



NB-IOT MODEM WITH RESISTANCE CONTROL

VEGA NB-14

USER MANUAL



DOCUMENT REVISION	FIRMWARE VERSION
05	0.7

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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.

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.



Long-term storage of equipment outside the operating mode leads to battery passivation, which does not allow the equipment to operate in the declared mode.

For correct operation, before starting the equipment, carry out the depassivation process. To request the instructions please e-mail us support@vega-absolute.ru

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

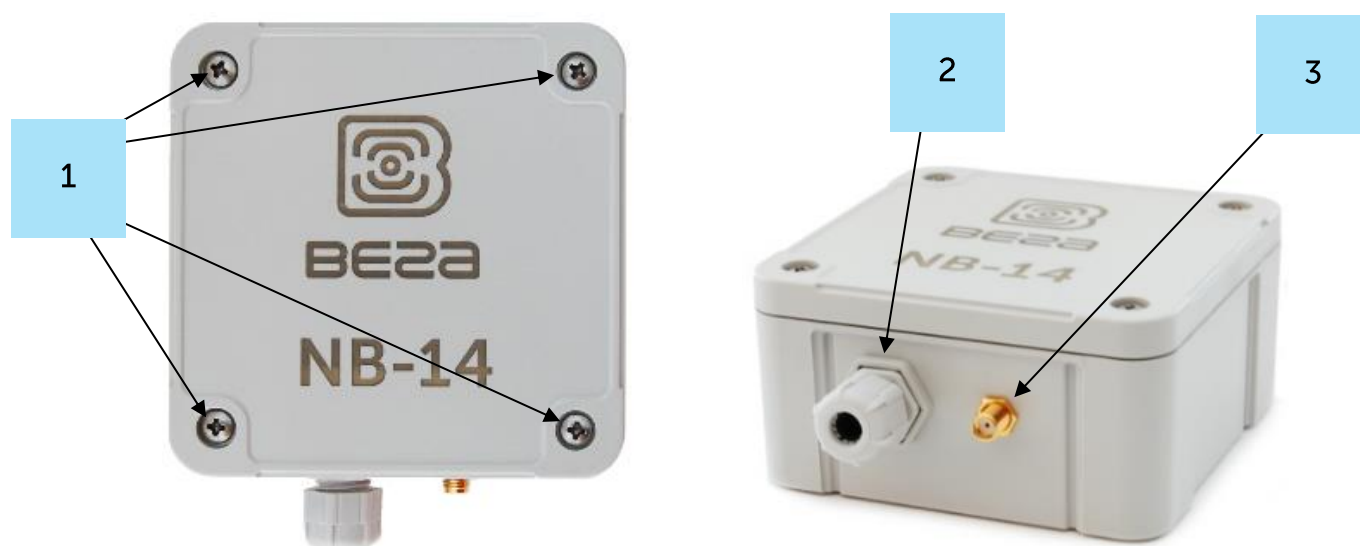
PARAMETER	VALUE
Confirmed Uplinks	OFF
Communication period	24 hours
Data collection period	24 hours
Time zone	UTC +00:00
Guard inputs operate	on short
Hall sensor	ON
Send network statistics	OFF


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

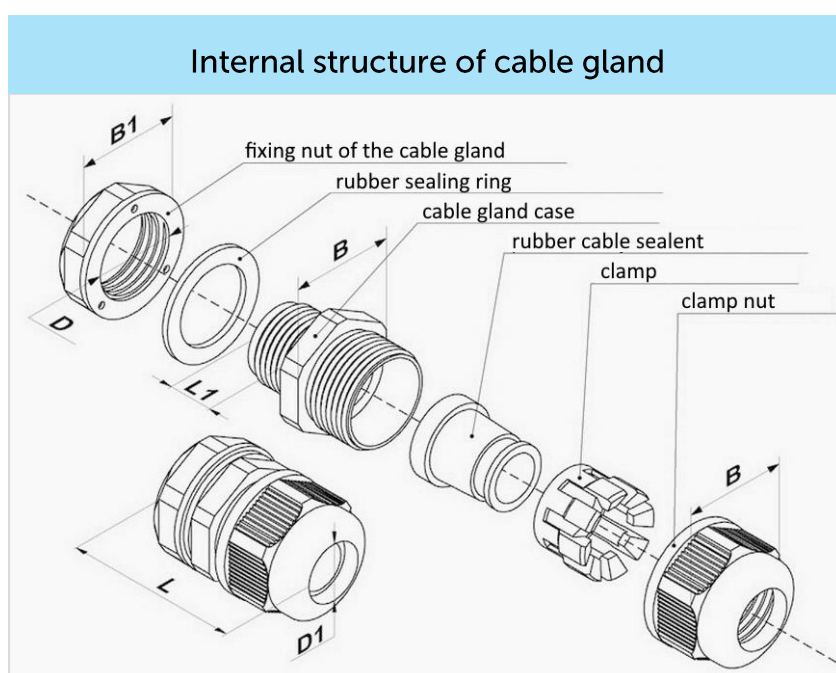
Vega NB-14 is represented in gray plastic case which has six screws and mounting for DIN-rail. The device case is equipped with a hermetic gland of M12 size. A sealant is installed inside the gland, ensuring compliance with the declared Ingress Protection rating of the device case.



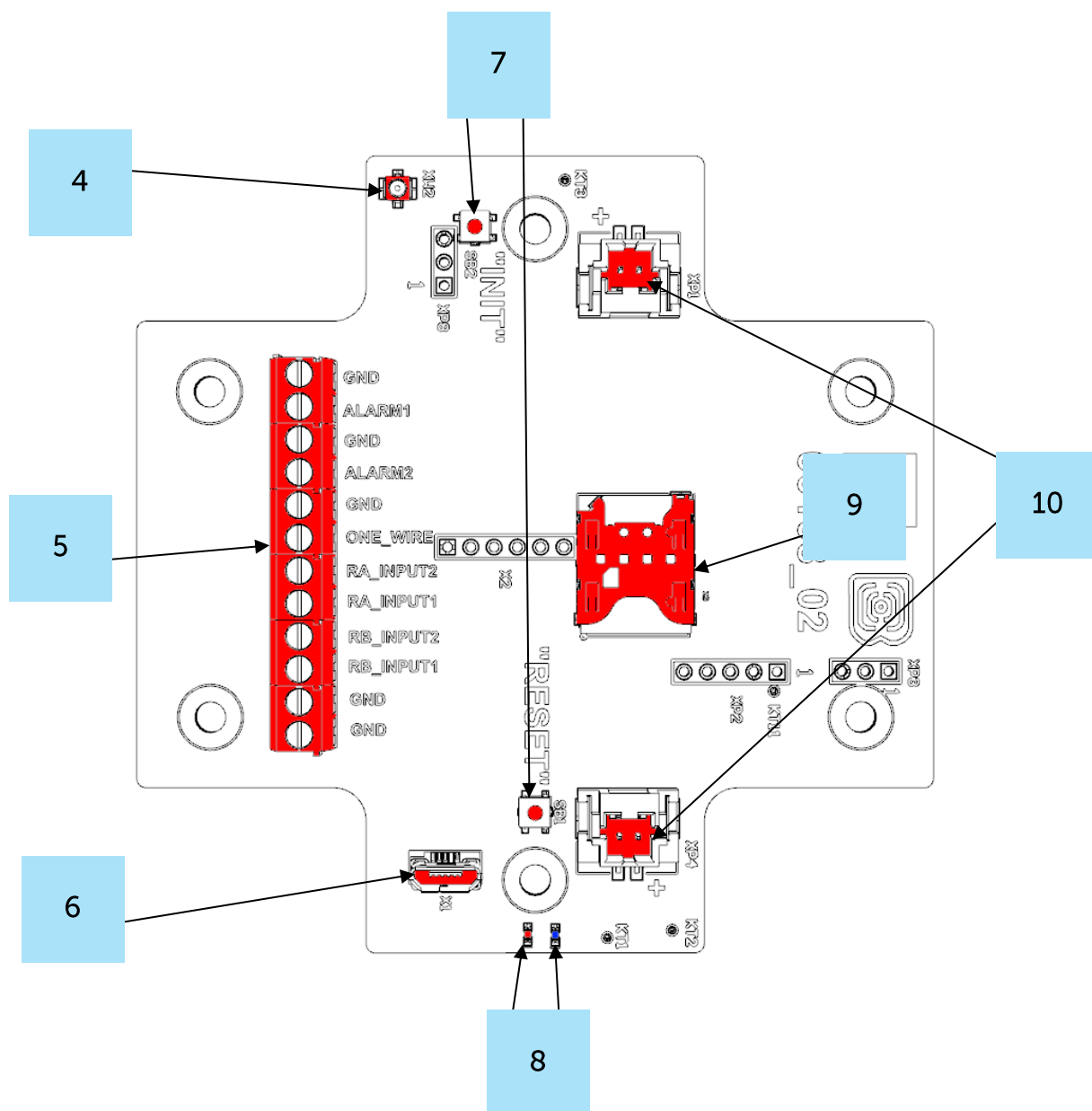
1 – screw \varnothing 4 mm x 27 mm, cross 

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



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

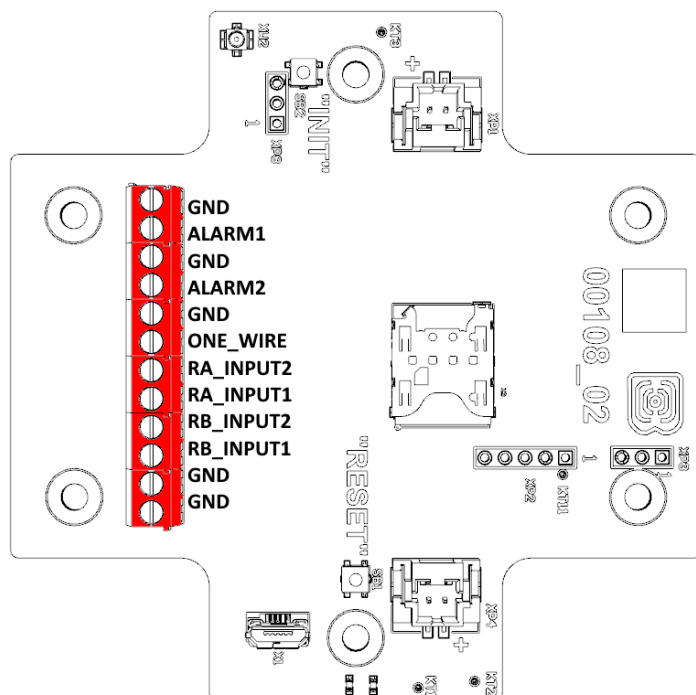
8 – LED indicators

9 – SIM holder

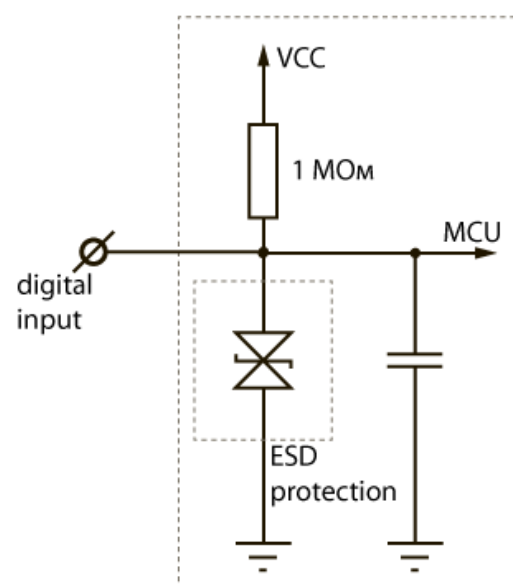
10 – input for connecting a battery

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

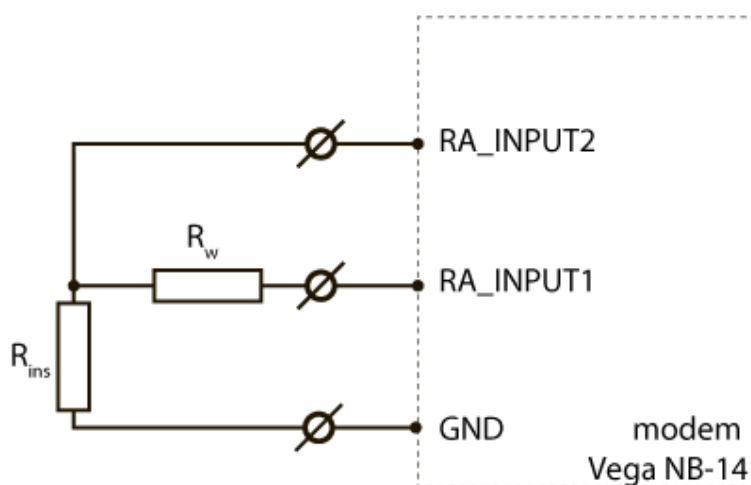
There are two digital security inputs on the boards which allows to connect circuits with the following types of NO contacts:

- 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:

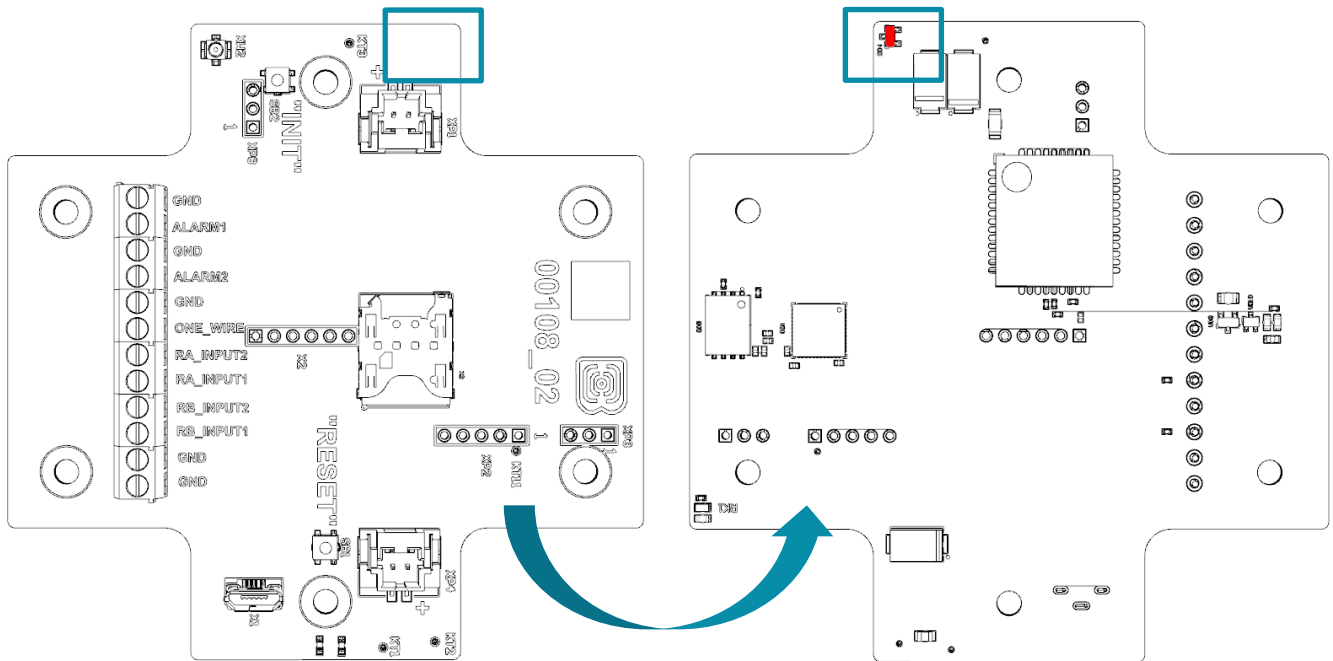
Object state	Values of control parameters	Text in the program (see part 4)	Color in the program (see part 4)
Signal wire is integrity	$R_w \leq 200 \text{ Ohm}$	OK	green
Breakage of the signal wire	$R_w > 200 \text{ Ohm}$	breakage	red
Pipeline insulation is OK	$R_{ins} > 1 \text{ MOhm}$	normal 1	green
	$500 \text{ kOhm} < R_{ins} \leq 1 \text{ MOhm}$	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).

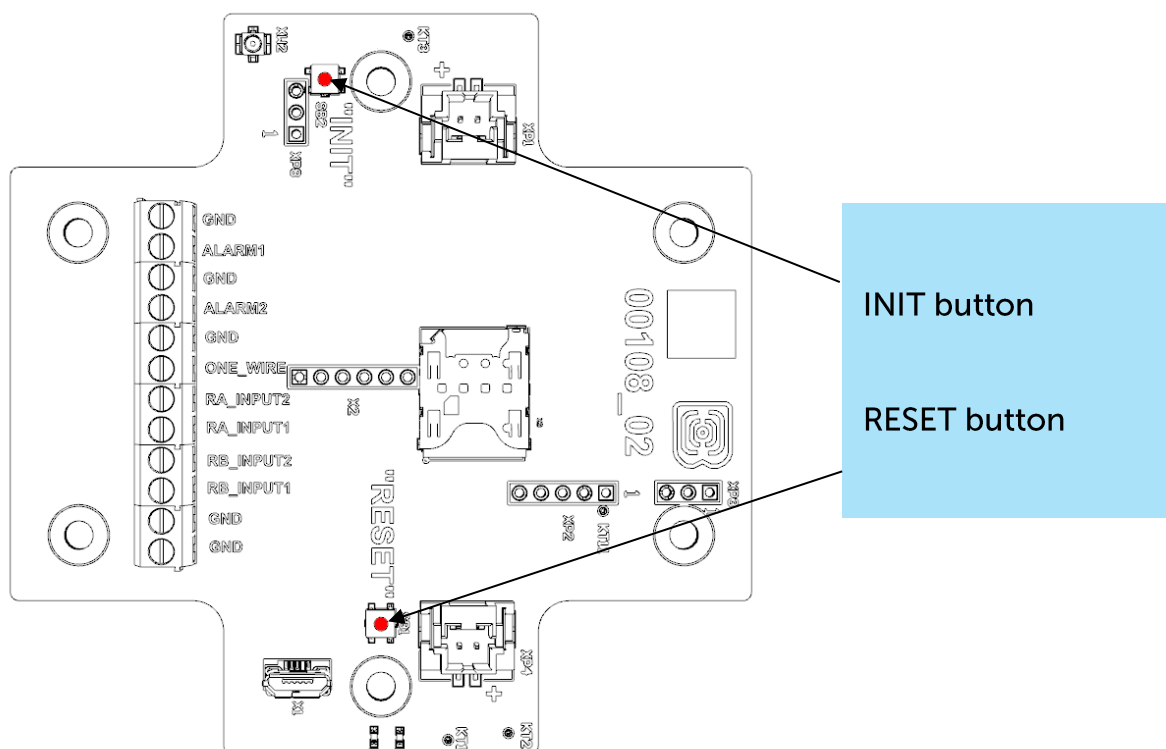
HALL SENSOR

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.

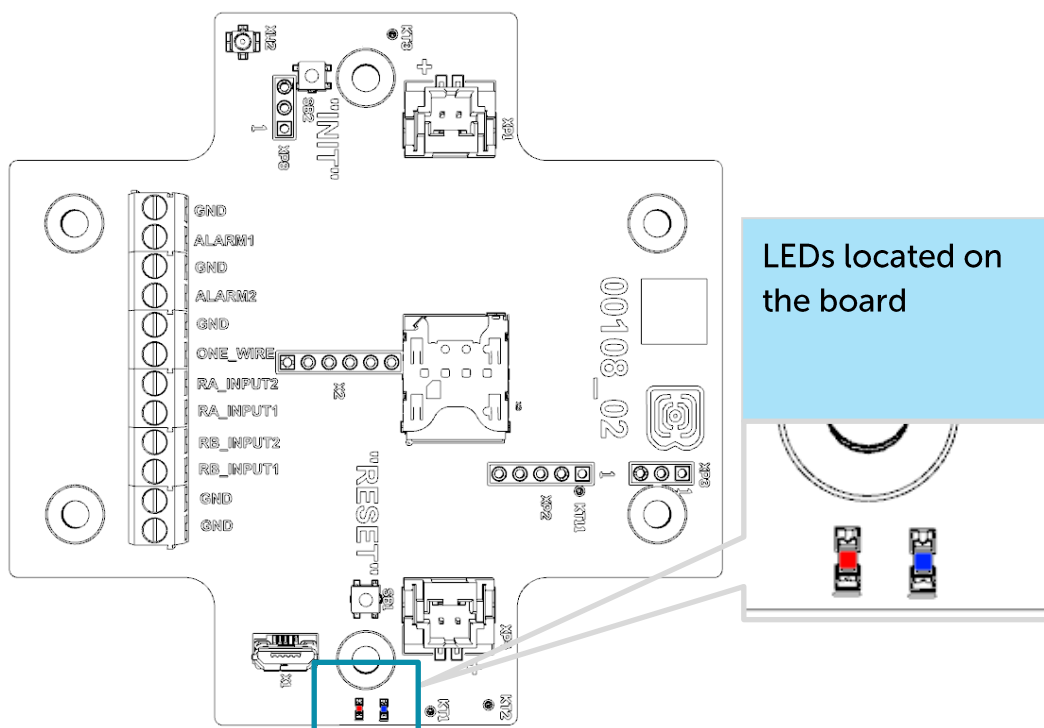



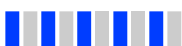
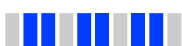




RESET	
Short pressing	Device reloading
INIT	
Pressing for 1 second	Registration at the network
Pressing for 2 seconds	Data transmitting
Pressing for 3 seconds	LTE-modem switching off

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.



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.


2nd 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:

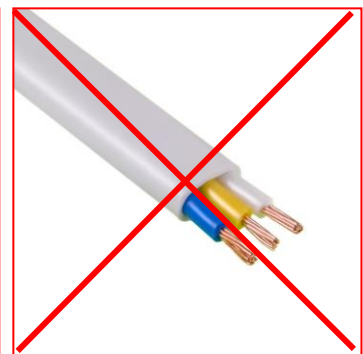
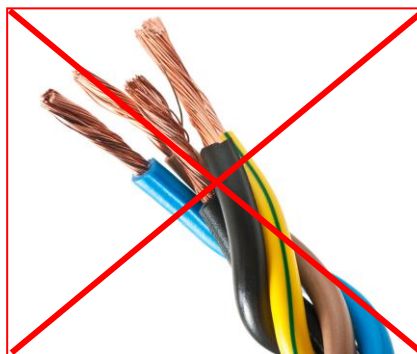
- ⦿ SIM-card;
- ⦿ cross-shaped screwdriver .
- ⦿ wire stripper;
- ⦿ laptop.

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.

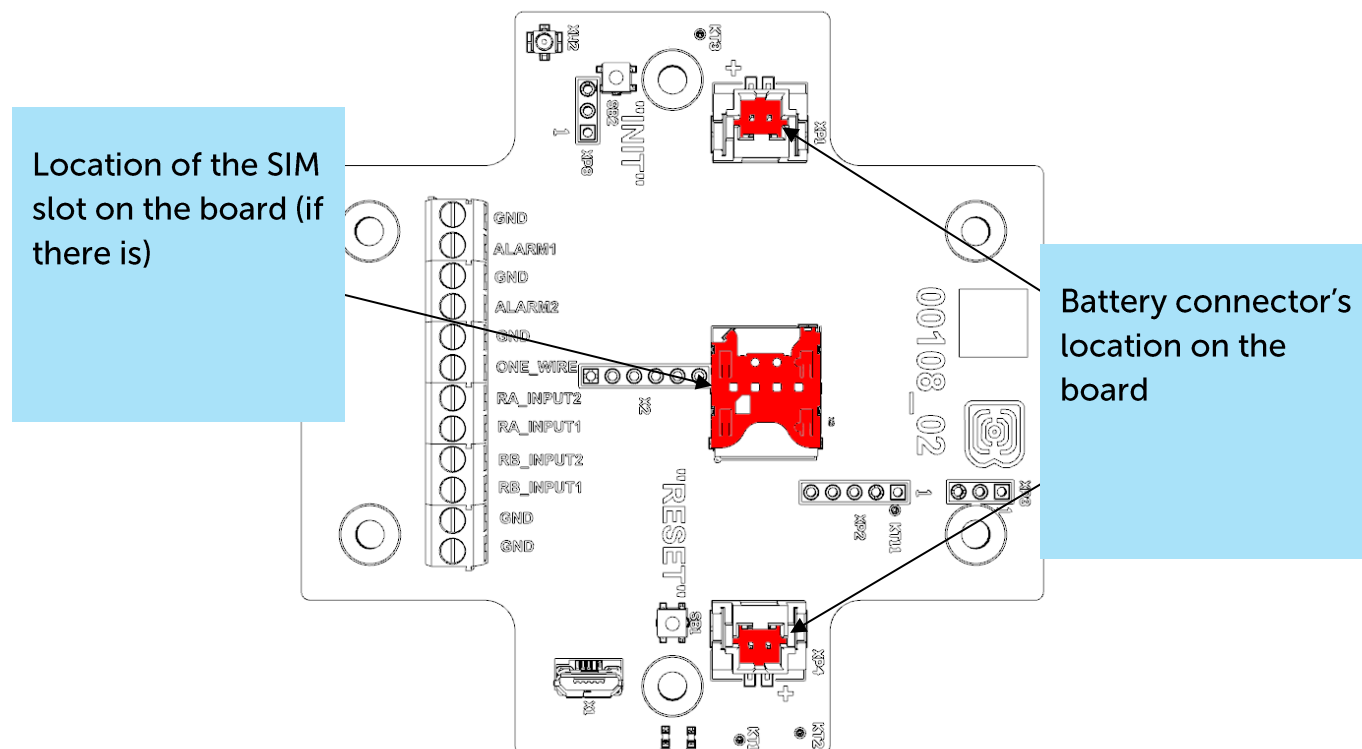


Inside the cable gland there is a sealant ensuring compliance with the declared Ingress Protection rating of the device case. When removing the sealant, as well as when installing wires of a different diameter or cross-section, device performance may deteriorate until failure due to moisture entering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



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.

Long-term storage of the device in the "Storage" mode (more than 6 month) can lead to passivation of the battery.

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.

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.

The warranty does not apply to batteries.

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

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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
05	22.08.2022	KMA	Minor edits



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