NB-IOT MODEM WITH 4-20 MA INTERFACE

VEGA NB-12

User manual

Document Information

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Revision History

Revision	Date	Name	Comments
01	24.10.2019	KEV	The first release
02	14.07.2020	KEV	Minor changes
03	02.03.2021	KEV	New parts "Pulse inputs settings", "Mounting recommendations", we replace configurator screenshots, new function of the pulse filtering, now alarm inputs can operate in pulse mode, maximum number of batteries is two

CONTENTS

INTRODUCTION

This manual is designated for Vega NB-12 modem with 4-20 mA interface (hereinafter – the modem) manufactured by Vega-Absolute OOO 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**

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 NB-12 modem is designed for collecting readings from devices with current loop interface 4-20 mA, with analog output, pulse output or 1-Wire interface, further accumulating and transmitting of this information in NB-IoT network.

In addition, Vega NB-12 can be used as a security device – two additional inputs operate in security mode, there is also Hall sensor.

The modem can be used for any sensors and industrial equipment with interface 4-20 mA or 1-Wire such as temperature sensors, humidity sensors, pressure sensors.

The modem is may powered by one or two batteries with capacity 6400 mAh.

COMUNICATION AND DATA COLLECTION ALGORITHM

The readings collecting from the meter with a configurable period 5, 15, 30 minutes, 1, 2, 3, 4, 6, 12 or 24 hours. The readings stored in the device memory and transmitting during the next communication session with the NB-IoT network.

The adjustable data transfer period can be equal to 5, 15, 30 minutes, 1, 2, 3, 4, 6, 12 and 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.

The device operates with confirmation all the time and send the next packet only after receiving a confirmation of the delivery of the previous one. If such confirmation was not received, NB-12 completes the communication session until the next one according to the schedule. Herewith, 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.

The internal clock is set automatically when device connected to the "Vega NB-IoT Configurator" via USB.

FUNCTIONAL

Vega NB-12 modem has the following features:

o Interface 'current loop' 4-20 mA
o Interface 1-Wire for connecting temperature sensors (up to 10 pc)
o Analog input for voltage measurement from 0 to 3 V
o Two inputs operating in the «security» mode for connecting the external leakage and safety sensors, etc. with ability to configure as pulse to count input pulses
o Queue of sending when delivery is not possible
o Time referencing of readings by internal clock (UTC)

- o Extra communication when current on the 'current loop' interface is out of specified thresholds
- o Communication in case of security inputs or Hall sensor actuation
- o Measurement of temperature inside housing
- o Charge measuring of the battery (%)
- o Ability to filter the pulses by the duration

MARKING

Device marked with sticker that contain the next information:
- o Device model;
- o IMEI;
- o Month and year of manufacture;
- o QR-code containing IMEI for automatized count.

Sticker located in three places – on device case, in factory certificate and on the packing box.

2 SPECIFICATION

|	Main
Analog inputs	1
Interfaces	1-Wire, current loop 4-20 mA
Security/pulse inputs	2
USB-port	micro-USB, type B
Operating temperatures	-40...+85 °C
Built-in temperature sensor	yes
Hall sensor	yes
Quantity of black box records	up to 100 000
	Cellular communications
Supported Cellular Standards	LTE Cat NB1
Data transfer protocol	MQTT
Battery Life	1 year if the data transferring once a day
LTE NB-IoT antenna type	external
	Power
Built-in battery	6400 mAh (one or two, depending on delivery conditions)
	Case
Housing dimensions	95 x 95 x 50 mm
Ingress protection rating	IP67

3 OPERATION

CONTACTS

Description of contacts assignment is in table below. When connecting a radio modem to external devices with pulse outputs, consider the circuit design of its pulse inputs.

Circuit design of the pulse inputs
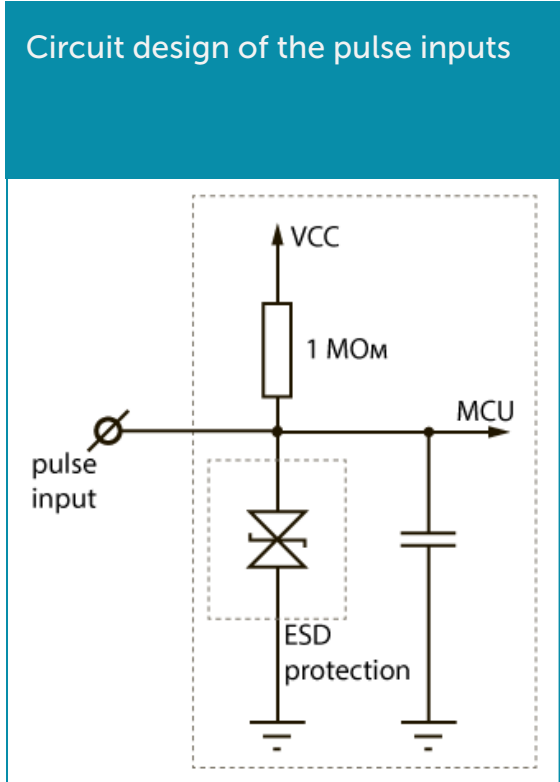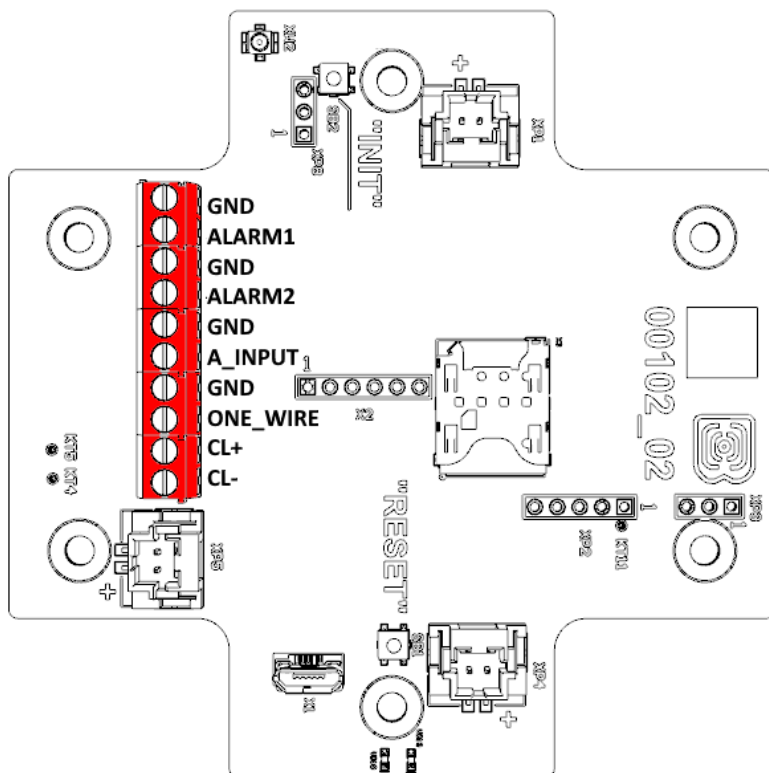
Contact	PCB designation	Description
1	GND	Ground
2	ALARM1	Security/pulse input 1
3	GND	Ground
4	ALARM2	Security/pulse input 2
5	GND	Ground
6	A_INPUT	Analog input
7	GND	Ground
8	ONE_WIRE	1-Wire
9	CL+	4-20 mA «+»
10	CL-	4-20 mA «-»

There are two security inputs on the boars which allows to connect circuits with the following types of NO contacts:

- reed switch;
- mechanical pushbutton;

- open-collector output.

The device monitors status changes on the security inputs and when the security input triggers, the device is activated and sends an alarm message to the network. The trigger mechanism is configured through the program "Vega NB-IoT Configurator".

Security inputs can operate as pulse.

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

CL+ and CL- contacts are used for connecting an external sensor with 4-20 mA interface. Scheme for connecting is shown on the picture below.
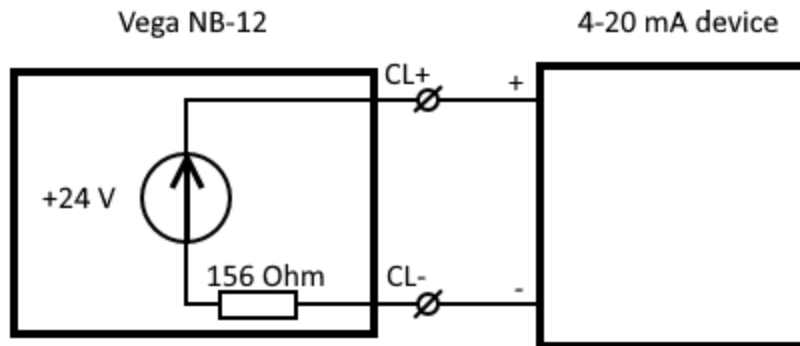

PULSE INPUTS SETTINGS

When you connect the modem to metering devices with a pulse output, it is necessary to consider the features of the pulse of a specific type of metering device: bounce, minimum pulse and pause duration. To do this, it is necessary to record the characteristics of the pulse with an oscilloscope or obtain information from the manufacturer of the meter.

The modem has a special software pulse filter. The filter is represented by two settings for each pulse input (see section 4, "Settings" tab). Consider the features of filtering settings for different pulse outputs.

1) Mechanical pulse output

Usually, the mechanical pulse output in metering devices is implemented on a reed switch, but it can also be a button or other mechanics. The main problem with such outputs is contact bounce. At a moment of falling and rising, there are many additional impulses that need to be no considered in the calculation. In addition, the pulse duration floats and depends on the current flow rate of the meter. For correct counting, it is necessary to determine the minimum useful pulse duration and the minimum pause between useful pulses (all that is less is bounce). The obtained values must be set in the modem settings.

The minimum useful pulse duration is the pulse duration that the meter produces at the maximum flow rate (the maximum flow rate is indicated in the meter's passport). This duration does not include bounce time. The minimum pause duration can be set equal to the minimum pulse width, or longer if necessary. Usually, the pause between pulses is an order of magnitude higher.
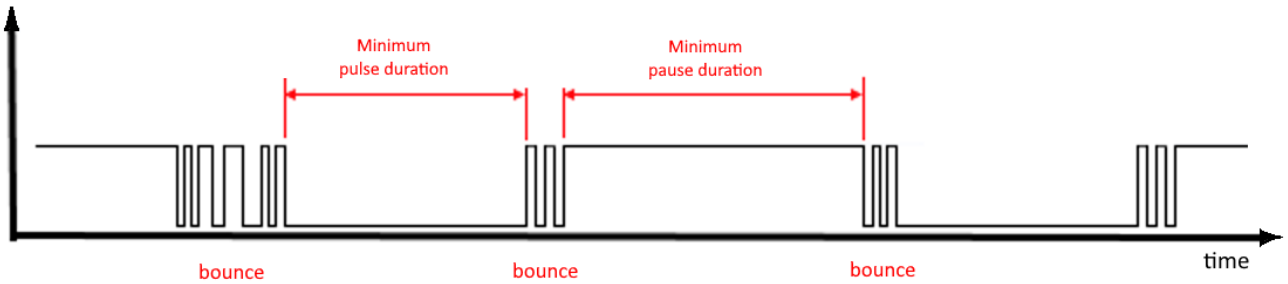

2) 2) Electronic pulse output

The electronic pulse output has no bounce (open collector output). This output usually has a fixed pulse width. For the modem to fix the pulse, it is necessary to set in the settings the minimum pulse duration less than the actual pulse duration issued by the meter.
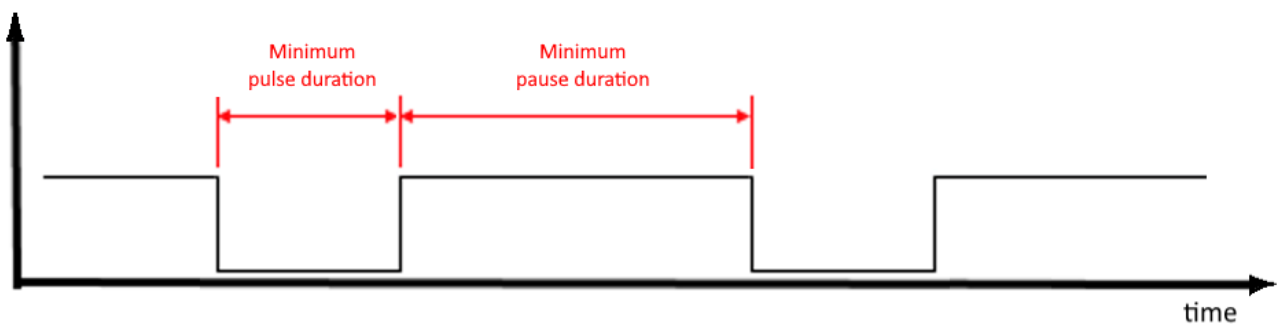
HALL SENSOR

The device has Hall sensor which located on the board edge on the bottom side. When the magnet is brought up the sensor triggered, and the device can form the alarm message which immediately transmitted to the server.
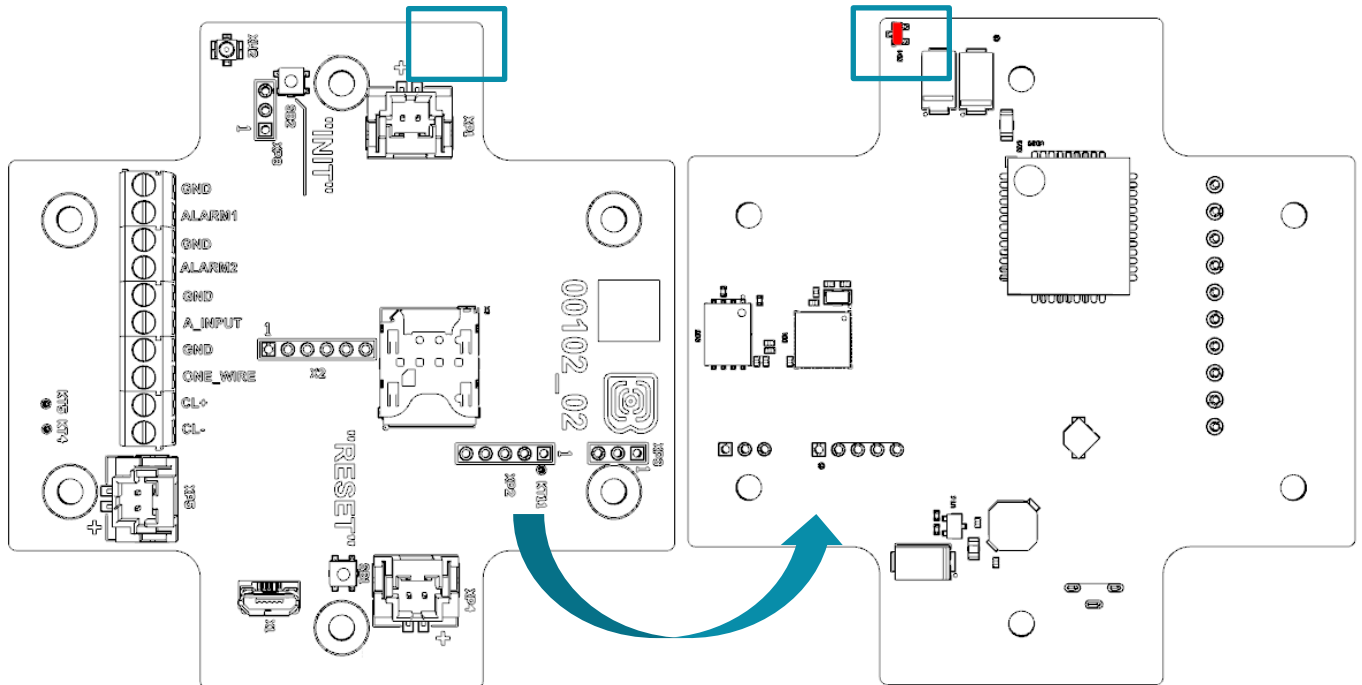
BUTTONS

There are two buttons on the board which can help you to manage the device. Buttons are described in the table below.


INIT button

RESET button
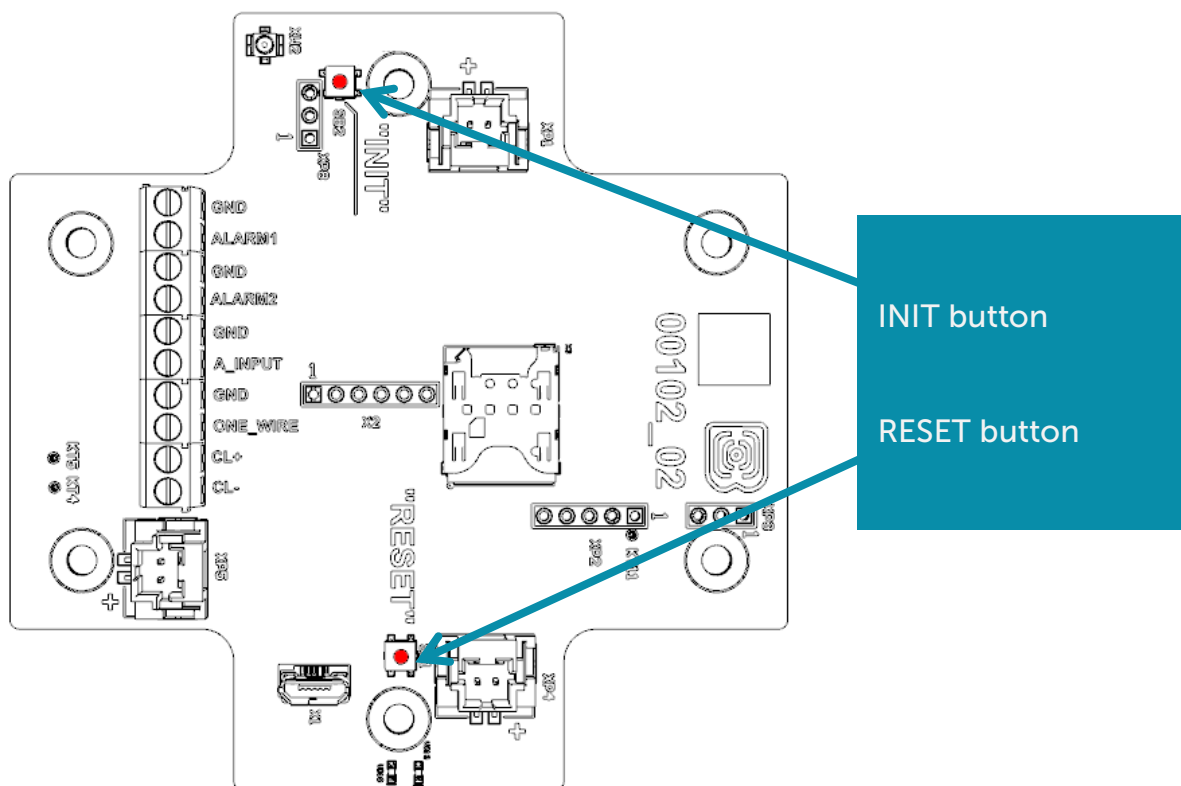
Action	Result
RESET	
Short pressing	Device reloading
INIT	
Pressing for 1 second	Registration at the network
Pressing for 2 seconds	Data transmitting
Pressing for 3 seconds	LTE-modem switching off
Pressing for 4 seconds	To form record to the black box

When you hold down the button, the red LED starts flashing once a second, which will help you to find out the duration of pressing. Pressing for 1 second corresponds to one flash of the LED, pressing for 2 seconds corresponds to two and so on.

INDICATION

There are two LEDs on the board: red and blue. Blue LED VD19 shows LTE-modem state, and red LED VD18 – the device state.

LEDs location oh the board
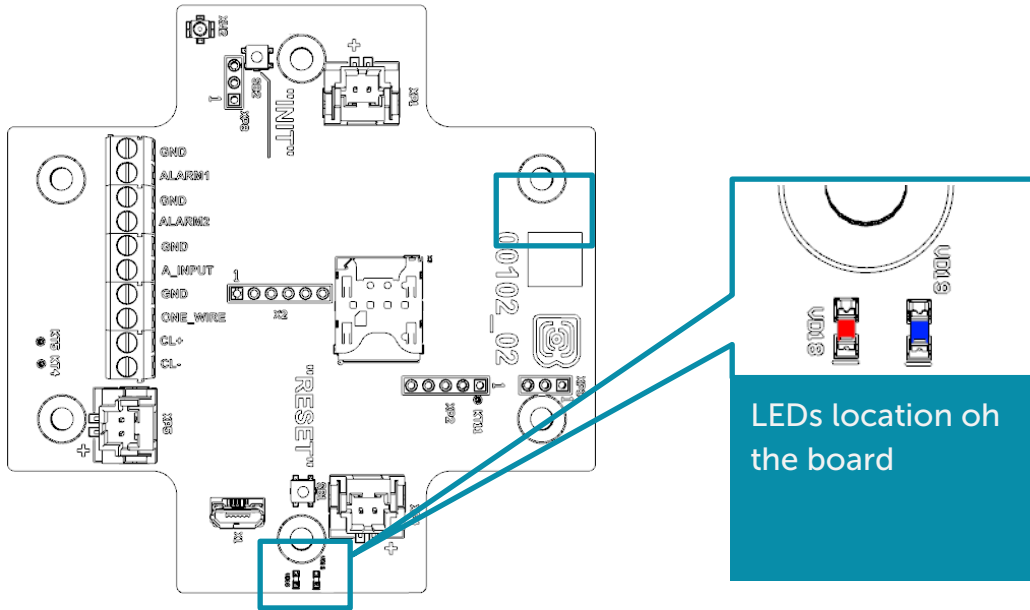
| LED signal		Meaning
LTE-modem		
	Short flash every three seconds	Device search the network
	Short flash every second	Device successfully registered and it is in the network
	Two short flashes every one second	Device transmits data to the network
	No light	LTE-modem switched off
Device		
	Short flash every second	Battery charge is lower than 5%
	Short flash every five seconds	Device in the 'Operation' mode
	No light	Device in the 'Sleep' mode or switched off

INITIAL STARTUP

Firstly, it is necessary to install SIM into slot on the board and set up the data transmitting with "Vega NB-IoT Configurator" (See part 4).

Location of the SIM slot on the board (if there is)

Location of the battery connectors on the board
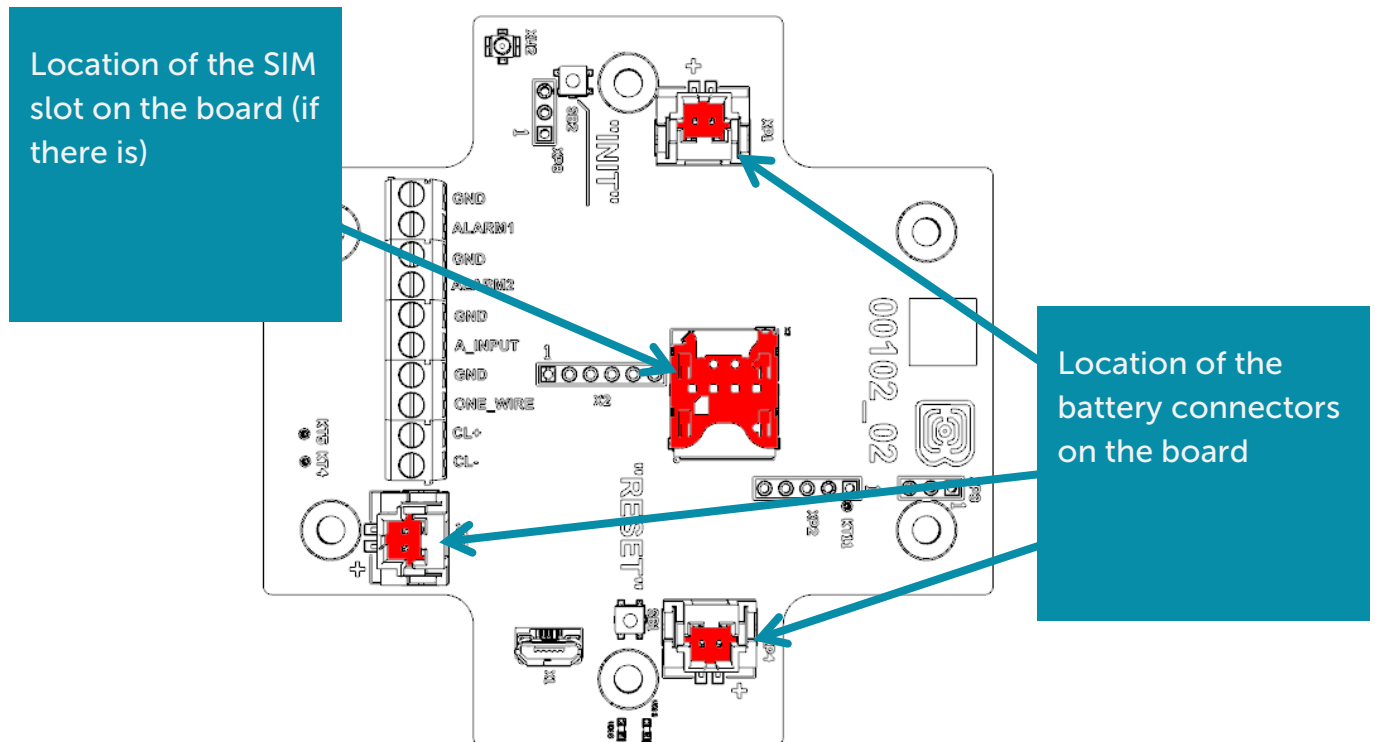
Vega NB-12 modem powered by the one or two batteries which comes with[1]. There are equivalent connectors located on the board. After battery connection to one of connectors, the device loaded and switched to the 'Sleep' mode until the communication session according with the schedule.

If you need to test the data transmitting, then press and hold the INIT button for the 2 seconds.

MOUNTING RECOMMENDATIONS

When you connect the pulse output of the metering device to the counting input of the modem, it is recommended to use braided shielding wires, and to install the metering device with the modem away from sources of radio interference. It is recommended to use a two-wire screened wire. The shield is connected on the side of the pulse counter to its ground.

1 wire – the signal from the pulse output is connected to the terminal COUNT/ALARM

2 wire – ground, connects to terminal GND

Shield – connects to terminal GND

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[1] The number of included batteries depending on the delivery conditions

CONNECTING VIA USB

The modem with 4-20 mA interface can be adjusted with the "Vega NB-IoT Configurator" application through the USB connection (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:
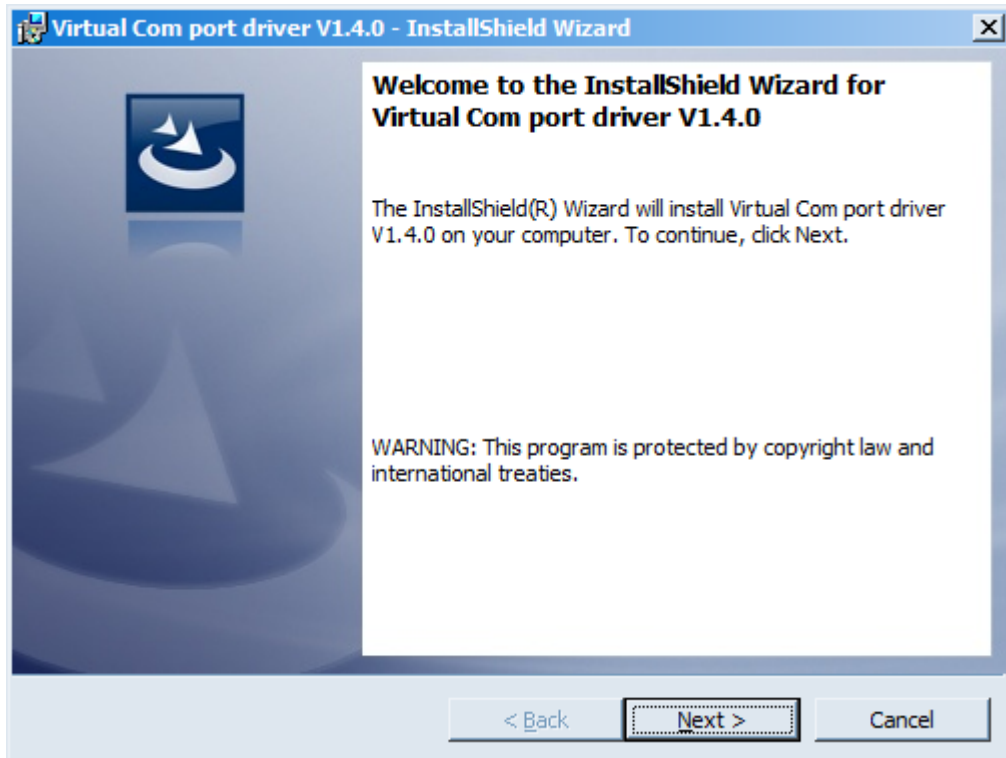
In this window, you need to click **Next**, then **Install**, and then the installation will begin. When the installation is completed successfully, the following screen appears:
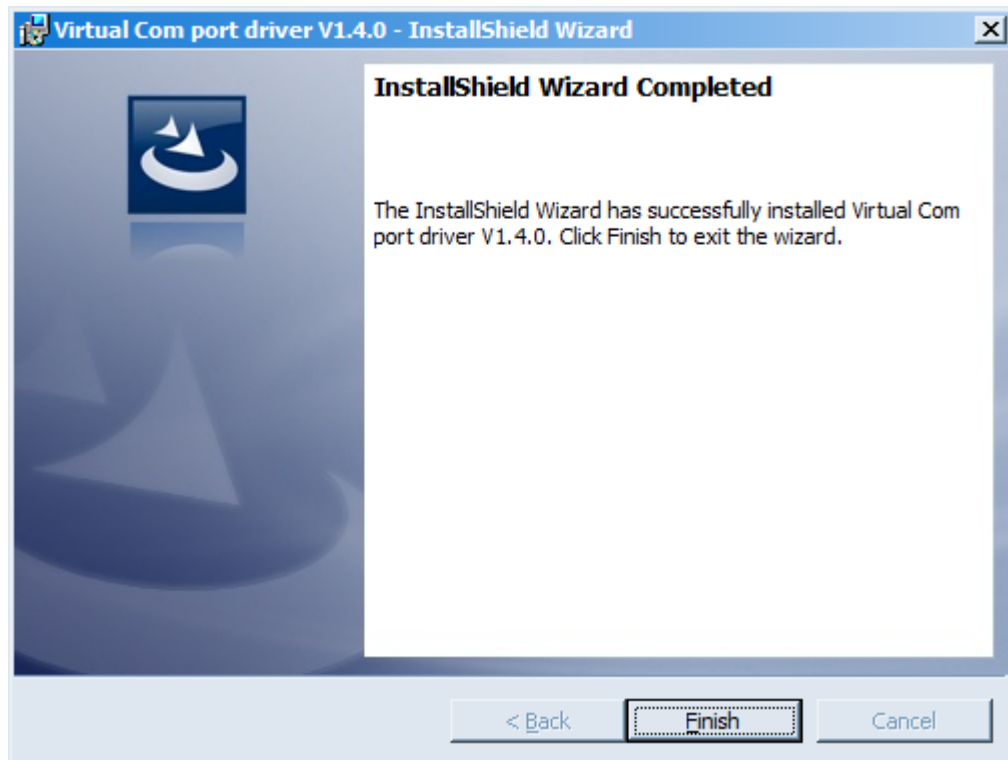
After pressing **Finish** the driver is ready for operation, - it is possible to connect the modem with 4-20 mA interface via USB.

4 VEGA NB-IOT CONFIGURATOR

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

INTERFACE OF THE APPLICATION

The "Vega NB-IoT Configurator" application does not require the special installation. When the executable file is launched, the window for working with the application appears.
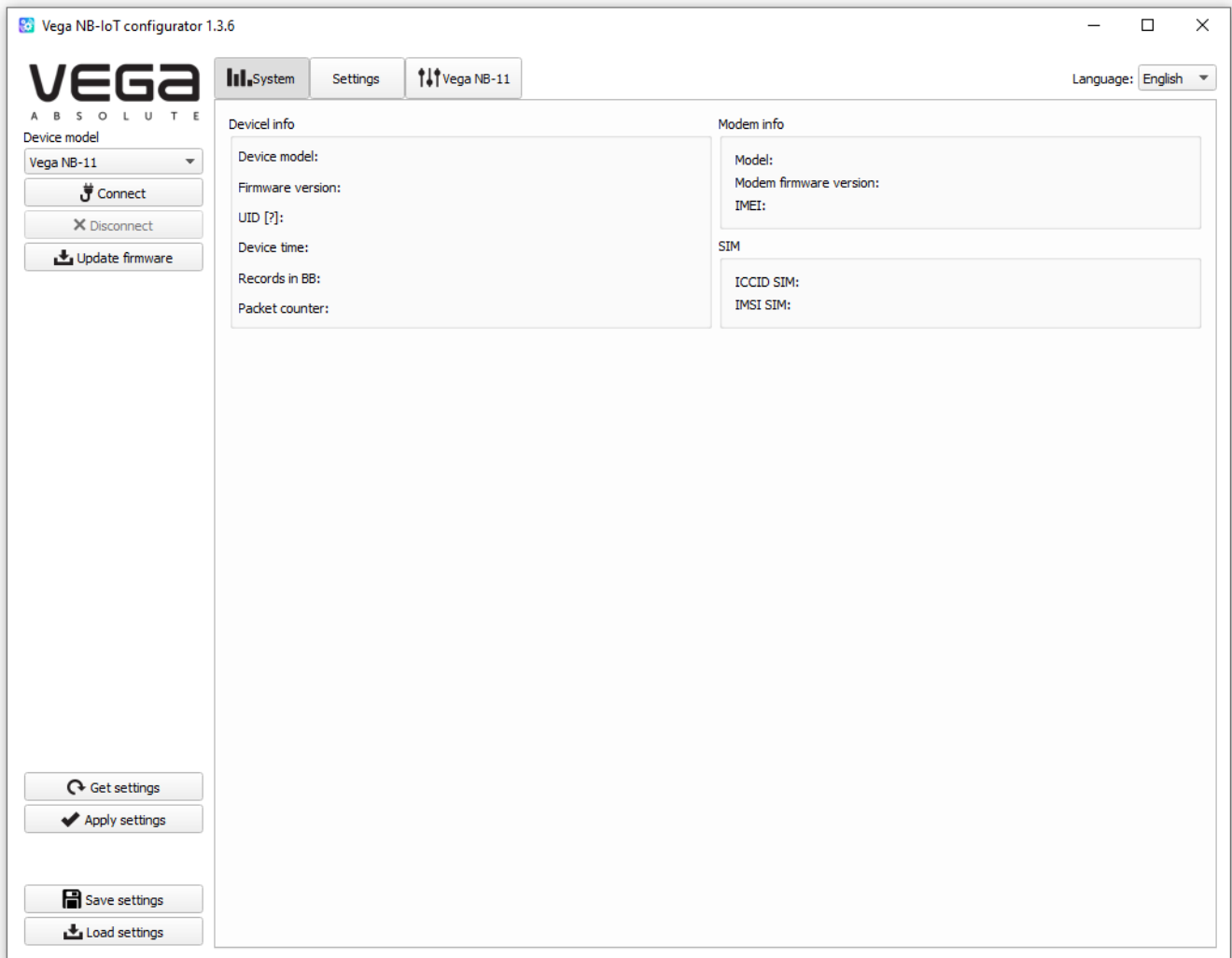
The menu on the left allows you to select the device model, connect to the device or disconnect from it, and update firmware.

The application window contains three tabs – System, Settings and device manage.

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 NB-IoT 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.
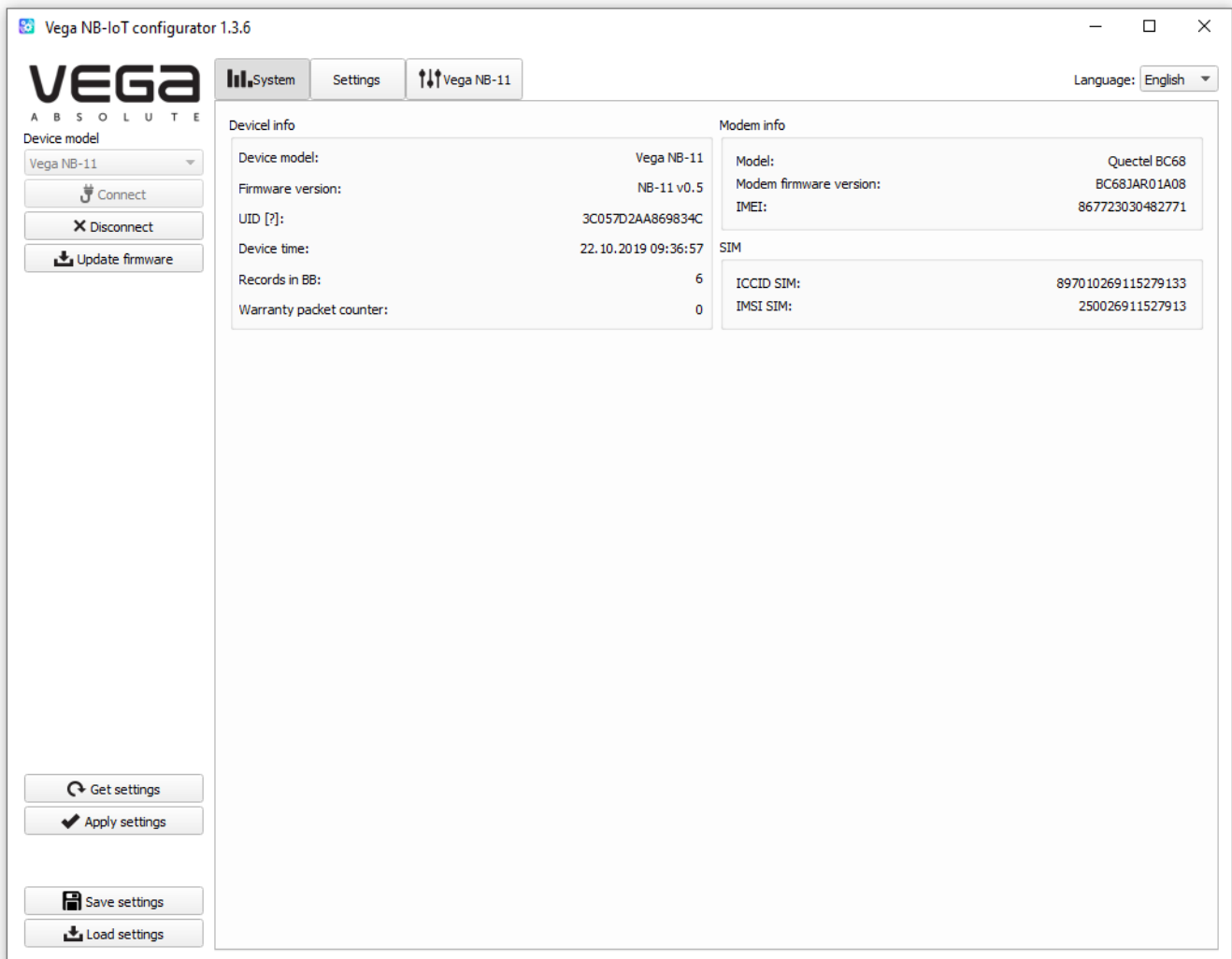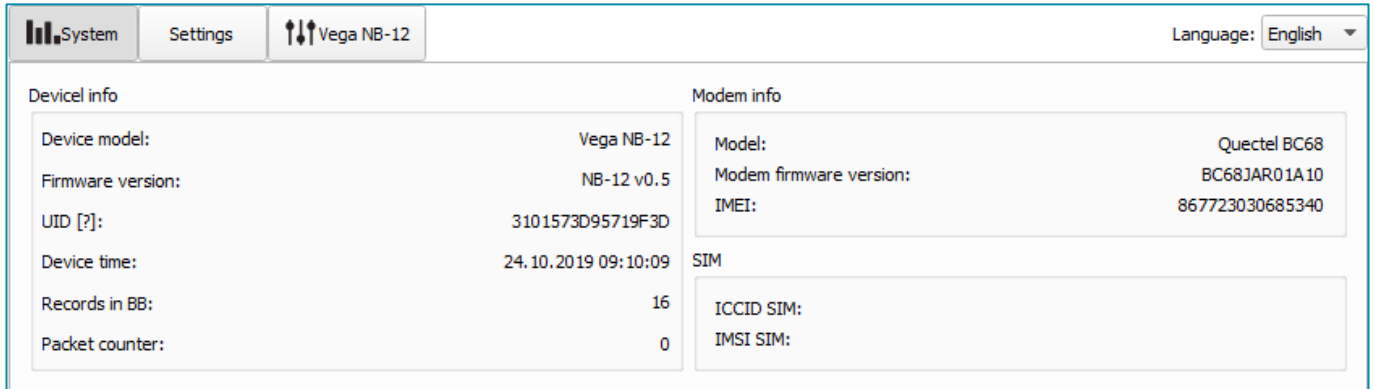

To read the settings from the device, you need to click the "Get settings" button, until this point the application will display the default settings or from the last connected device.

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. Also, the application allows to save settings into a file after what you can load it from that file on other similar devices for speed up the debugging process.

"SYSTEM" TAB

The "System" tab displays information about the device, about modem, and SIM.

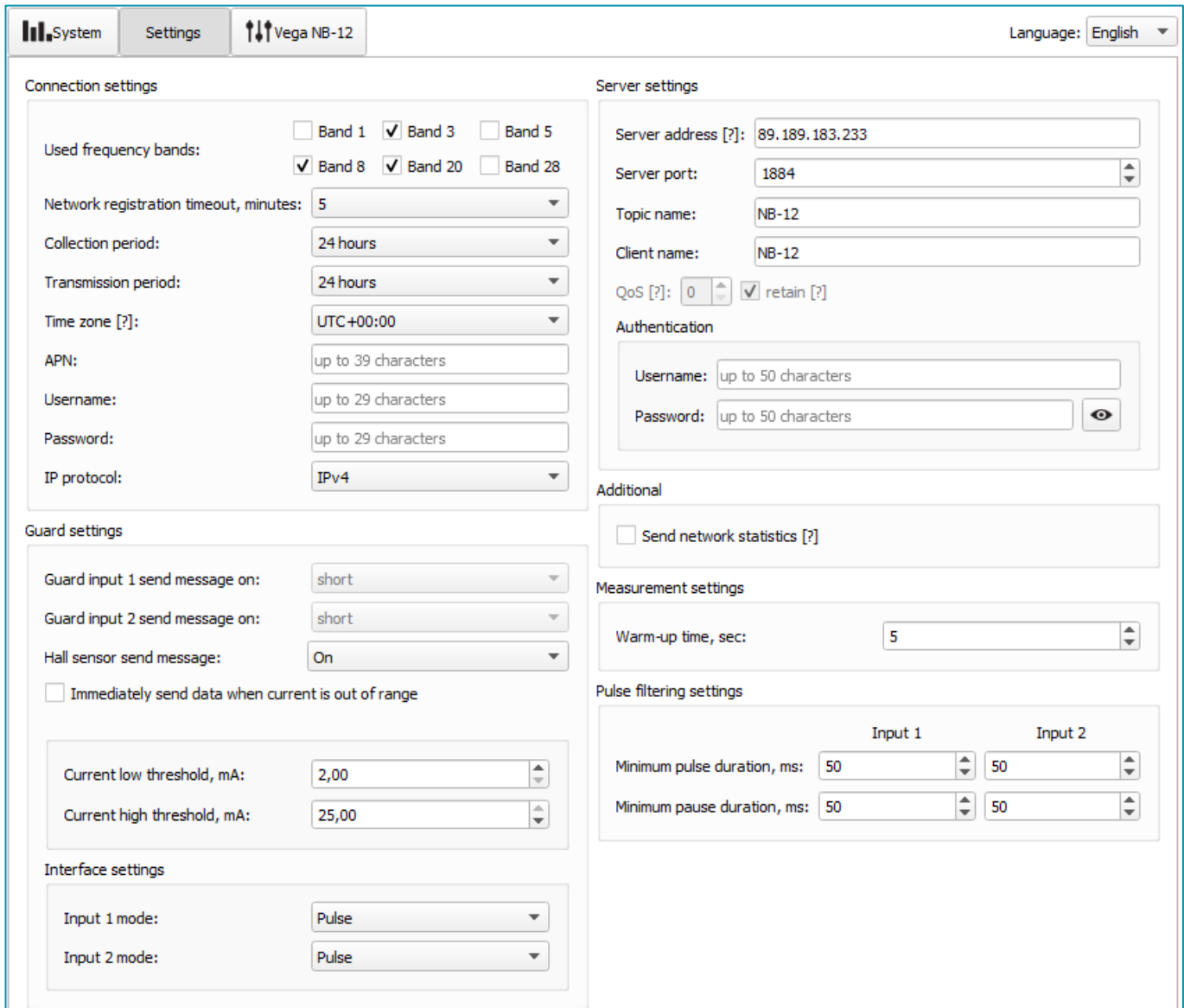**Device info** - the configurator reads information about the device model, its firmware and automatically corrects the device's time when connected to it. In that block you can find out the number of records in the black box and the number of packets sent by the device.

Modem info – in that block information about LTE-modem is displayed.

SIM – identifiers of the SIM card (SIM chip).

The " Settings" tab allows to configure various parameters of the network connection and device operation.

Connection settings – a group of parameters set up the data collection and transmitting.

Used frequency bands for NB-IoT devices connection can be different for different cellular operators. You can ask the operator about used band or select all the bands.

Network registration timeout – it is a period after which the modem will switch to the 'Sleep" mode when registration waiting. For battery economy it is better to set minimal period for which the device can registered in the network in the specific covering conditions.

Cellular operator can give you APN or set it by default if the field is empty.

Time zone set up for the data collection period which is equal to the device time (UTC) plus time zone. Transmission period is always use UTC time regardless of the time zone setting.

Readings collected at 00:00 if the collection period is 24 hours; at 00:00 and at 12:00 if the period is 12 hours etc. All readings stored in the device memory until the next communication session.

Transmission period can be equal to 5, 15, 30 minutes, 1, 2, 3, 4, 6, 12 and 24 hours. When beginning of communication session, the device starts sending packets with readings from the earliest packet. The time of data transmitting cannot be specified, it is defined in random way for every device in chosen period of transmission from the moment of connection to the network. For example, transmission period is 30 minutes, and device was started at 16:40 by the internal device clock. In random way the device calculate data transmitting time and set it at 16:41 in the half-hour period from 16:40 to 17:10. Thus, packets from this device will transmit at 16:41, at 17:11, at 17:41, at 18:11 and so on every 30 minutes by the internal device clock.

Guard inputs settings – allows to set up mode of security inputs triggering – when security circuit is short, open or in a both cases. Also, to switch on/off an alarm by the Hall sensor.

"Current low threshold" and "current high threshold" parameters are specified in mA. This range cooperates with the parameter "Immediately send data when current is out of range".

If the parameter is active, then the modem finds out that values is out of range while collecting data according with the schedule and send this data immediately. Every next message formed according with the schedule will send immediately until the current value come back to specified range.

Interface settings – allows to configure operation mode for each pulse input. There may be security or pulse mode.

Server settings – settings of connection with MQTT broker.

In **additional** you can receive network statistics. By default, for traffic economy there are no information about connection quality, base station number and other in the packet.

Measurement settings – allows to specify the startup time for an external sensor power. Value of this parameters may vary from 1 to 60 seconds.
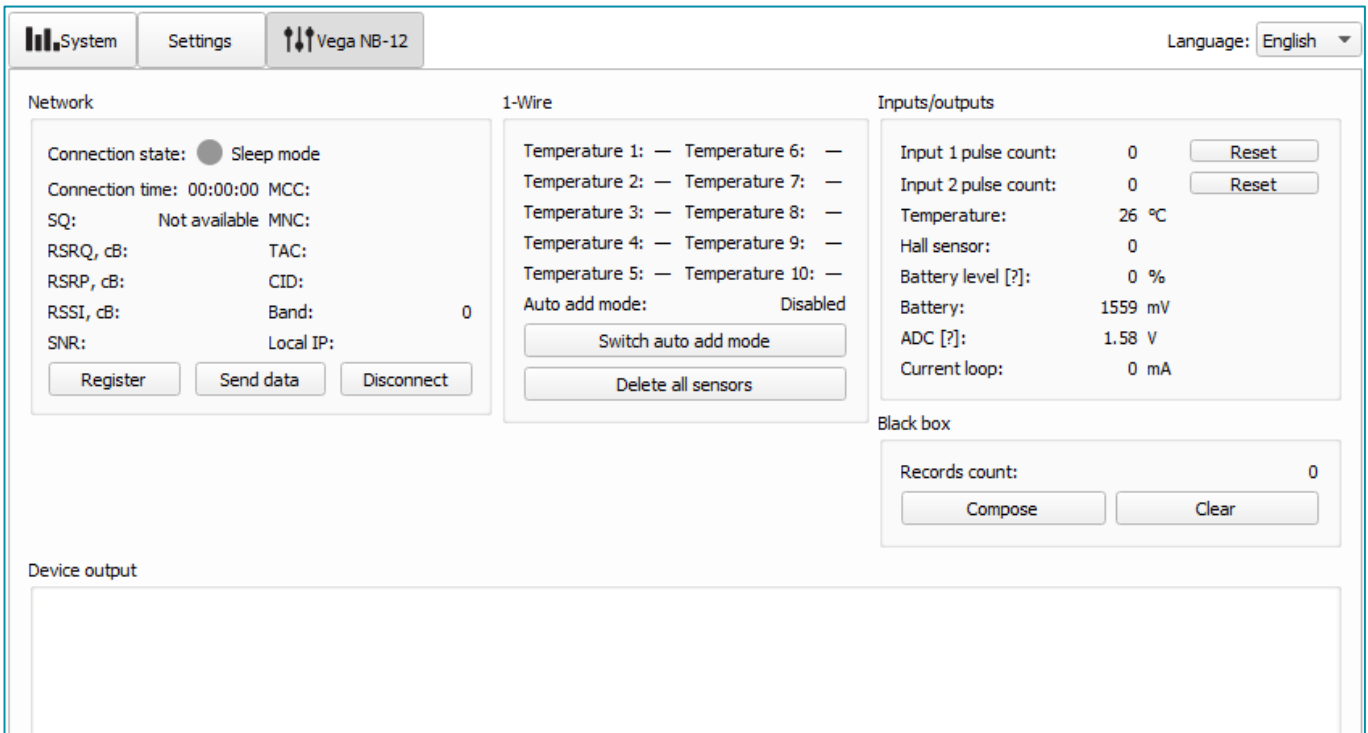
Pulse filtering settings – in this part you can set minimum values of the pulse and pause duration apparently for each of four pulse inputs. Value can be set in milliseconds and can be equal from 2 to 65535 ms.

Minimum pulse duration - the value of the minimum pulse duration in ms, at which the pulse will be recorded by the modem, pulses with a duration less than the specified one will be regarded as bounce and will not be recorded by the modem.

Minimum pause duration - the value of the minimum pause duration in ms, after which the next pulse is let to be fixed.

"VEGA NB-12" TAB

The "Vega NB-12" tab contains detail information about the connected device, its sensors, and inputs.

Network – displays the current parameters of the connection and allows to control it. Buttons in this block have logic like INIT button on the board.

SQ parameter – Signal Quality – may be from 0 to 31 while connection is on, and 99 value means the connection absent. Table of values is shown below.

Value in program	Signal Quality, dBm
0	-113 and lower
1	-111
2...30	-109...-53
31	-51 and more
99	No connection
100	-116 and lower
101	-115
102...190	-114...-26
191	-25 and more
199	No connection

1-Wire – settings of connection external temperature sensors and it's readings. For adding a sensor in system, you need to switch ON the auto add mode. Sensors get numbers in order which them were connected. After switching the auto add mode ON the device starts search the new sensors on the bus. When new sensor is found, the device add it in memory and the auto add mode OFF automatically. To add the next sensor, you need to switch the auto

add mode ON again. All sensors may be removed from the memory with button "Delete all sensors".

Inputs/outputs – displays current parameters of the device and allows to reset pulse counters on the input.

Unlike other values displayed in Configurator, the value of parameter "Current loop, mA" not displayed in real time mode. Instead of this the field shows current value from the last data slice by the schedule.

Black box – there are buttons for black box management and the number of records is displayed. The button "Compose" initiates data collection from all the inputs and this packet is placed in the black box until the next communication session. The button "Clear" deletes all records from the black box.

Device output – displays device's events in real time.

5 COMMUNICATION PROTOCOL

Data is transmitted via MQTT protocol. You should specify in the device settings the address and port of the server where the data will be sent. Those settings specified in application "Vega NB-IoT Configurator". It must be MQTT broker as a server (received side). You should specify in the device settings the address and port of the broker. Also, you should specify a topic name where the data published and a client name – the name which the device use for publishing. All those settings specified in "Vega NB-IoT Configurator" in part "MQTT settings". For watching the data sending by the device you should deploy MQTT broker on a PC and become subscribed on MQTT broker with any application.

Vega NB-12 sends the message on the server as a text of JSON format. See example below.

```
{
 "Message": {
  "dev": "NB-12 v0.1",
  "IMEI": "867723030711633",
  "IMSI": "250990283462252",
  "ICCID": "8970199170730496783",
  "num": 3,
  "UTC": 1571227504
 },
 "CellStatus": {
  "SQ": 19,
  "EARFCN": 1240,
  "PCID": 26,
  "RSRP": -822,
  "RSRQ": -108,
  "RSSI": -744,
  "SNR": 119
 },
 "Telemetry": {
  "reason": "time",
  "UTC": 1571227500,
  "bat": 99,
  "temp": 28,
  "ADC1": 0,
  "current": 12.76,
  "pulse1": 0,
  "pulse2": 0,
  "s_alarm1": 0,
  "s_alarm2": 0,
  "s_magnet": 0,
  "s_curovr": 0,
  "onewire":[21.6,20.6,21.6,2.2,1.4,33.2,31.7,18.4,14.9,-11.8],
 }
```

}

Transcription of the message fields:

Message – part with information about current message.

dev – name and version of the device firmware

IMEI – LTE-modem identifier

IMSI, ICCID – SIM-card (SIM-chip) identifiers

num – the number of the message

UTC – the date and the time of message sending in UTC format by Greenwich

CellStatus – part with information about the cellular state

SQ – gateway signal quality

EARFCN – the number of radio frequency channel (absolute)

PCID – physical network address

RSRP – input signal power

RSRQ – input signal quality

RSSI – indicator of the input signal power

SNR – signal to noise ratio

Telemetry – part with collected data (one packet)

reason – reason for packet forming*

UTC – the date and the time of message collecting in UTC format by Greenwich

bat – battery charge

temp – processor temperature

ADC1 – voltage on the input A_INPUT

current – measured current of the current loop interface

onewire – values of temperatures of sensors on 1-Wire bus

pulse1 – pulse number on the input 1

pulse2 – pulse number on the input 2

s_alarm1 – state of ALARM1 input at the time of data slice ("0" - logic zero input, "1" - logic one input)

s_alarm2 – state of ALARM2 input at the time of data slice ("0" - logic zero input, "1" - logic one input)

s_magnet – the presence of an external magnetic field at the time of data slice ("0" - absent, "1" - presence)

s_curovr – flag for exceeding the current limits of the current loop interface specified in the settings ("0" - the limit is not exceeded, "1" - the limit is exceeded)

*Possible values for **Reason** field (Reason for packet forming):

time – packet formed by the time (data collection period set up in the Configurator for the device)

alarm1 – packet formed by the alarm on the input "ALARM1" (communication session initiated by this event)

alarm2 – packet formed by the alarm on the input "ALARM2" (communication session initiated by this event)

cnfg – packet formed by the command from Configurator

hall sensor – packet formed by the Hall sensor (communication session initiated by this event)

button – packet formed by the button pressing (communication session initiated by this event)

6 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega NB-12 modem with 4-20 mA interface 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:

Vega NB-12 modem with 4-20 mA interface – 1 pc.

Antenna – 1 pc.

Battery 6400 mAh – 1...2 pcs. [2]

Factory certificate – 1 pc.

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[2] The quantity of batteries depending on delivery conditions

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 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;

- 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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