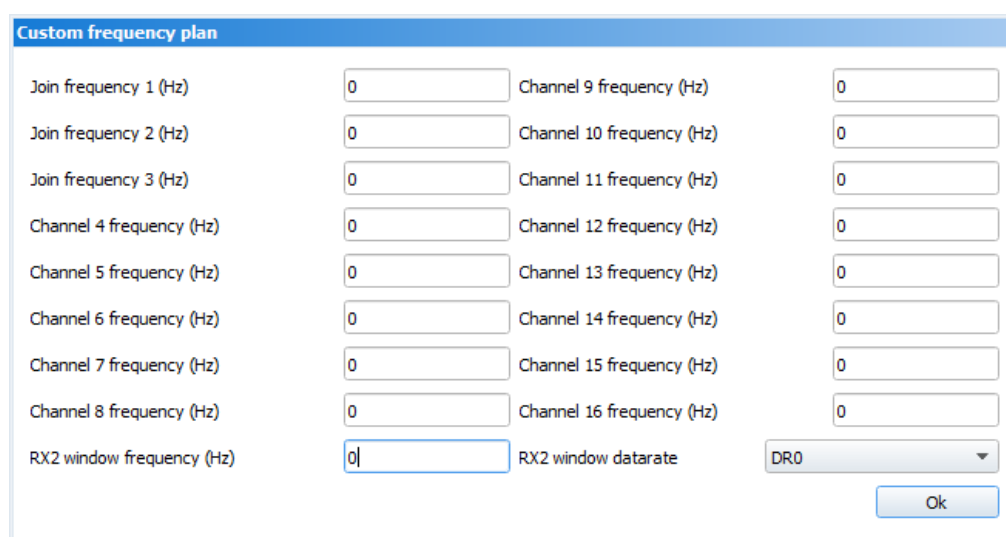
**Region** - allows you to select RU-868, EU-868 or specify a custom frequency plan.



Region	Action
EU_868	Edit
RU_868	
Custom	

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:



Custom frequency plan			
Join frequency 1 (Hz)	0	Channel 9 frequency (Hz)	0
Join frequency 2 (Hz)	0	Channel 10 frequency (Hz)	0
Join frequency 3 (Hz)	0	Channel 11 frequency (Hz)	0
Channel 4 frequency (Hz)	0	Channel 12 frequency (Hz)	0
Channel 5 frequency (Hz)	0	Channel 13 frequency (Hz)	0
Channel 6 frequency (Hz)	0	Channel 14 frequency (Hz)	0
Channel 7 frequency (Hz)	0	Channel 15 frequency (Hz)	0
Channel 8 frequency (Hz)	0	Channel 16 frequency (Hz)	0
RX2 window frequency (Hz)	0	RX2 window datarate	DR0
Ok			

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.

Activation type:	<div>OTAA</div> <div>ABP</div>
------------------	--------------------------------

**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).

Confirmed uplinks:	<div>Confirmed</div> <div>Unconfirmed</div>
--------------------	---

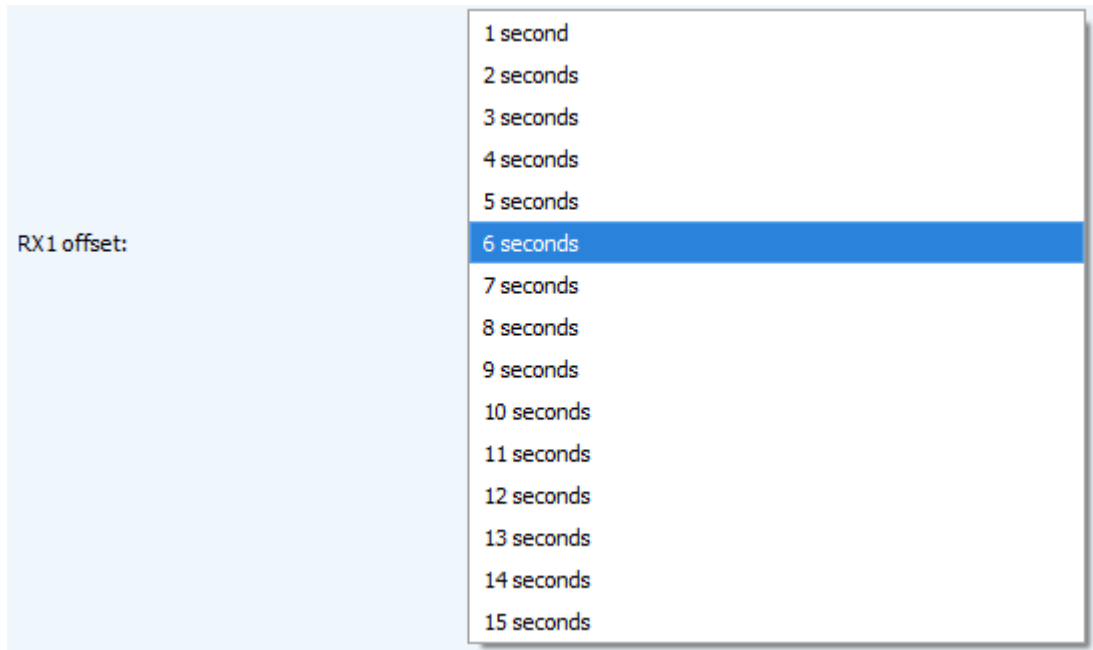


**If you choose to send a packet without confirmation, the modem will not know whether the packet is delivered or not**

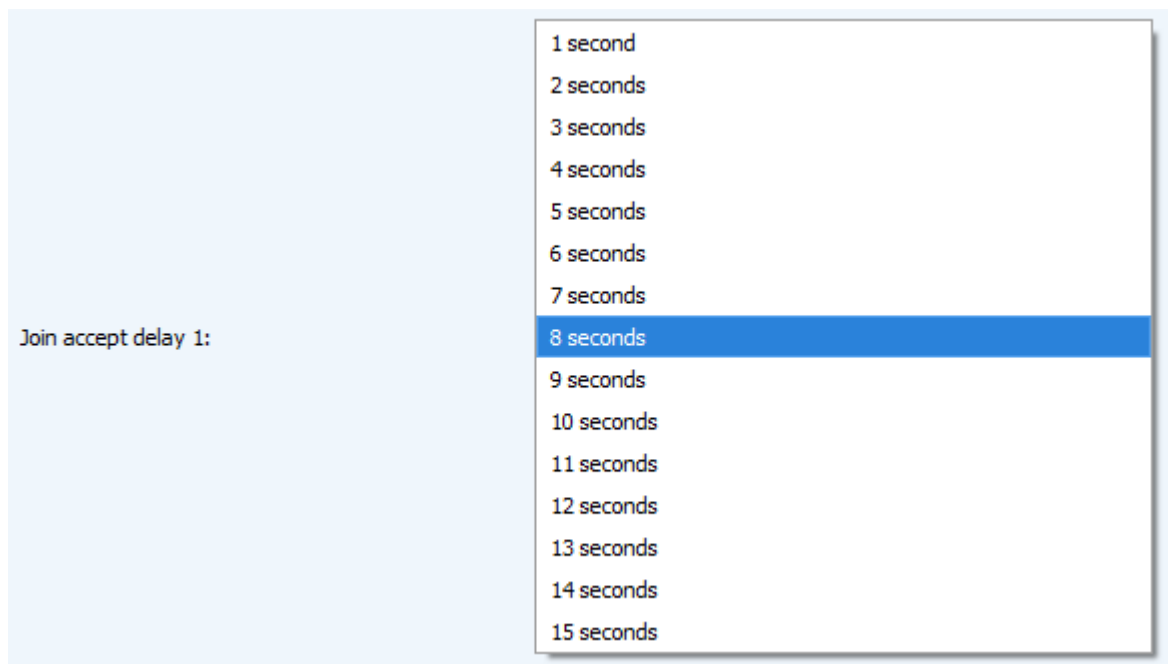
**ADR** – this option activates the Adaptive Data Rate algorithm for automatic control of the data transfer rate from the LoRaWAN network server side. The higher the quality of the signal received by the network, the higher the speed will be installed on the device. This option is recommended only on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

ADR:	<div>Enabled</div> <div>Disabled</div>
------	--

**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.



**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.

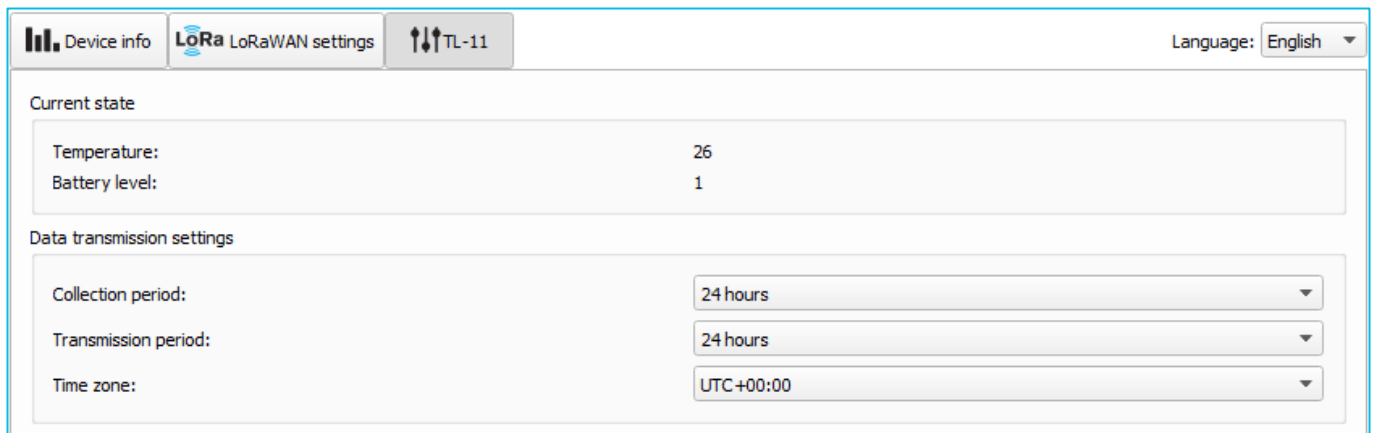
TX power:	2 dBm
	5 dBm
	8 dBm
	11 dBm
	14 dBm
	20 dBm

**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 TL-11» TAB

The “Vega TL-11” tab contains the settings of the connected device.



The screenshot shows the 'Vega TL-11' settings tab. At the top, there are three tabs: 'Device info', 'LoRa LoRaWAN settings', and 'TL-11' (which is selected). In the top right corner, there is a 'Language: English' dropdown menu. The main content area is divided into two sections. The first section, 'Current state', displays two parameters: 'Temperature: 26' and 'Battery level: 1'. The second section, 'Data transmission settings', contains three dropdown menus: 'Collection period: 24 hours', 'Transmission period: 24 hours', and 'Time zone: UTC +00:00'.

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

**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.

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 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.

## 5 COMMUNICATION PROTOCOL

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



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

### SENSOR TL-11 TRANSMITS THE FOLLOWING TYPES OF PACKETS

#### 1. Packet with current readings

Size in bytes	Field description	Data type
1 byte	Battery level, %	uint8_t
4 bytes	Time of sending readings (unixtime UTC)	uint32_t
1 byte	Temperature of built-in thermistor in °C multiplied by 10	int16_t
1 byte	Temperature of external probe in °C multiplied by 10	int16_t
1 byte	Main parameters	uint8_t



If thermistor is not connected to the TL-11 in the «Temperature» field of the corresponding thermistor will be sent an -1000 value for breakage or fault indication. In case of thermistor short circuit will be sent an -1270 value

#### "Main parameters" bit field decoding

Bits	Field description	Value
0-1 bits	Reason of message forming	
2 bit	Tamper state	"0" – case not open, "1" – case open
3...7 bits	Reserved (0 always)	

#### "Reason of message forming" field codes

Code	Value
0x00	Sending packet by the time
0x01	By the tamper triggering
0x02	Reserved
0x03	Reserved



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

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 255	uint8
4 bytes	Time of the modem at a moment of the packet transmission (unixtime UTC)	uint16

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 TL-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	Data type
1 byte	Packet type, this packet = 255	uint8
8 bytes	The value in seconds for which you need to adjust the time. Can be positive or negative	int64

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

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 1	uint8

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 TL-11 parameters and these possible values

<b>ID of parameter</b>	<b>Description</b>	<b>Data length</b>	<b>Possible values</b>
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
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

## 6 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega TL-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 TL-11 device is delivered complete with:

Temperature logger Vega TL-11 – 1 pc.

Factory certificate – 1 pc.

## 8 WARRANTY

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

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

The consumer 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](http://vega-absolute.ru)

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