



NB-IOT MODEM WITH RESISTANCE
CONTROL

VEGA NB-14

User manual



Document Information

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INTRODUCTION

This manual is designated for Vega NB-14 modem resistance control (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-14 modem is designed for monitor of insulation state of the warm network pipelines and for control of integrity of pipelines signal wires, further accumulating and transmitting of this information in NB-IoT network.

Modem allows to detect the following defects:

- wet insulation;
- the breakage of the signal wires;
- closing of the signal wire to the pipe (detected like 'wet insulation' defect).



Modem does not detect a reason and a place of defect appearing

In addition, Vega NB-14 can be used as a security device – two additional inputs operate in security mode, there is also Hall sensor.

The modem can be used on pipelines with polyurethane foam heat insulation and/or collect data from 1-Wire interface connected temperature sensors etc.

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, 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, 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-14 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-14 modem has the following features:

- Resistance measurement from 0 to 1 MOhm on the two inputs (insulation wetting control)
- Resistance value control on the two inputs - there more or less than 200 Ohm (signal wire breakage control)
- Two inputs operating in the «security» mode for connecting the external leakage and safety sensors, etc.
- Interface 1-Wire for connecting temperature sensors (up to 10 pc)
- Queue of sending when delivery is not possible
- Time referencing of readings by internal clock (UTC)
- Extra communication when resistance is out of specified thresholds (signal wire breakage, wet insulation)
- Communication in case of security inputs or Hall sensor actuation
- Measurement of temperature inside housing
- Charge measuring of the battery (%)

MARKING

Device marked with sticker that contain the next information:

- Device model;
- IMEI;
- Month and year of manufacture;
- 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

Monitoring of signal wire integrity and wet insulation	2 channels
Interfaces	1-Wire
Security 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	2 years 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)
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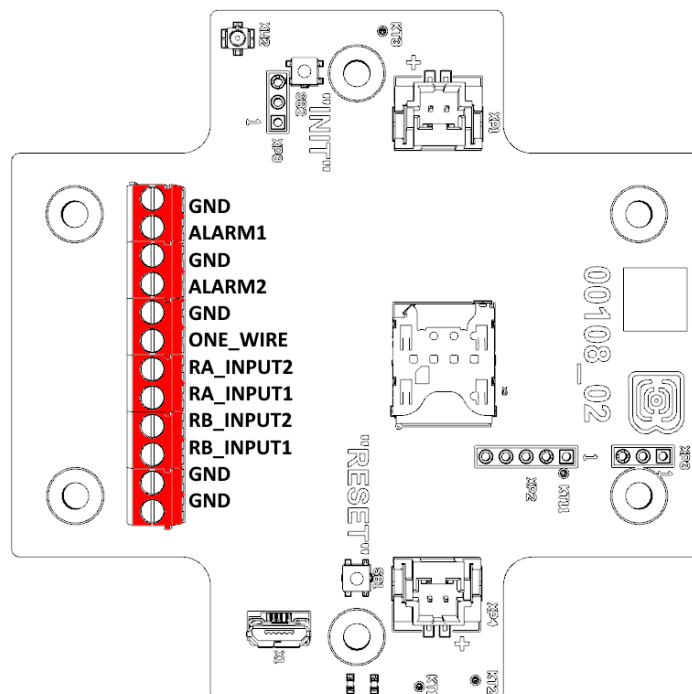
Case

Housing dimensions	95 x 95 x 50 mm
Ingress protection rating	IP67

3 OPERATION

CONTACTS

Description of contacts assignment is in table below.



Contact	PCB designation	Description
1	GND	Ground
2	ALARM1	Security input 1
3	GND	Ground
4	ALARM2	Security input 2
5	GND	Ground
6	ONE_WIRE	1-Wire
7	RA_INPUT2	Input 2 of channel A
8	RA_INPUT1	Input 1 of channel A
9	RB_INPUT2	Input 2 of channel B
10	RB_INPUT1	Input 1 of channel B
11	GND	Ground
12	GND	Ground

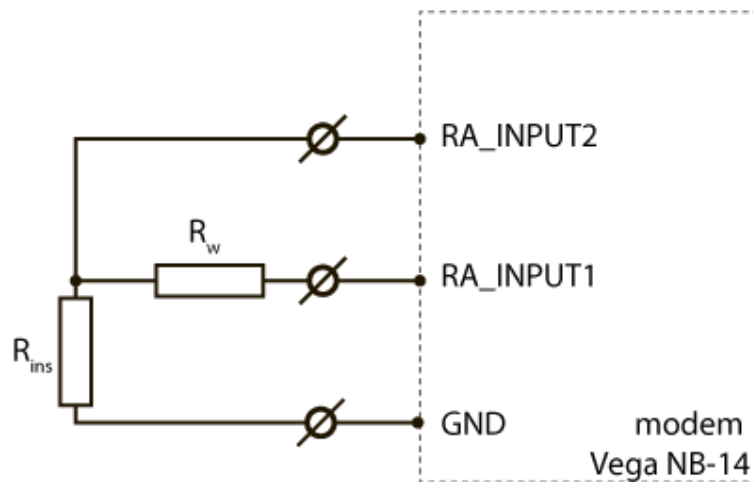
There are two security inputs on the boards which allows to connect circuits with the following types of NO contacts:

- 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".

For resistance monitoring the modem has two equivalent channels: A and B. Every channel designed for measurement of two types of the resistance – pipeline insulation resistance R_{ins} and signal wire resistance R_w . Consider the principle of device operation on the example of channel A.



Device measures resistance according with scheme pictured above and determines presence of defects of the pipeline insulation or the signal wire after that. Table of control values:

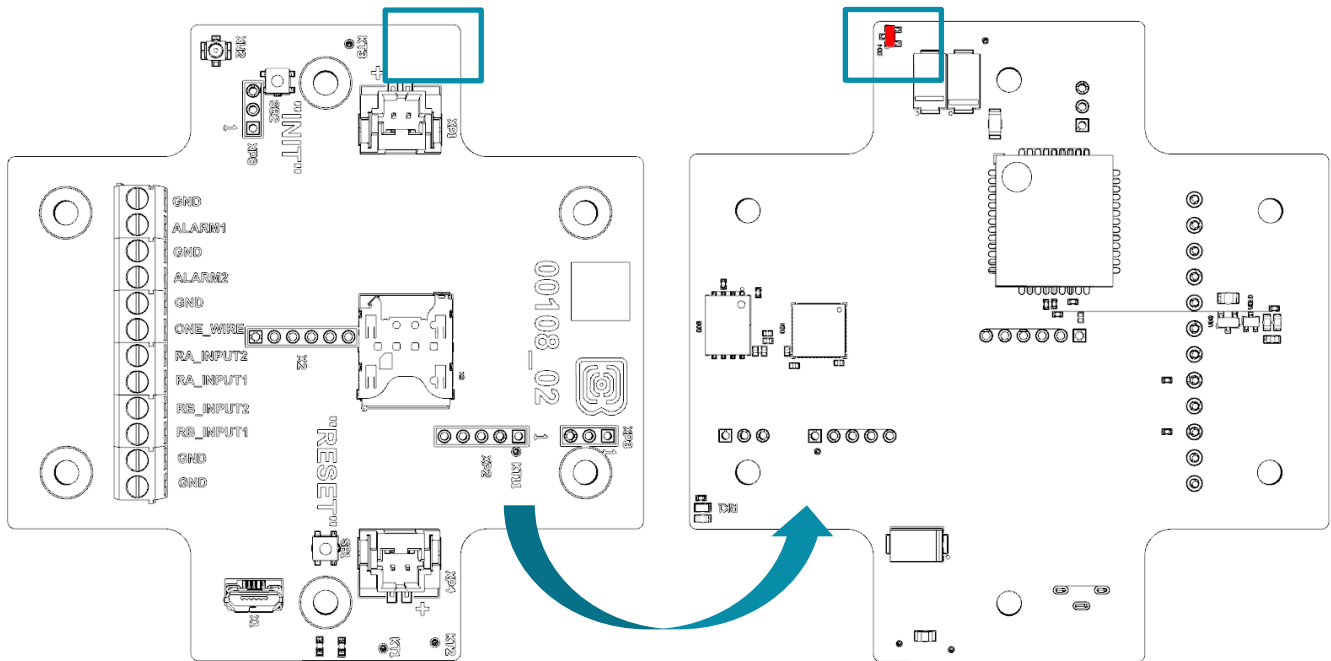
Object state	Values of control parameters	Text in the program (see part 4)	Color in the program (see part 4)
Signal wire is integrity	$R_w \leq 200 \text{ Ohm}$	OK	green
Breakage of the signal wire	$R_w > 200 \text{ Ohm}$	breakage	red
Pipeline insulation is OK	$R_{ins} > 1 \text{ MOhm}$	normal 1	green
	$500 \text{ kOhm} < R_{ins} \leq 1 \text{ MOhm}$	normal 2	green
	$100 \text{ kOhm} < R_{ins} \leq 500 \text{ kOhm}$	normal 3	green
	$50 \text{ kOhm} < R_{ins} \leq 100 \text{ kOhm}$	normal 4	green
	$5 \text{ kOhm} < R_{ins} \leq 50 \text{ kOhm}$	normal 5	green
Wet insulation (or signal wire closed to metal pipe)	$R_{ins} \leq 5 \text{ kOhm}$	wet	yellow

When device finds out a defect from 'red' or 'yellow' zone, it forms an alarm packet and if setting 'Send data immediately' is active then sends it in the NB-IoT network. If the setting

does not active the alarm packet is saved in black box until the communication session according the schedule (see details in part 4).

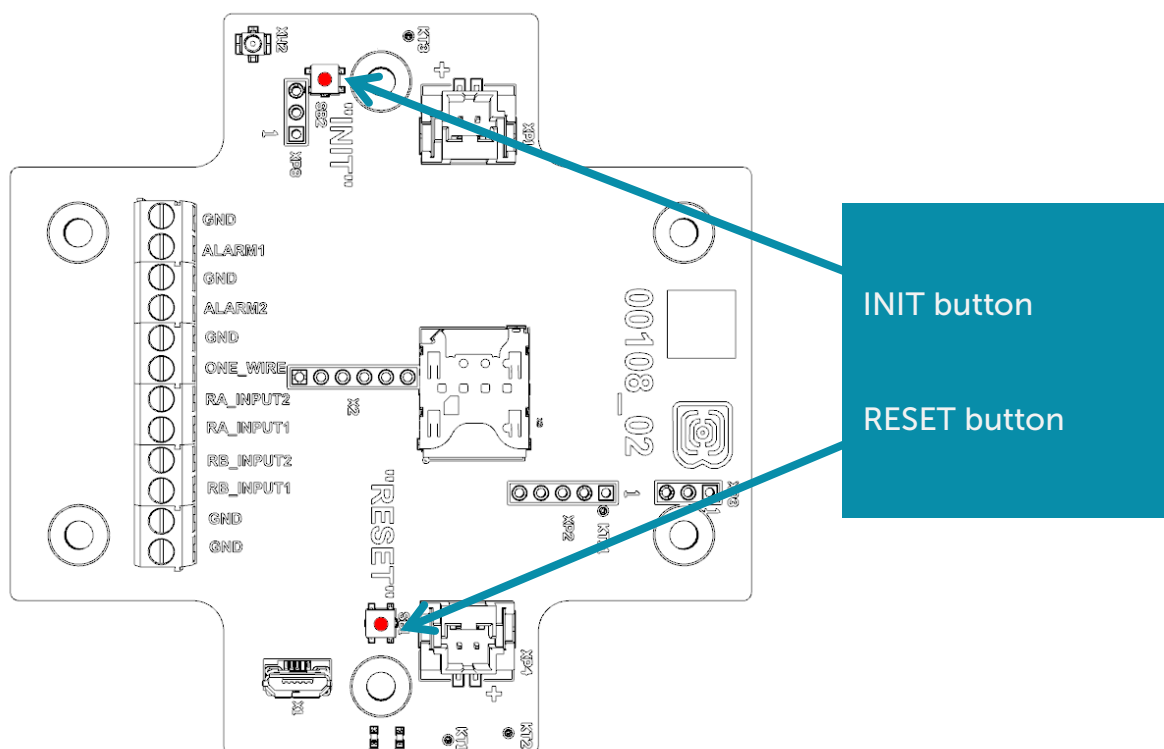
HALL SENSOR

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.

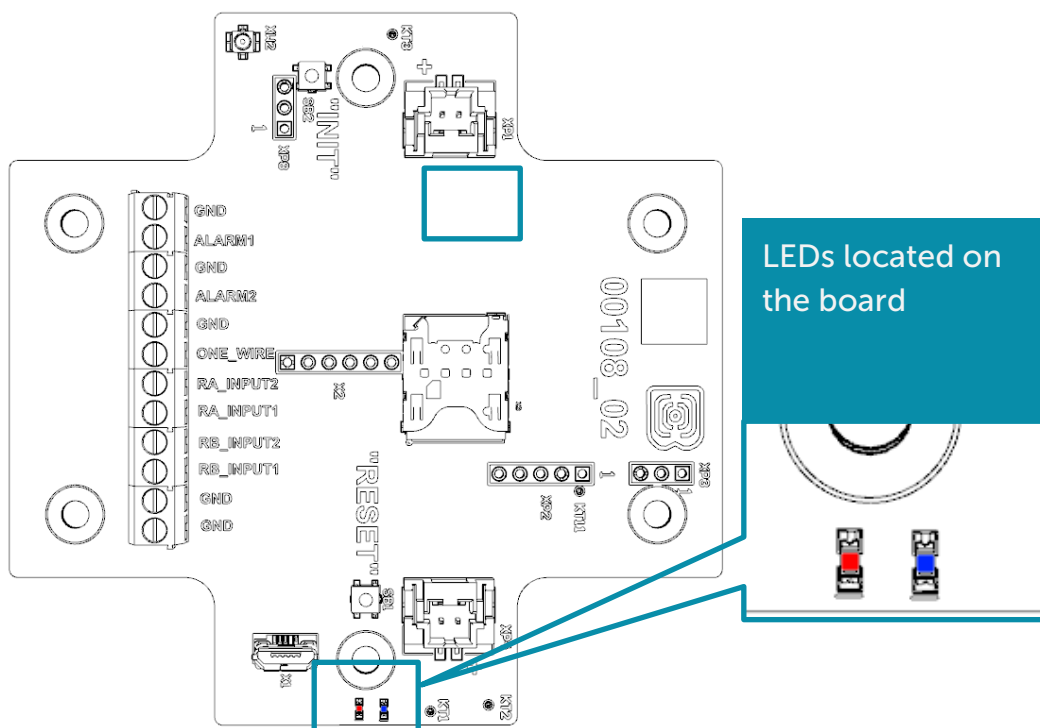


Action	Result
RESET	
Short pressing	Device reloading
INIT	
Pressing for 1 second	Registration at the network
Pressing for 2 seconds	Data transmitting
Pressing for 3 seconds	LTE-modem switching off

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

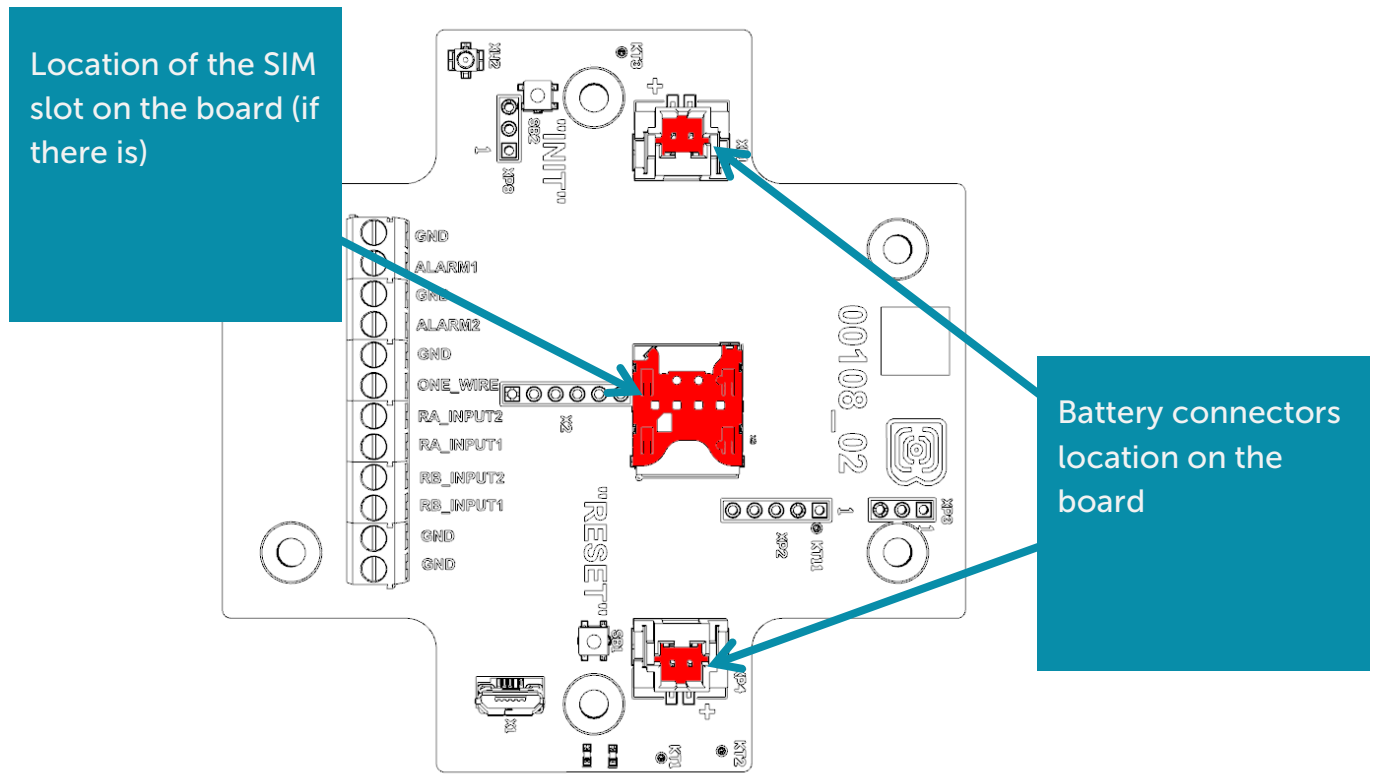
There are two LEDs on the board: red and blue. Blue LED VD19 shows LTE-modem state, and red LED VD18 – the device state.



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).



Vega NB-14 modem powered by the one or two batteries which comes with¹. 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.

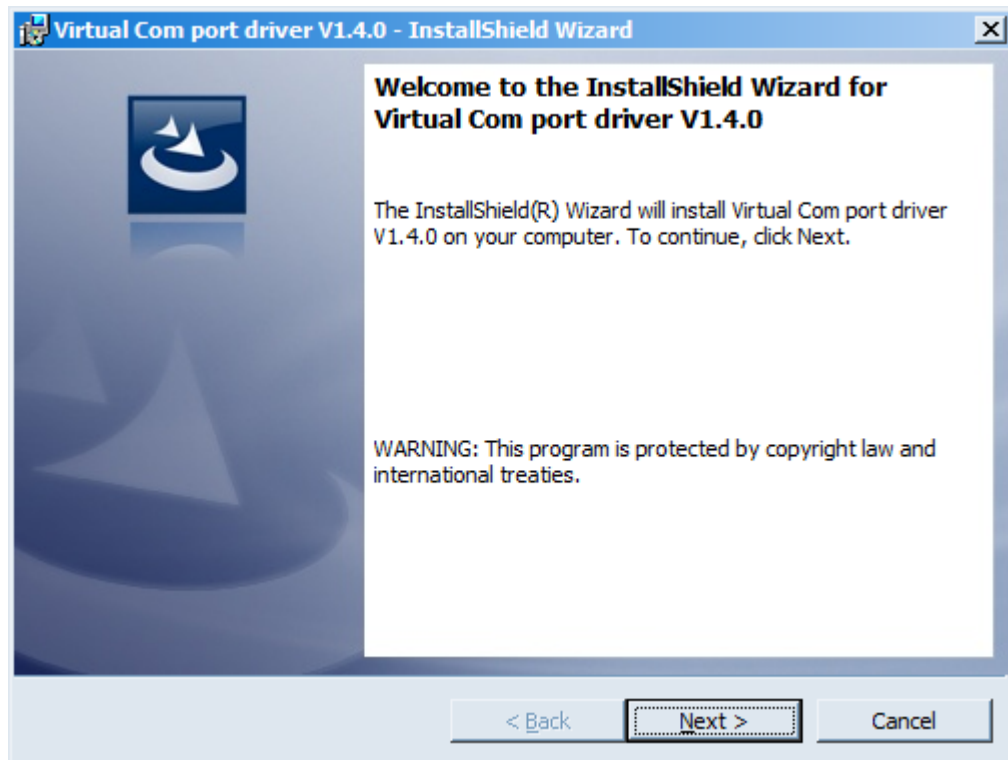
If you need to test the data transmitting, then press and hold the INIT button for the 2 seconds.

CONNECTING VIA USB

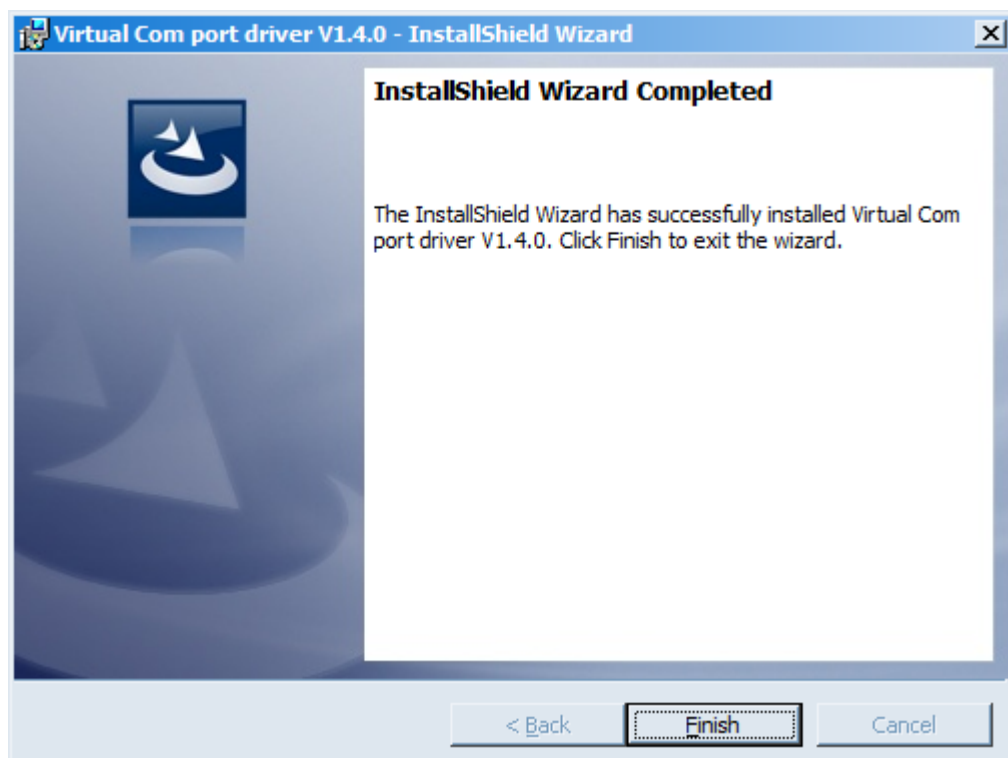
The modem with 4-20 mA interface can be adjusted with the "Vega NB-IoT Configurator" application through the USB connection (See part 4).

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:

¹ The number of included batteries depending on the delivery conditions



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:



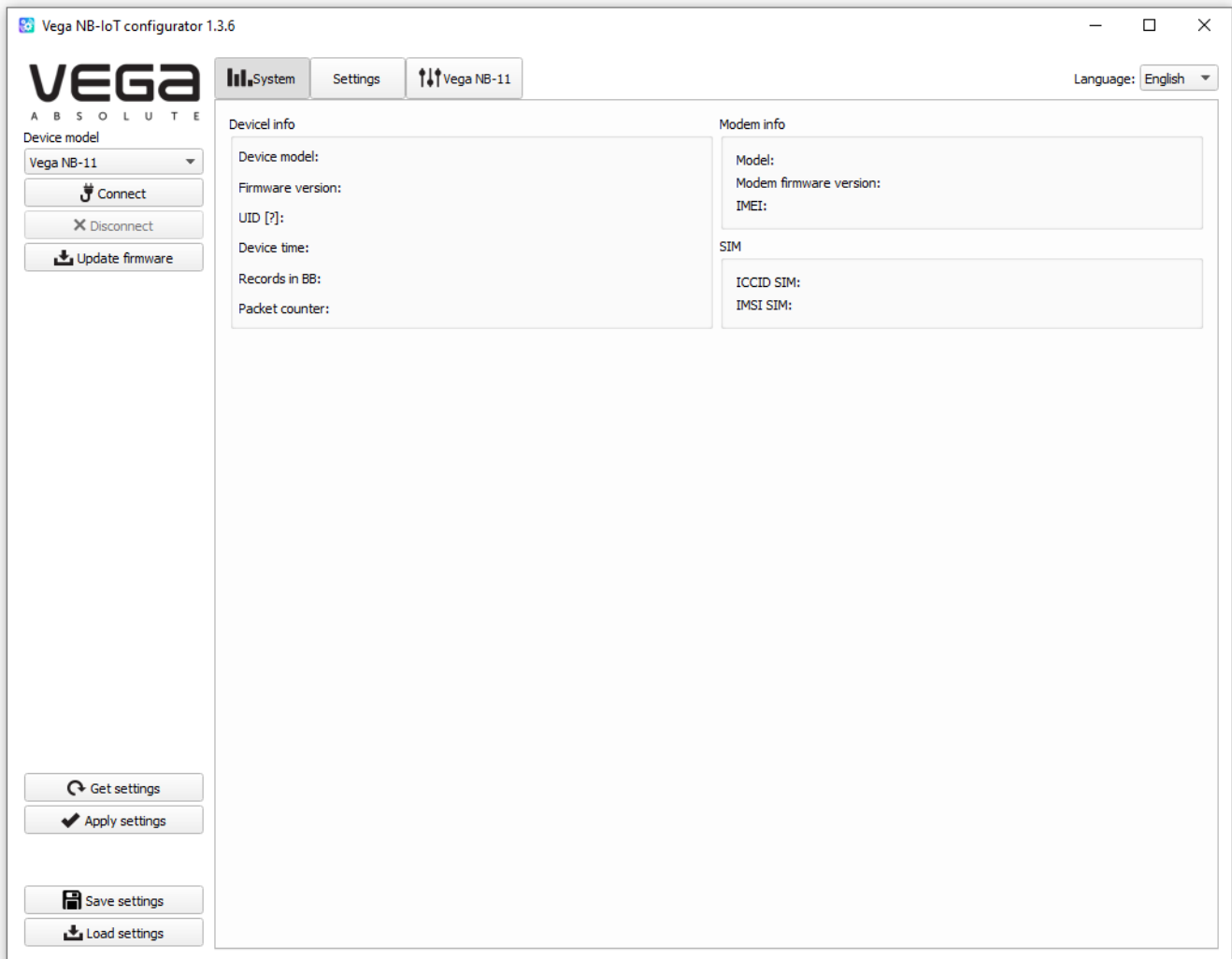
After pressing **Finish** the driver is ready for operation, - it is possible to connect the modem with 4-20 mA interface via USB.

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.

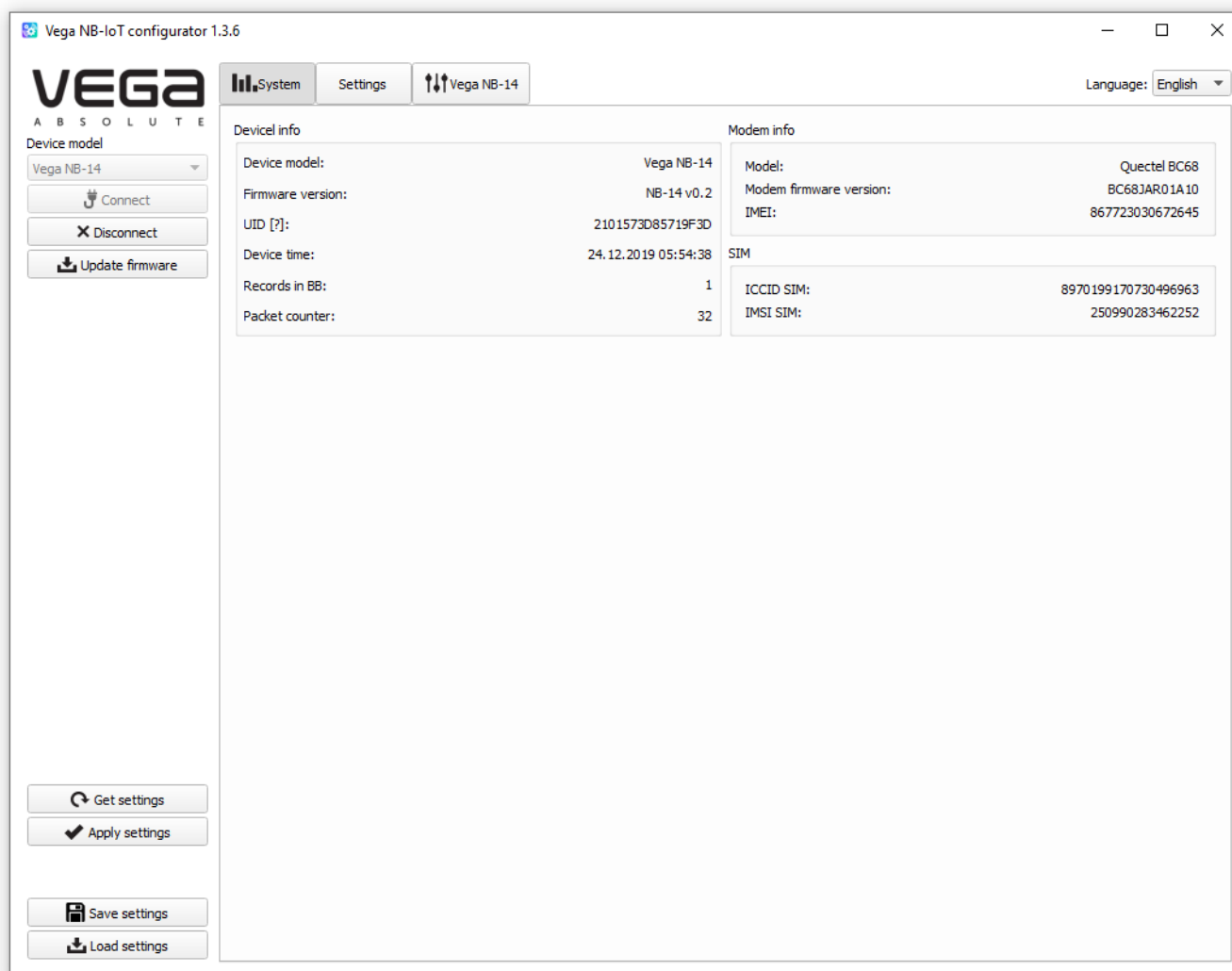
The application window contains three tabs – System, Settings and device manage.

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.

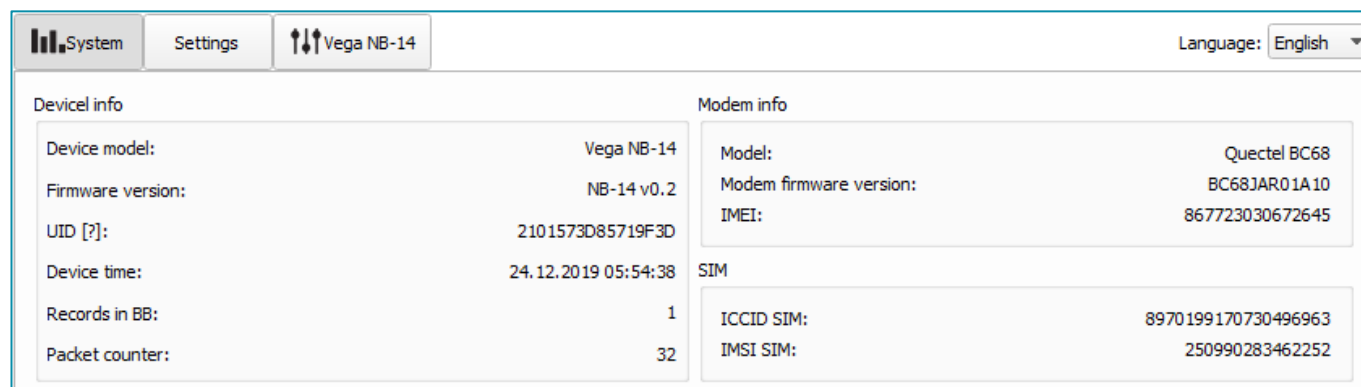


To read the settings from the device, you need to click the "Get settings" button, until this point the application will display the default settings or from the last connected device.

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.



The screenshot shows the 'System' tab interface for the Vega NB-14 device. At the top, there are three tabs: 'System' (selected), 'Settings', and 'Vega NB-14'. On the right, there is a 'Language' dropdown menu set to 'English'. The main content area is divided into three sections: 'Device info', 'Modem info', and 'SIM'.

Device info		Modem info	
Device model:	Vega NB-14	Model:	Quectel BC68
Firmware version:	NB-14 v0.2	Modem firmware version:	BC68JAR01A10
UID [?]:	2101573D85719F3D	IMEI:	867723030672645
Device time:	24.12.2019 05:54:38	SIM	
Records in BB:	1	ICCID SIM:	8970199170730496963
Packet counter:	32	IMSI SIM:	250990283462252

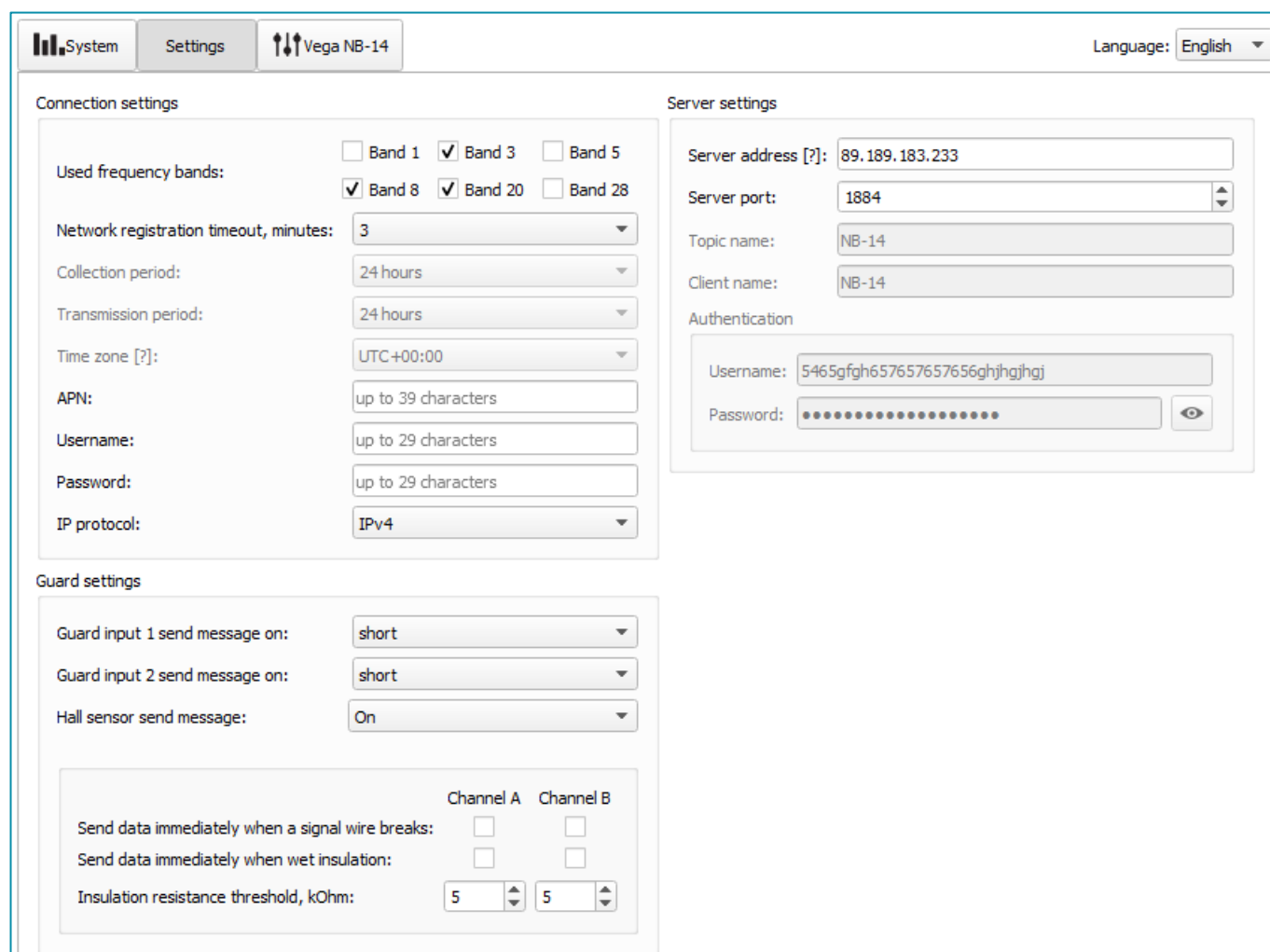
Device info - the configurator reads information about the device model, its firmware and automatically corrects the device's time when connected to it. In that block you can find out the number of records in the black box and the number of packets sent by the device.

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

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

"SETTINGS" TAB

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



The screenshot shows the "Settings" tab for the Vega NB-14 device. The interface is divided into three main sections: Connection settings, Server settings, and Guard settings. The top navigation bar includes "System", "Settings", and "Vega NB-14" tabs, along with a "Language" dropdown set to "English".

Connection settings:

- Used frequency bands:** Checkboxes for Band 1, Band 3 (checked), Band 5, Band 8 (checked), Band 20 (checked), and Band 28.
- Network registration timeout, minutes:** 3
- Collection period:** 24 hours
- Transmission period:** 24 hours
- Time zone [?]:** UTC +00:00
- APN:** up to 39 characters
- Username:** up to 29 characters
- Password:** up to 29 characters
- IP protocol:** IPv4

Server settings:

- Server address [?]:** 89.189.183.233
- Server port:** 1884
- Topic name:** NB-14
- Client name:** NB-14
- Authentication:**
 - Username:** 5465gfggh657657657656ghjhghghj
 - Password:** [masked]

Guard settings:

- Guard input 1 send message on:** short
- Guard input 2 send message on:** short
- Hall sensor send message:** On
- Channel A / Channel B settings:**
 - Send data immediately when a signal wire breaks:** [checkbox] Channel A, [checkbox] Channel B
 - Send data immediately when wet insulation:** [checkbox] Channel A, [checkbox] Channel B
 - Insulation resistance threshold, kOhm:** 5 for both Channel A and Channel B

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's a period after which the modem will switch to the "Sleep" mode when registration waiting. For battery economy it's 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, 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's 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.

Active checkbox in front of **"Send data immediately when a signal wire breaks"** means that the device will immediately initiates communication session if while collecting data according with the schedule it finds out that resistance of signal wire is more than 200 Ohm.

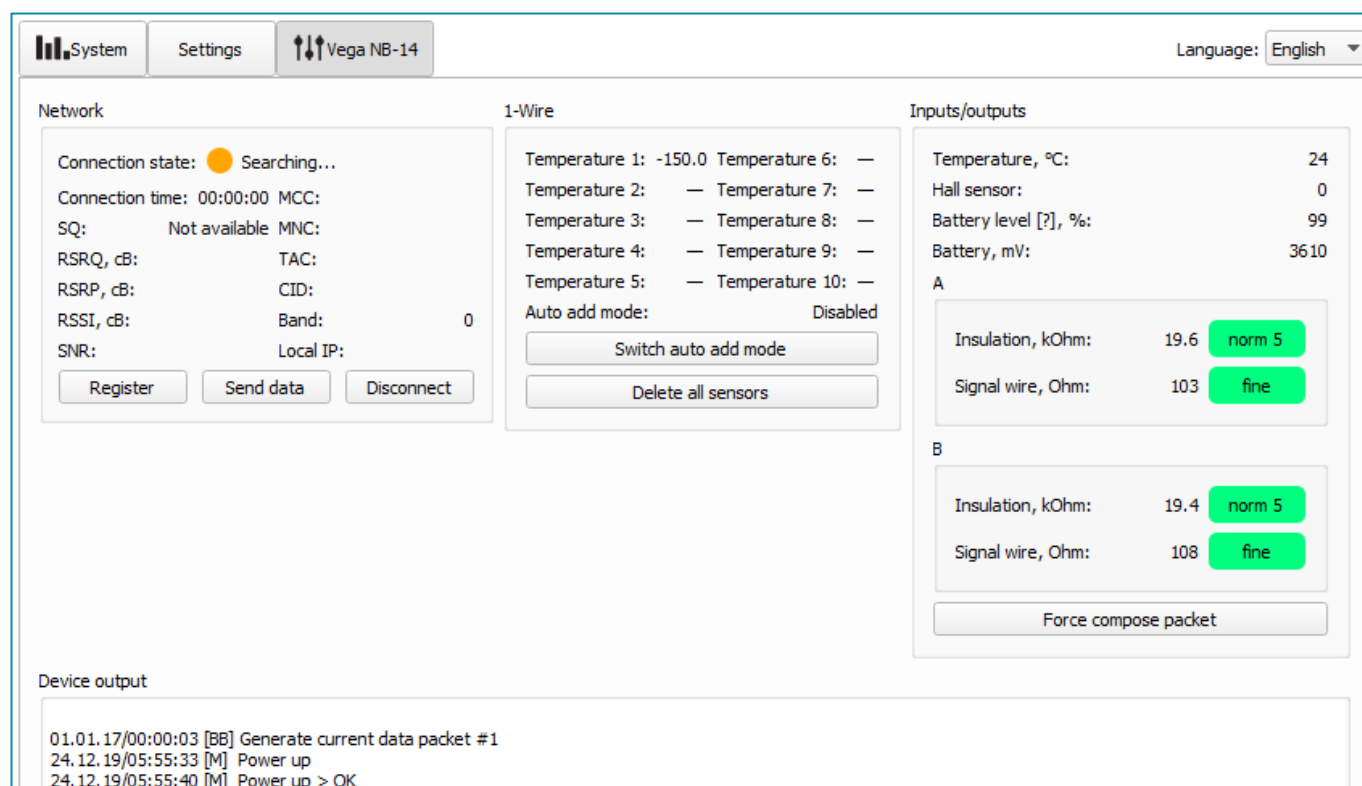
Active parameter **"Send data immediately when wet insulation"** means that the device will immediately initiates communication session if another data slice shows that the insulation resistance is lower than the specified value in setting **"Insulation resistance threshold"** in kOhm.

By default, "Insulation resistance threshold" setting is set on 5 kOhm for both channels.

MQTT settings – settings of connection with MQTT broker.

"VEGA NB-14" TAB

The "Vega NB-14" 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 they 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 adds 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 form a packet, i. e. to collect data from all the inputs and put the packet to the black box until the next communication session.

There is a visualization of state of pipeline insulation and signal wire for every channel. Green color means regular operation mode but yellow and red signalizes about alarm state and device sends alarm message.



When device is connected to Configurator all parameters are displayed in online mode

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-14 sends the message on the server as a text of JSON format. See example below.

```
{
  "Message": {
    "dev": "NB-14 v0.1",
    "IMEI": "867723030711443",
    "IMSI": "250990283462252",
    "ICCID": "8970199170730496235",
    "num": 3,
    "UTC": 1571227504
  },
  "CellStatus": {
    "TAC": "9C8D",
    "CID": "0856831D",
    "SQ": 19,
    "EARFCN": 1240,
    "PCID": 26,
    "RSRP": -822,
    "RSRQ": -108,
    "RSSI": -744,
    "SNR": 119
  },
  "Telemetry": {
    "reason": "time",
    "UTC": 1571227500,
    "bat": 99,
    "temp": 28,
    "RAW": 43,
    "RAI": 580,
    "RBW": 22,
    "RBI": 1100,
    "onewire": [21.6, 20.6, 21.6, 2.2, 1.4, 33.2, 31.7, 18.4, 14.9, -11.8],
    "s_alarm1": 0,
    "s_alarm2": 0,
    "s_magnet": 0,
    "s_raw": 0,
    "s_rai": 1,
    "s_rbw": 0,
    "s_rbi": 1
  }
}
```

}

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

TAC, CID – gateways identifiers

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

RAW – wire resistance on channel A [Ohm] (RAW - Resistance, channel A, Wire)

RAI – insulation resistance on channel A [kOhm] (RAI - Resistance, channel A, Isolation)

RBW – wire resistance on channel B [Ohm] (RBW - Resistance, channel B, Wire)

RBI – insulation resistance on channel B [kOhm] (RBI - Resistance, channel B, Isolation)

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

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_raw – alarm flag, signal wire breakage on channel A ("0" - normal, "1" - breakage)

s_rai – alarm flag, insulation resistance lower than threshold on channel A ("0" - normal, "1" – under threshold)

s_rbw – alarm flag, signal wire breakage on channel B ("0" - normal, "1" - breakage)

s_rbi – alarm flag, insulation resistance lower than threshold on channel B ("0" - normal, "1" – under threshold)

6 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega NB-14 modem 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-14 modem – 1 pc.

Antenna – 1 pc.

Battery 6400 mAh – 1 or 2 pcs.²

Factory certificate – 1 pc.

² The quantity of batteries depending on delivery conditions

8 WARRANTY

The warranty period for the device is 5 years from the date of sale.

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

The consumer is obliged to comply with the conditions and rules of transportation, storage and operation specified in this user manual.

Warranty does not apply to:

- power supplies of devices which have send more than 720 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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