# NB-IOT MODEM WITH RESISTANCE CONTROL

# VEGA NB-14

## USER MANUAL



| DOCUMENT REVISION | FIRMWARE VERSION |
|---|---|
| 04 | 0.7 |
| | |

# CONTENTS

# 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.

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 DEVICE PURPOSE AND OPERATION PRINCIPAL

## DEVICE PURPOSE

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.

## OPERATION 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

## DEVICE 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) |
| **CASE** | |
| Housing dimensions | 95 x 95 x 50 mm |
| Ingress protection rating | IP67 |
| **PACKAGE** | |
| Dimensions, mm | 165 x 118 x 57 |
| Weight, kg | 0,350 |

## DEFAULT DEVICE SETTINGS

| PARAMETER | VALUE |
|---|---|
| Confirmed Uplinks | OFF |
| Communication period | 24 hours |
| Data collection period | 24 hours |
| Time zone | UTC +00:00 |
| Guard inputs operate | on short |
| Hall sensor | ON |
| Send network statistics | OFF |

For changing the device settings, you need to connect to it with "Vega NB-IoT Configurator" application. You can download app on the iotvega.com site in SOFT section as well as User Manual for configurator. Go to the app page.

# 3 OPERATION

## DEVICE APPEARANCE

Vega NB-14 is represented in gray plastic case which has six screws and mounting for DIN-rail. The device case is equipped with a hermetic gland of M12 size. A sealant is installed inside the gland, ensuring compliance with the declared Ingress Protection rating of the device case.
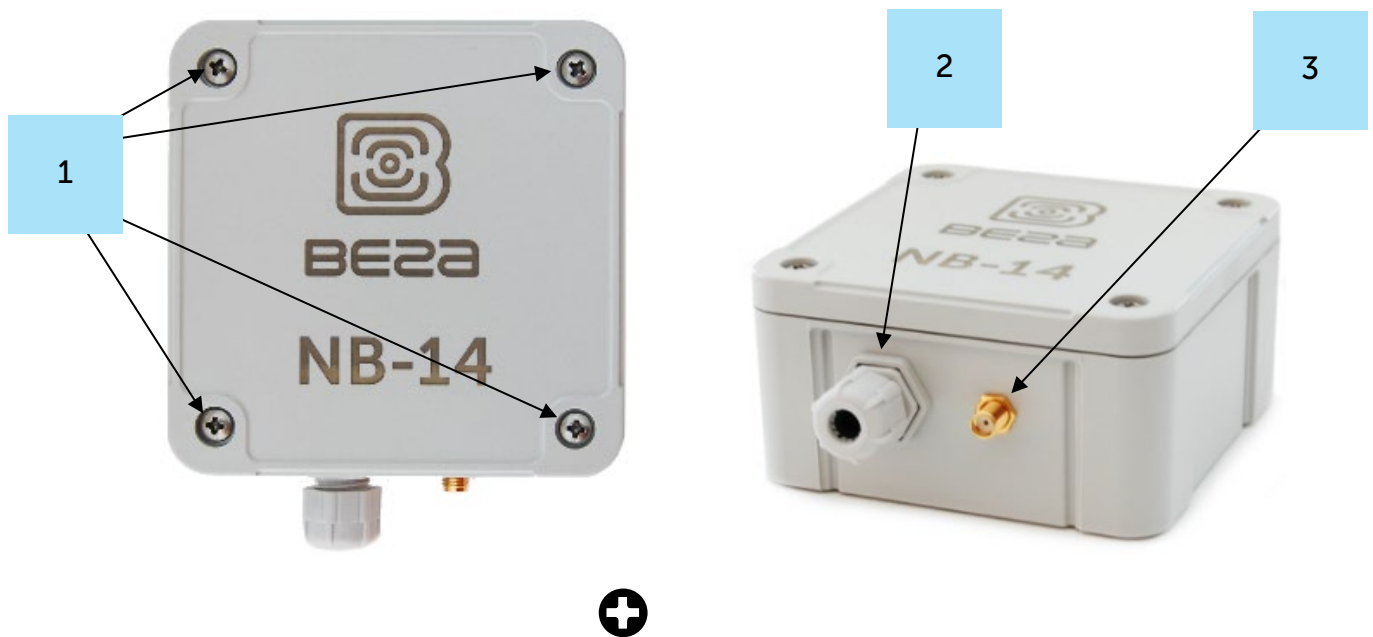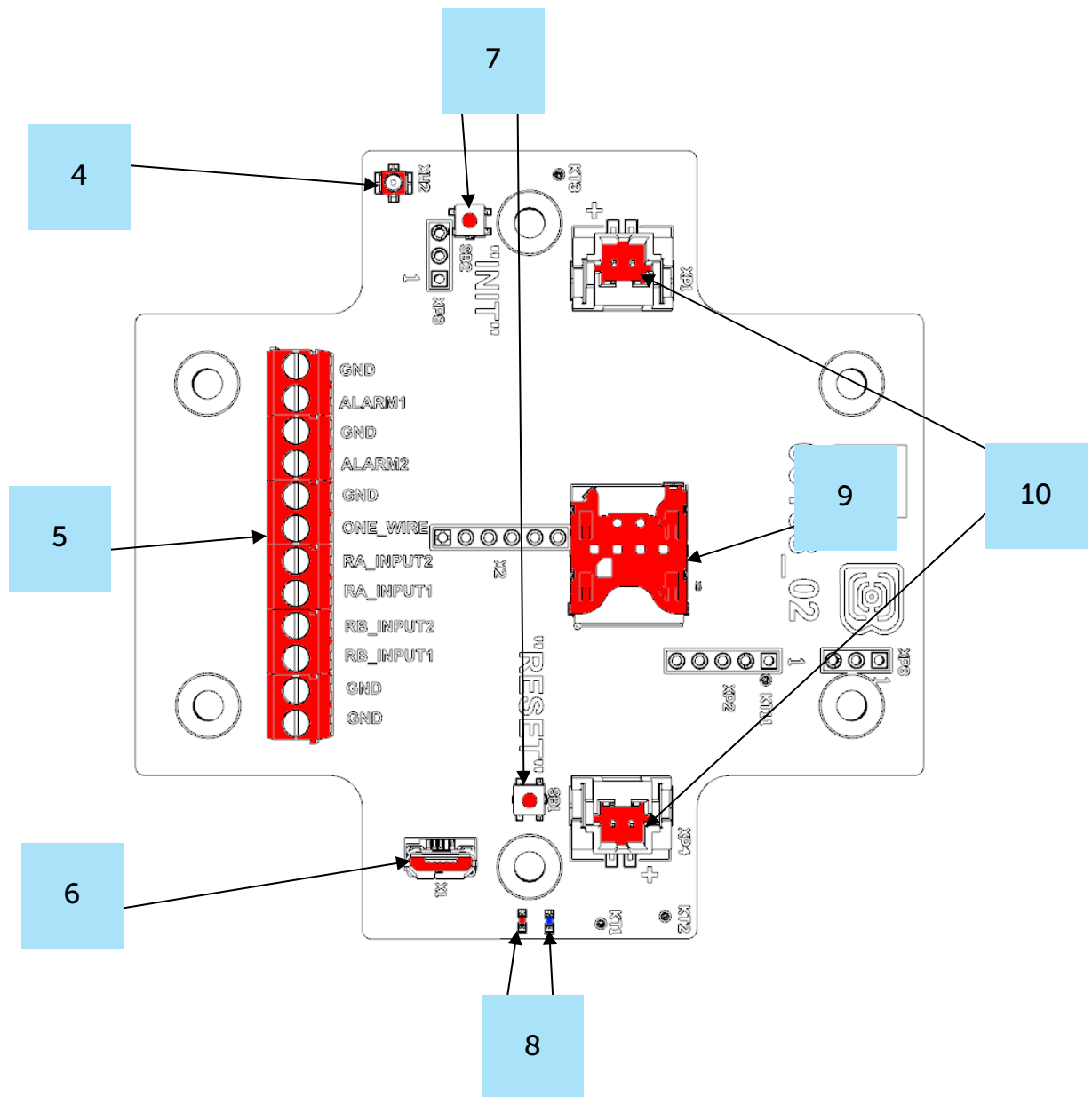


2 – cable gland of M12 size for installing the cables and wires with circular cross-section with a diameter of 5...6 mm

3 – input of external antenna



**Internal structure of cable gland**
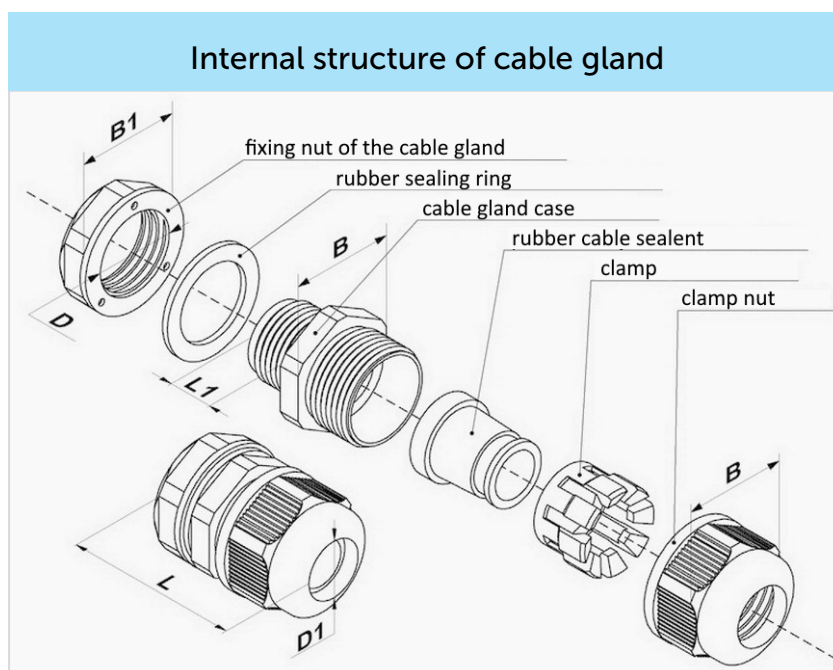
All of elements for manage and indication as well as connecting contacts are placed on the board inside the case.



4 – input for connecting an external antenna

5 – contacts

6 – USB-port

7 – manage buttons

8 – LED indicators

9 – SIM holder

10 – input for connecting a battery

## CONTACTS

When connecting a radio modem to external devices, consider the internal circuitry of its digital inputs ALARM1 and ALARM2 shown below.
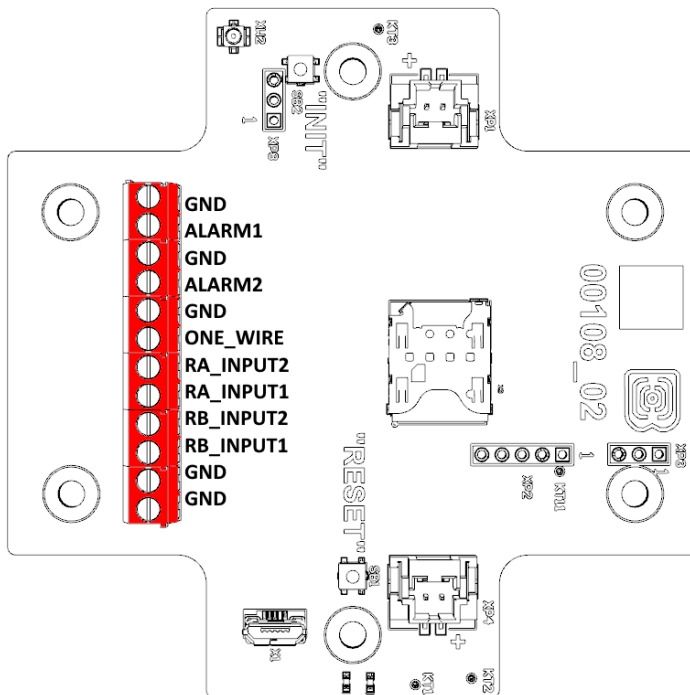


Circuit design of the digital inputs
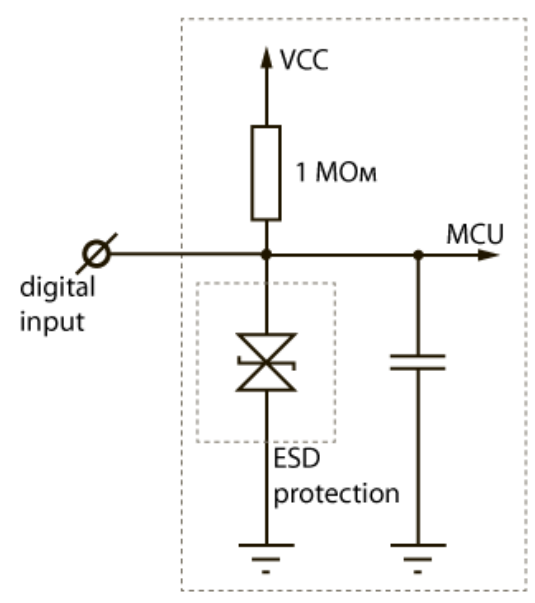
| Contact | PCB designation | Description |
|---------|-----------------|-------------|
| 1 | GND | Ground |
| 2 | ALARM1 | Security input 1 |
| 3 | GND | Ground |
| 4 | ALARM2 | Security input 2 |
| 5 | GND | Ground |
| 6 | ONE_WIRE | 1-Wire |
| 7 | RA_INPUT2 | Input 2 of channel A |
| 8 | RA_INPUT1 | 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 digital 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".

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.
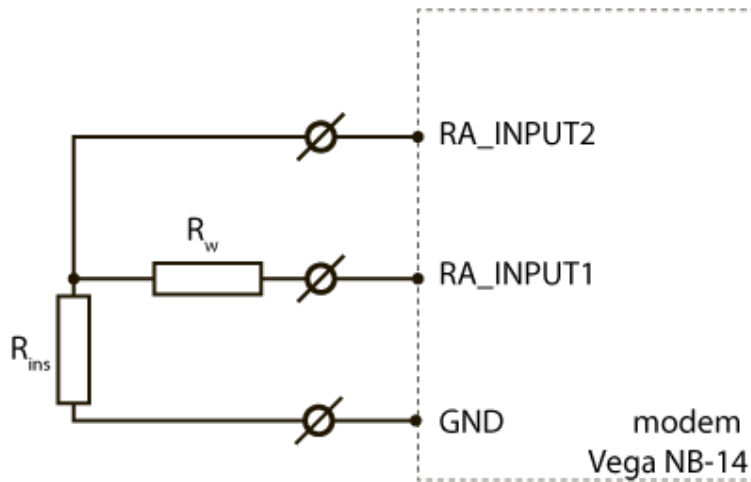


Device measures resistance according with scheme pictured above and determines presence of defects of the pipeline insulation or the signal wire after that. Table of control values:

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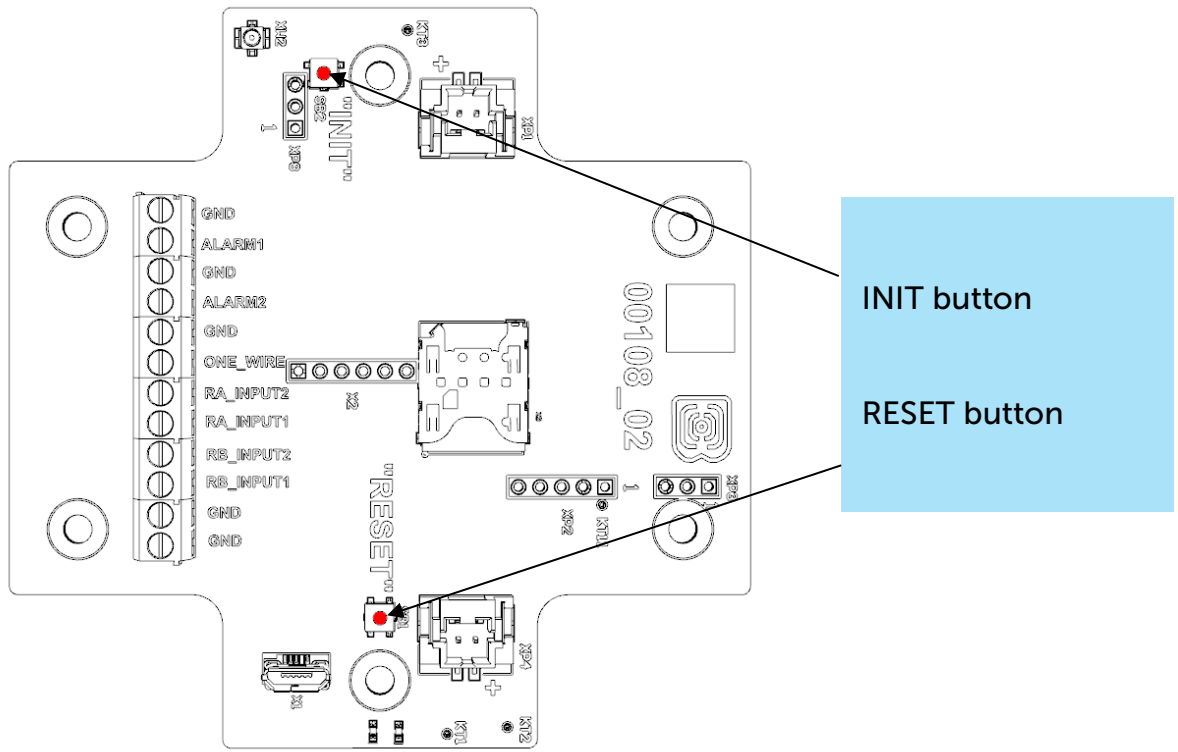
## HALL SENSOR

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.
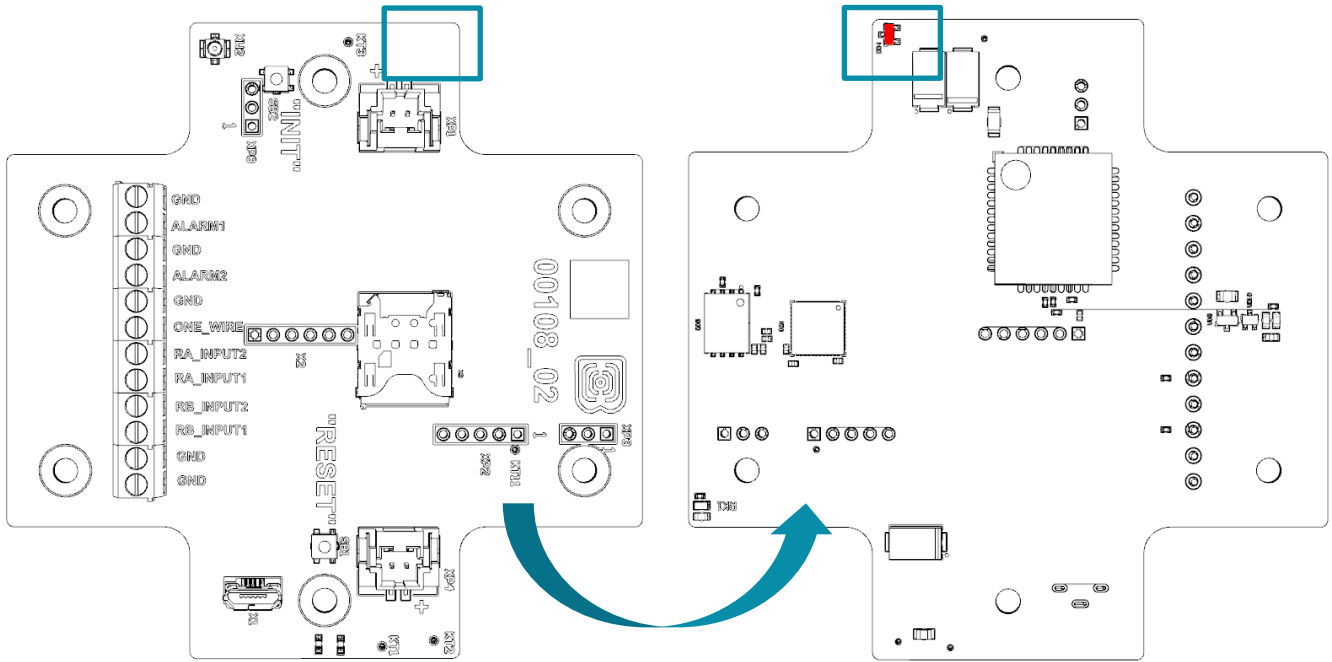
## BUTTONS

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



INIT button
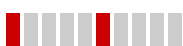
RESET button

| 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.



LEDs located on the board
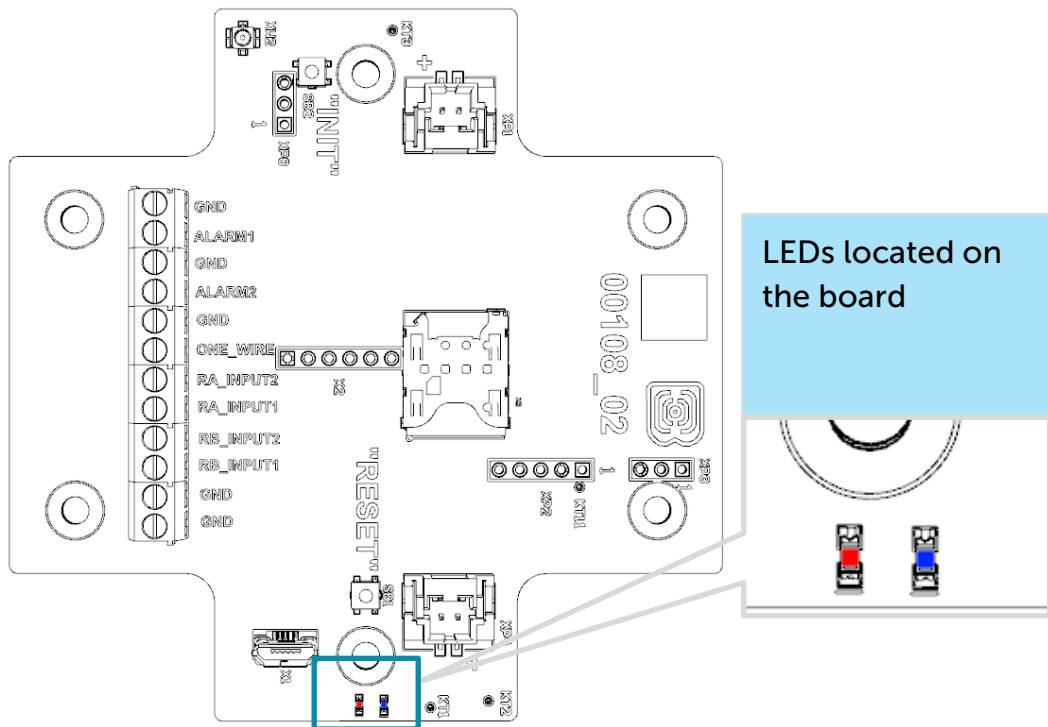
| LTE-modem | | |
|---|---|---|
|  | Short flash every three seconds | Device search the network |
|  | Short flash every second | Device successfully registered and it is in the network |
|  | Two short flashes every one second | Device transmits data to the network |
|  | No light | LTE-modem switched 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 |

## MOUNTING RECOMENDATIONS

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

2$^{nd}$ wire – ground is connecting to contact GND

Shield – is connecting to contact GND

**Before starting mounting work, you must make sure that the latest firmware version is installed on the equipment**

For mounting you will need:

- SIM-card;
- ➕
- wire stripper;
- laptop.

Step by step mounting be like:

1. Installing SIM-card into holder;
2. Setting the device through the "Vega NB-IoT Configurator" – the first and second steps are usually carried out in the office.
3. De-energizing the connected equipment, metering devices, etc.
4. Placement the wires in the cable gland. It must be remembered that the wires must be united in one cable of circular cross-section with diameter of 5...6 mm.

**Inside the cable gland there is a sealant ensuring compliance with the declared Ingress Protection rating of the device case. When removing the sealant, as well as when installing wires of a different diameter or cross-section, device performance may deteriorate until failure due to moisture entering the case**
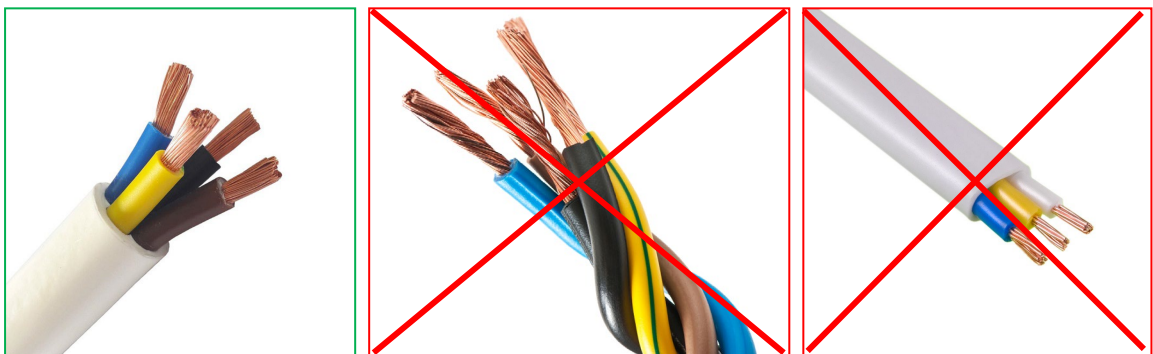
5. Connecting all necessary wires to the contacts.

6. Connecting the battery at the connector. After the battery connection the device loads and comes to sleep until the next communication session.

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

Battery connector's location on the board
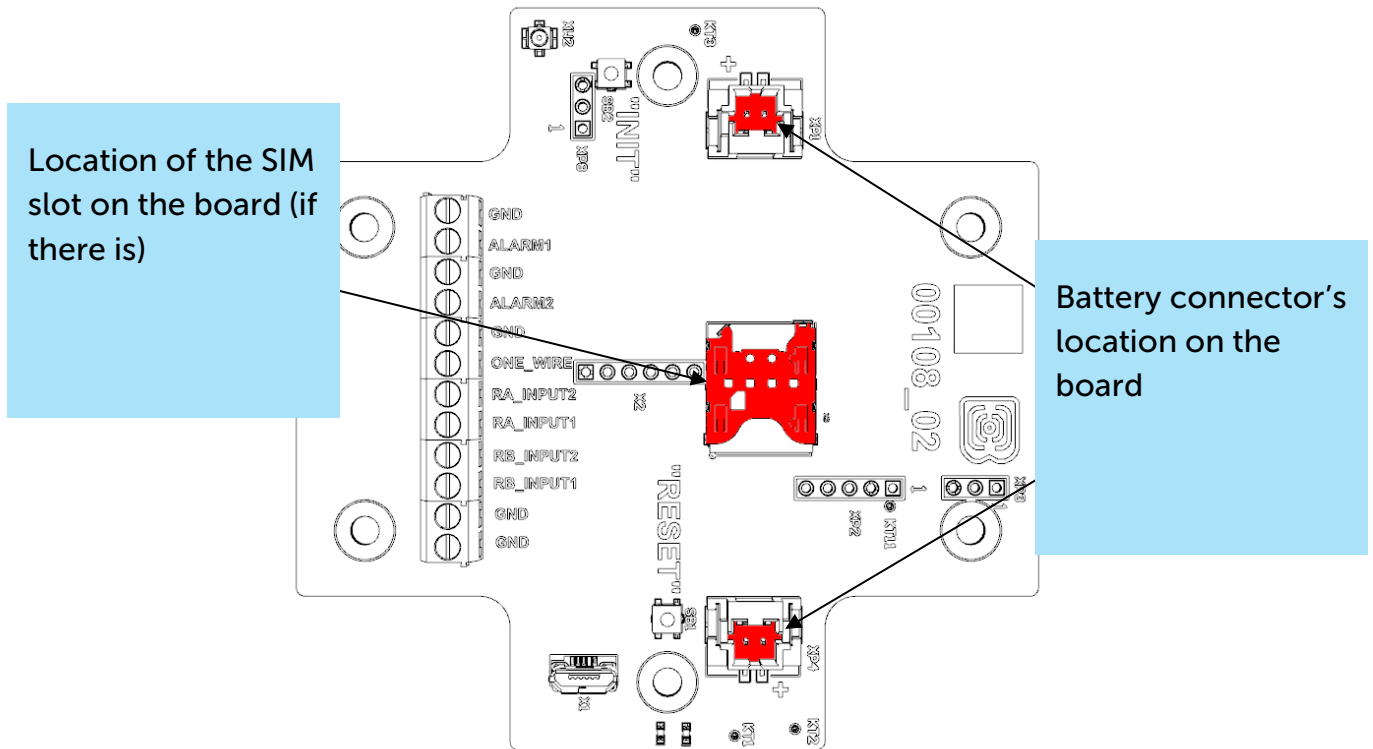
7. If you need to test the data transmitting, then press and hold the INIT button for the 2 seconds.
8. Before assembling the device, you can reset the pulses accumulated during testing and connection through the "Vega NB-IoT Configurator" if it is necessary.
9. Assembling the device.

# 4 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)

# 5 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.

# 6 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. [1]

Factory certificate – 1 pc.

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[1] The quantity of batteries depending on delivery conditions

# 7 WARRANTY

The manufacturer guarantees that the product complies with the current technical documentation, subject to the storage, transportation and operation conditions specified in the "User Manual".

The warranty period is 36 months. Warranty does not apply to power supplies of devices.

The warranty period of operation is calculated from the date of sale marked in the product factory certificate, and from the release date when such a mark is absent. During the warranty period, the manufacturer is obliged to provide repair services or replace a failed device or its components.

The manufacturer does not bear warranty obligations in the event of a product failure if:

◉ the product does not have a factory certificate;

◉ the factory certificate does not have an TCD stamp and / or there is no sticker with information about the device;

◉ the serial number (DevEUI, EMEI) printed on the product differs from the serial number (DevEUI, EMEI) specified in the factory certificate;

◉ the product has been subject to alterations in the design and / or software which are not provided for in the operational documentation;

◉ the product has mechanical, electrical and / or other damage and defects arising from violation of the conditions of transportation, storage and operation;

◉ the product has traces of repair outside the manufacturer's service center;

◉ the components of the product have internal damage caused by the ingress of foreign objects / liquids and / or natural disasters (flood, fire, etc.).

The average service life of the product is 7 years.

In the event of a warranty claim, contact the service center:

119A, Bol'shevistskaya Str., Novosibirsk, 630009, Russia.

Tel.: +7 (383) 206-41-35.

e-mail: remont@vega-absolute.ru

| Document Information | |
|---|---|
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| Document type | Manual – Translation from Russian |
| Document number | V02-NB14-01 |
| Revision and date | 04 of 24 January 2022 |

Revision History

| Revision | Date | Name | Comments |
|---|---|---|---|
| 01 | 30.10.2019 | KEV | The first release |
| 02 | 13.12.2019 | KEV | New settings added to Configurator, communication protocol is changed |
| 03 | 14.07.2020 | KEV | Minor changes |
| 04 | 24.01.2022 | KMA | Planned revision |

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