NB-IOT MODEM WITH RS-232/RS-485 INTERFACE

VEGA NB-13

USER MANUAL

DOCUMENT REVISION	FIRMWARE VERSION
06	0.9

CONTENTS

INTRODUCTION

This manual is designated for Vega NB-13 modem with RS-232/RS-485 interface (hereinafter – the modem) manufactured by Vega-Absolute OOO and provides information on powering and activation procedure, control commands and functions of the counter.

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-13 modem with RS-232/RS-485 interface is designed for the data collection from the external devices connected through RS-232/RS-485 interfaces and transmitting them to the server by the NB-IoT technology.

In addition, Vega NB-13 can be used as a security device – two additional inputs operate in security mode, there is also a Hall sensor.

The modem with RS-232/RS-485 interface can be used for any utilities' meters and industrial equipment with RS-232 or RS-485 interface or for the periodic collection of temperature values from the 1-Wire sensors.

RS-232 and RS-485 have the separate contacts but they can't operate at the same time. You can choose it at a software level while setting the device.

Vega NB-13 has an external NB-IoT antenna and ingress protection rating IP67. Also, modem has an output for external devices powering with 8 V.

The counter is powered by an external supply with power 5…55 V.

OPERATION ALGORITHM

Modem can operate in two modes: in the transparent mode the Vega NB-13 modem does not collect data, in the data collection mode the data collection and communication are carried out by the schedule.

In the "Transparent" mode, the modem opens a transparent radio channel between the device connected via the RS-485/RS-232 interface and the TCP server. After connecting the power, the device immediately opens the communication channel if the timeout of the transparent channel session is not set, and the session is supported indefinitely. If the timeout is set, then the session closes automatically after the timeout. Opening a session can be performed: when the power is connected (only when the timeout is not set), during an event at the security input, by the Hall sensor, by the button (holding up to two LED flashes), by command from the configurator. In the transparent mode, the modem does not accumulate data in the black box.

In the "Data collection" mode the readings are collected 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. If there is no network registration or server connection the undelivered packets are saved in the device memory until the next communication session according to the schedule. Herewith, the device

continues to collect data according to the data collection period and store it in memory. When any event occurs (time, alarm at the security input, the "Init" button pressed on the board, the "Generate" button pressed in the Configurator), the modem collects all data, including polling the ModBus device (if the checkbox "Enable ModBus" is active). All received data is stored in non-volatile memory as a record in a black box.

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

FUNCTIONAL

Vega NB-13 modem has the following features:

⊙ RS-232 or RS-485 interface;

⊙ Requests through ModBus protocol;

⊙ 1-Wire interface for connection of temperature sensors (up to 10) in 'data collection' mode;

⊙ Two inputs operating in the «security» mode for connecting the external leakage and safety sensors, etc;

⊙ Two operating modes: "Transparent" and "Data collection";

⊙ Time referencing of readings by internal clock;

⊙ Communication in case of security inputs or Hall sensor actuation ;

⊙ Temperature measurement;

⊙ External voltage measuring

MARKING

Device marked with sticker that contain the next information:

⊙ Device model;

⊙ IMEI;

⊙ Month and year of manufacture.

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

2 SPECIFICATION

DEVICE SPECIFICATION

MAIN	
Interfaces	RS-232/RS-485, 1-Wire
ModBus support	yes
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
LTE NB-IoT antenna type	external
POWER	
External power	5...55 V
CASE	
Housing dimensions	95 x 95 x 50 mm
Ingress protection rating	IP67
PACKAGE	
Dimensions	165 x 118 x 57 mm
Weight	0,290 kg

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-13 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.

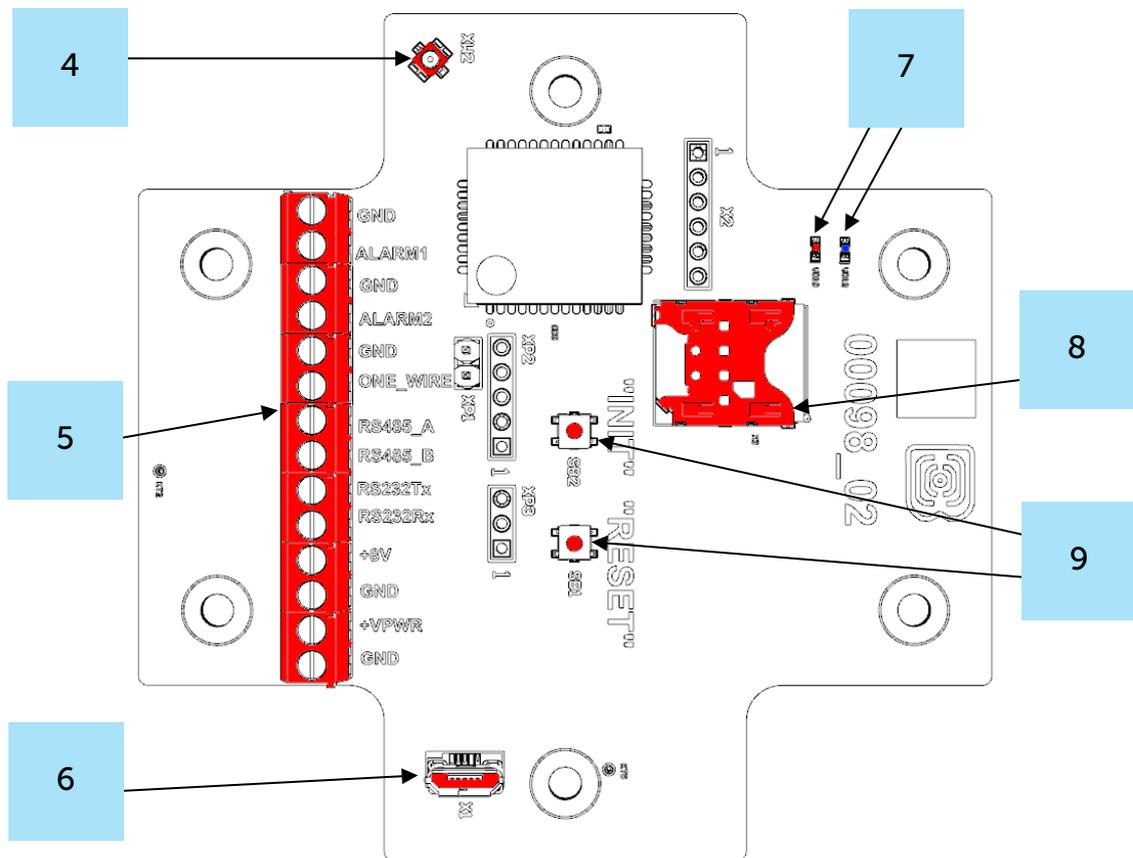2 – cable gland of M12 size for installing the cables and wires with circular cross-section with a diameter of 5...6 mm
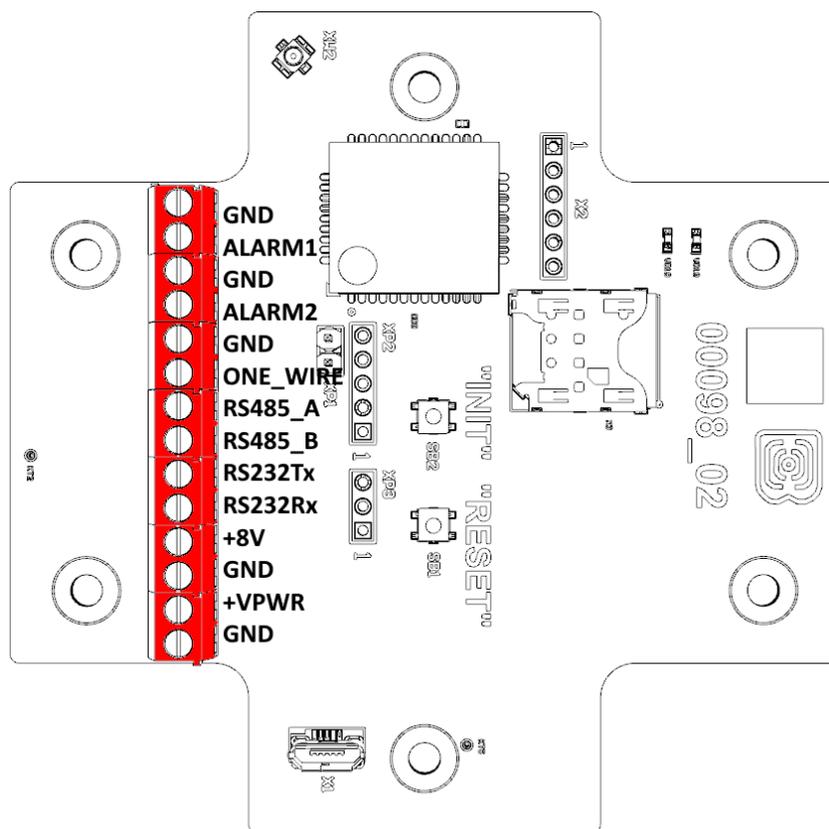
3 – input of external antenna

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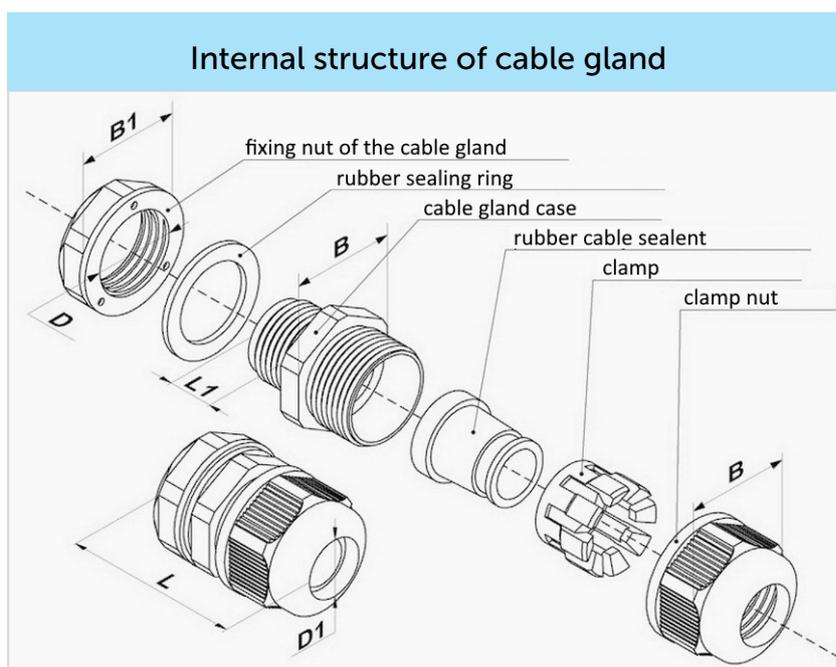
All of elements for manage and indication as well as connecting contacts are placed on the board inside the case.

4 – input for connecting an external antenna

5 – contacts

6 – USB-port

7 – LED indicators

8 – SIM holder

9 – manage buttons

Contacts description is in the table below.

Contact	Naming on the board	Description
1	GND	Ground
2	ALARM1	Security input 1
3	GND	Ground
4	ALARM2	Security input 2
5	GND	Ground
6	ONE_WIRE	Interface 1-Wire
7	RS485_A	Interface RS-485 A
8	RS485_B	Interface RS-485 B
9	RS232Tx	Interface RS-232 Tx
10	RS232Rx	Interface RS-232 Rx
11	+8V	Output power 8 V for external devices
12	GND	Ground
13	+VPWR	External power 5…55 V
14	GND	Ground

RS-232 and RS-485 interface can not be used at the same time. You can change one interface to other through Vega NB-IoT Configurator application.

ModBus device can be connected both via RS-485 and RS-232 interfaces. Below is a connection diagram. To equalize the signal levels when connecting, it is necessary to connect

the ground of the devices, thus, for connection, at least 3 wires are required: GND, RS485_A/RS232Tx, RS485_B/RS232Rx.
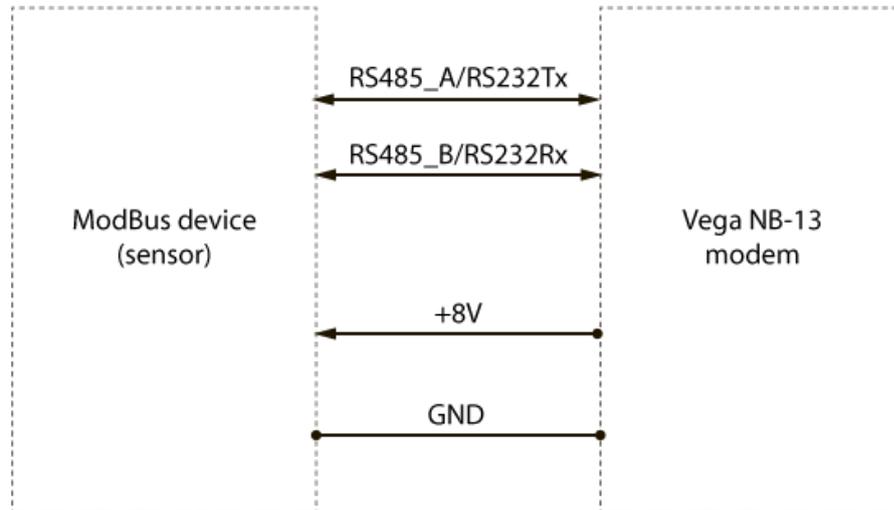
The modem can power up the ModBus device connected to it before polling it, for this use the "+8V" contact.
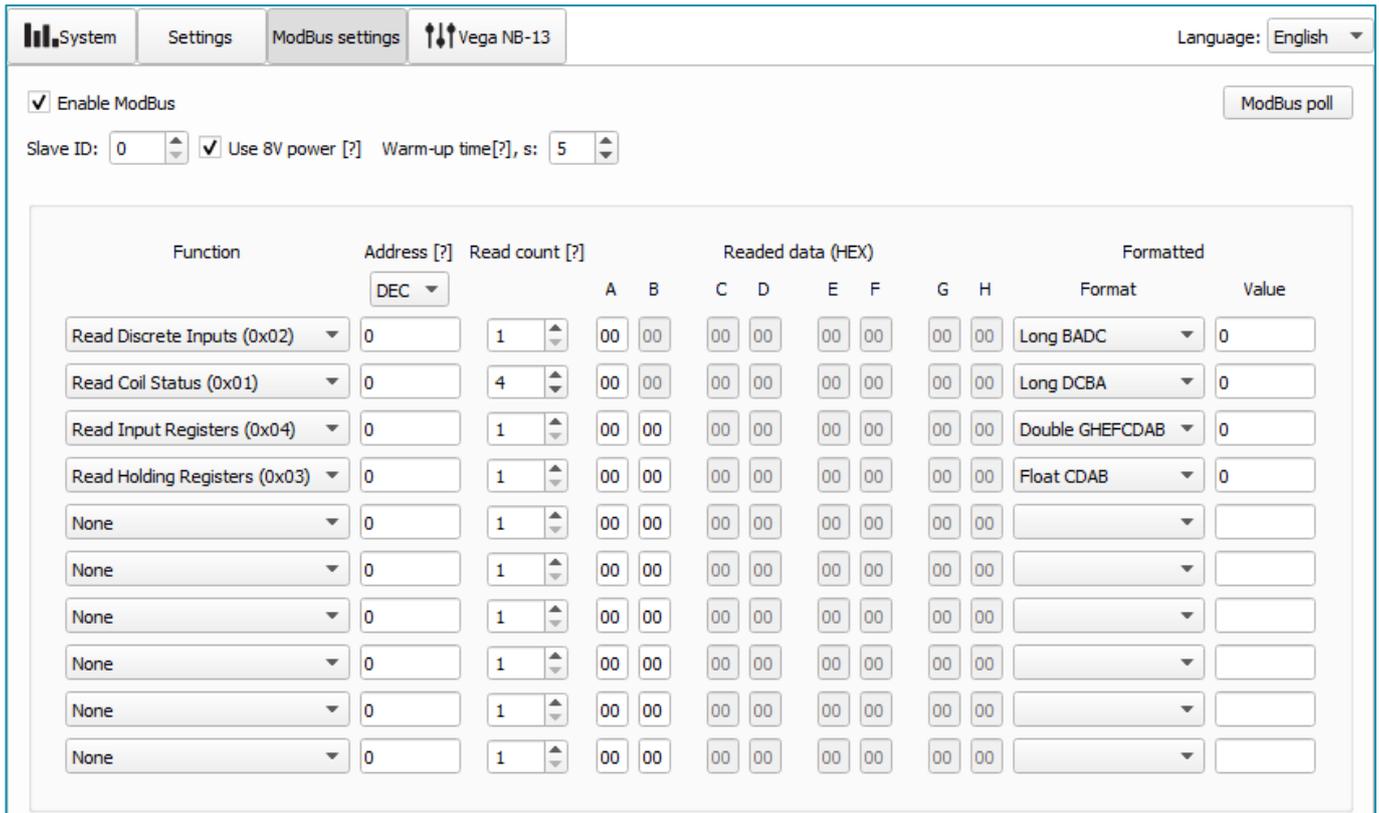
1-Wire interface allows to connect there up to 10 temperature sensors (see details in part 4).

There are two security inputs on the board. 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 "ModBus settings" tab is used when the ModBus devices are connected.

The modem at the time of polling the sensor can perform up to 10 read operations (requests), at independent addresses. Each read operation can read up to 8 bytes of data (four 16-bit registers or 64-bit registers). This means that the maximum amount of encoder data read out is 80 bytes. For each request, a response timeout is started. If the response is not accepted during the timeout, the modem proceeds to the request at the next address. The timeout is set in the "RS interface settings" section on the "Settings" tab.

Function	Address [?]	Read count [?]	A	B	C	D	E	F	G	H	Format	Value
	DEC											
Read Discrete Inputs (0x02)	0	1	00	00	00	00	00	00	00	00	Long BADC	0
Read Coil Status (0x01)	0	4	00	00	00	00	00	00	00	00	Long DCBA	0
Read Input Registers (0x04)	0	1	00	00	00	00	00	00	00	00	Double GHEFCDAB	0
Read Holding Registers (0x03)	0	1	00	00	00	00	00	00	00	00	Float CDAB	0
None	0	1	00	00	00	00	00	00	00	00		
None	0	1	00	00	00	00	00	00	00	00		
None	0	1	00	00	00	00	00	00	00	00		
None	0	1	00	00	00	00	00	00	00	00		
None	0	1	00	00	00	00	00	00	00	00		
None	0	1	00	00	00	00	00	00	00	00		

Readed data (HEX) · Formatted · Enable ModBus · Slave ID: 0 · Use 8V power [?] · Warm-up time[?], s: 5 · ModBus poll

Enable ModBus – activates the ModBus functionality. The modem additionally polls the ModBus device by events and puts the received data into a black box. When sending to the server, the "modbus" key with data is added to the JSON message. If the checkbox is off, the ModBus device is not polled, therefore, ModBus data is not accumulated in the black box, the "modbus" key is missing in the JSON message.

Use 8V power - if the checkbox is checked, the modem supplies power to the "+8V" contact, maintains the time specified in the "Warm-up time" field, and only then polls.

Warm-up time - time in seconds (from 1 to 60) from the moment of power up until the moment of polling. It should be noted that the longer the warm-up time, the greater the consumption of the modem.

ModBus poll - the button allows to poll the ModBus device in real time without adding data to the black box. Can be used to debug ModBus connections. In this case, the request

packets, and the corresponding response packets from the ModBus device are displayed in the Configurator's log completely without any transformations.

Function, Address, Read count - supports configuring up to 10 independent read operations of a ModBus device. For each read operation, you can set the start address of the read, the function, and the number of registers to be read. If the "None" function is selected, then the reading of the corresponding address is not performed. If the function 0x01, 0x02 (read bits) is selected, then the "Read count" field sets the number of read bits (from 1 to 64 bits). If the function 0x03, 0x04 (reading 16-bit registers) is selected, then the "Read count" field sets the number of registers to be read (from 1 to 4 registers).

Read data - the field contains data read from the ModBus device. The data is displayed in cells with the name: A, B, C, D, E, F, G, H. Each cell displays a byte in HEX format. If fewer bytes are read, then unused cells are darkened and "00" is displayed in them.

Format and Value - fields are used for visual display of the read data in the required format in the Configurator. In the ModBus JSON message sent to the server, the data is presented in its original form (HEX) without any transformation, in the same sequence as transmitted in the packet on the RS line. See below for the JSON message format.

The sequence of actions for configuring ModBus:

1. Specify settings on the "Settings" tab of the Configurator.

Specify the "Collect data" operation mode (ModBus works only in this mode). Specify connection settings and server settings. Specify the RS interface settings in accordance with the documentation for the connected ModBus device.

2. Enter the settings on the "ModBus Settings" tab of the Configurator.

Enable ModBus, set the "Function", "Address" and "Read count" parameters.

3. Press the button "Apply settings".

CONNECTION OF TERMINATOR

Terminator installed on the board is a resistor with nominal of 120 Ohm which is inactive by default.

For resistor activation you need to install a jumper at the XP1 connector on the board.

Terminator is used for defense from distortion in long transmission lines RS-485, therefore it must be activated when line is longer than 100 meters.

Location of XP1 connector on the board
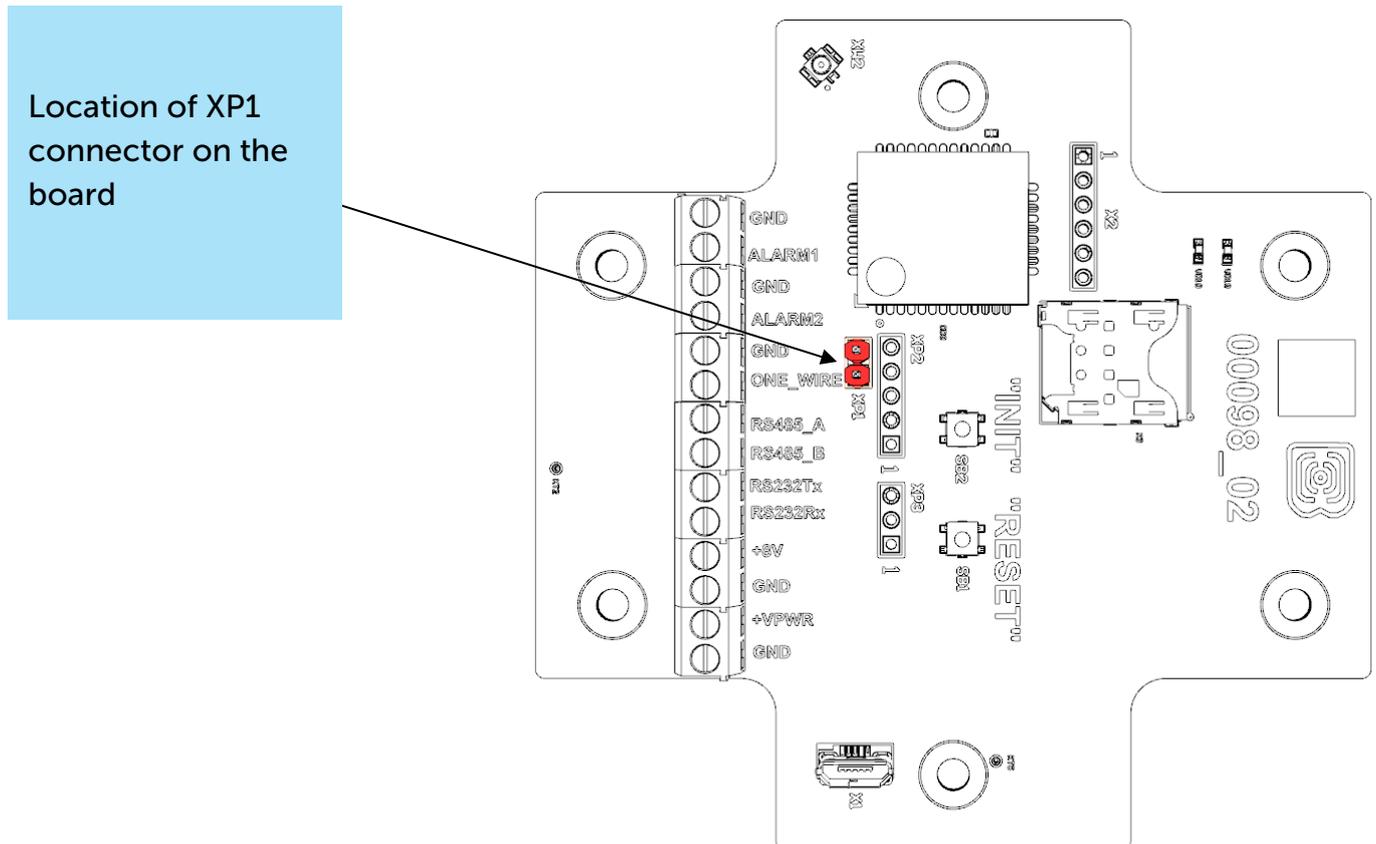
HALL SENSOR

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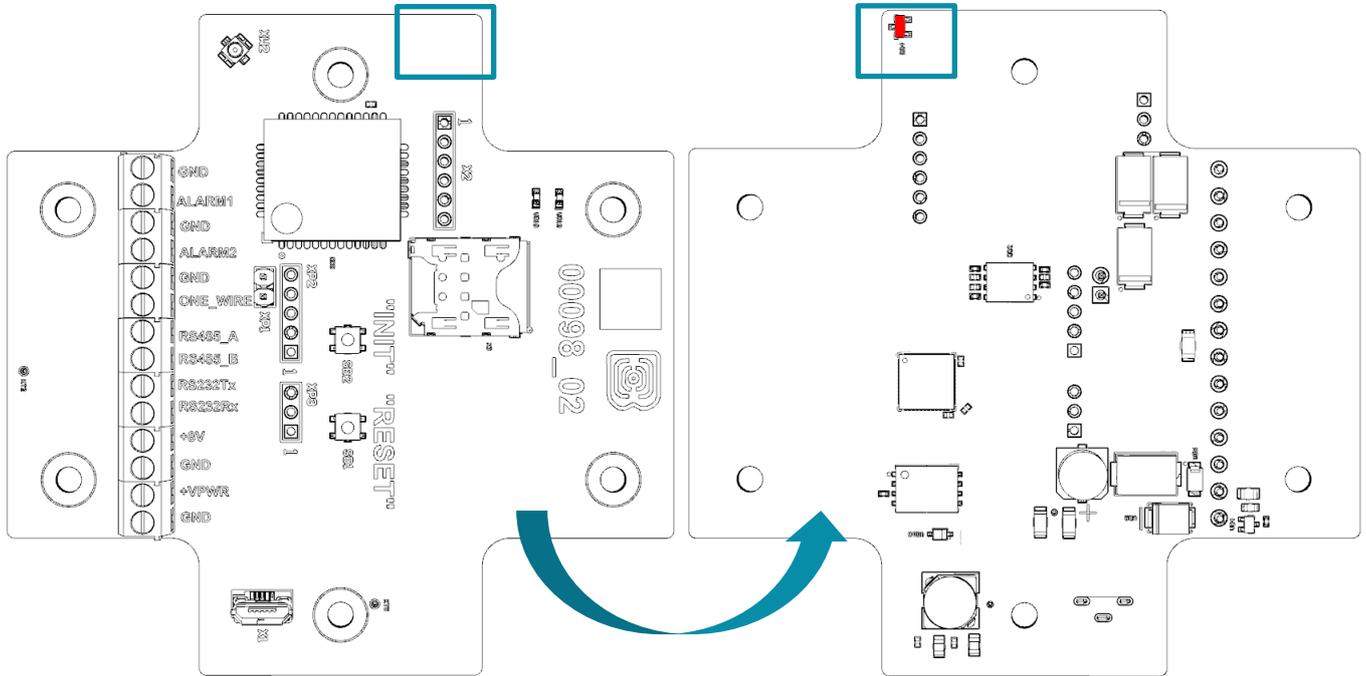
BUTTONS

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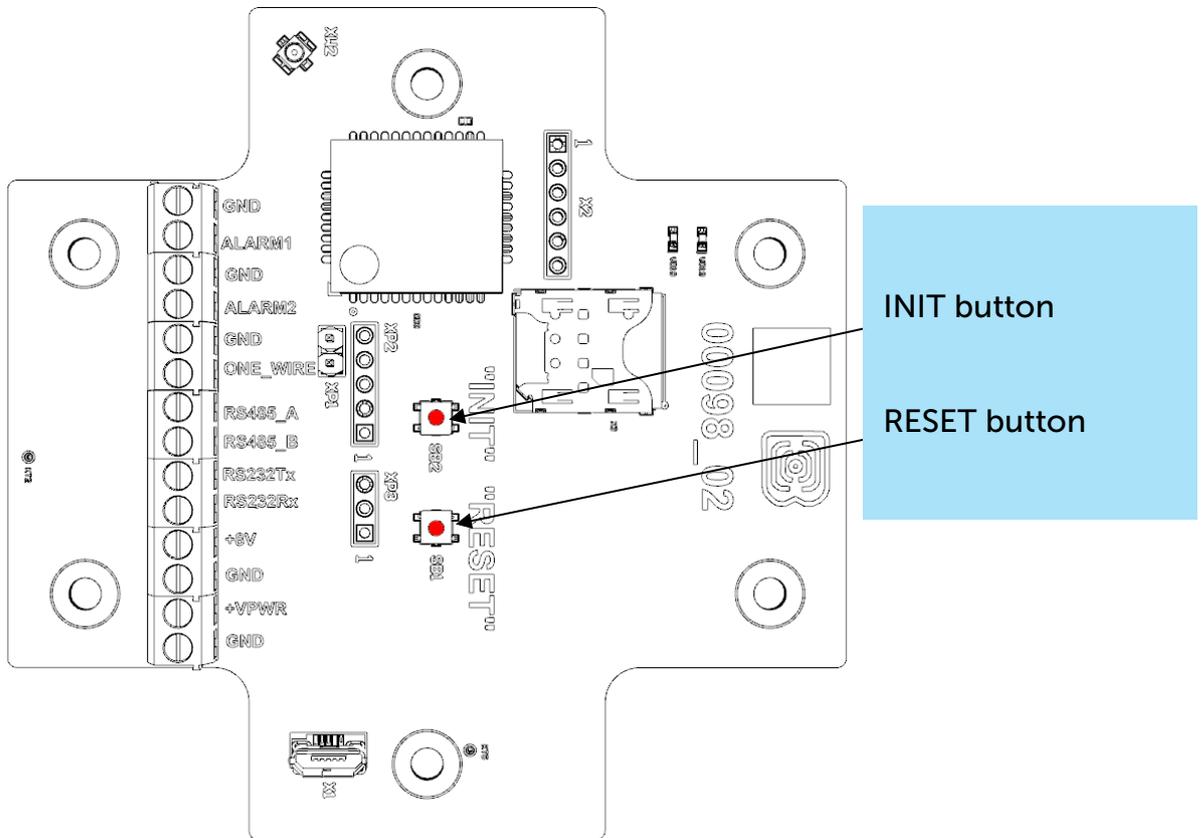

INIT button

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 location on the board
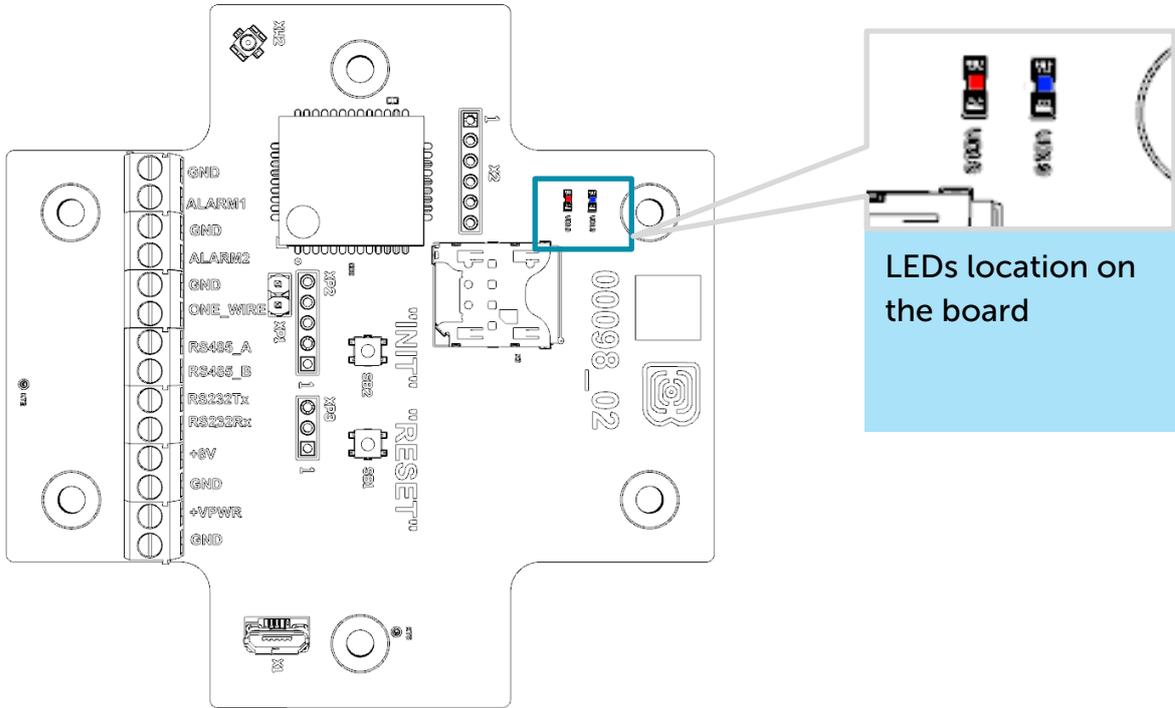
GSM-modem		
	Short flash every three seconds	Device search the network
	Short flash every second	Device successfully registered and it is in the network
	Two short flashes every one second	Device transmits data to the network
	No light	LTE-modem switched off
DEVICE		
	Short flash every five seconds	Device 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.

> **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**
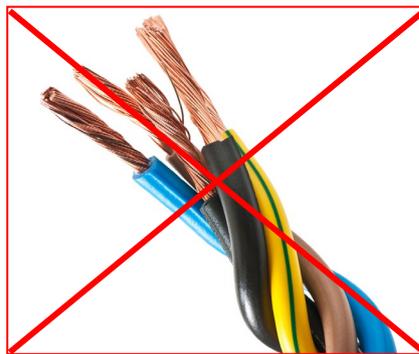
5. Connecting all necessary wires to the contacts.
6. Connecting the battery at the connector. After the battery connection the device loads and comes to sleep until the next communication session.

Расположение слота для SIM-карты на плате (если есть)

Питание 5...55 В подключать здесь
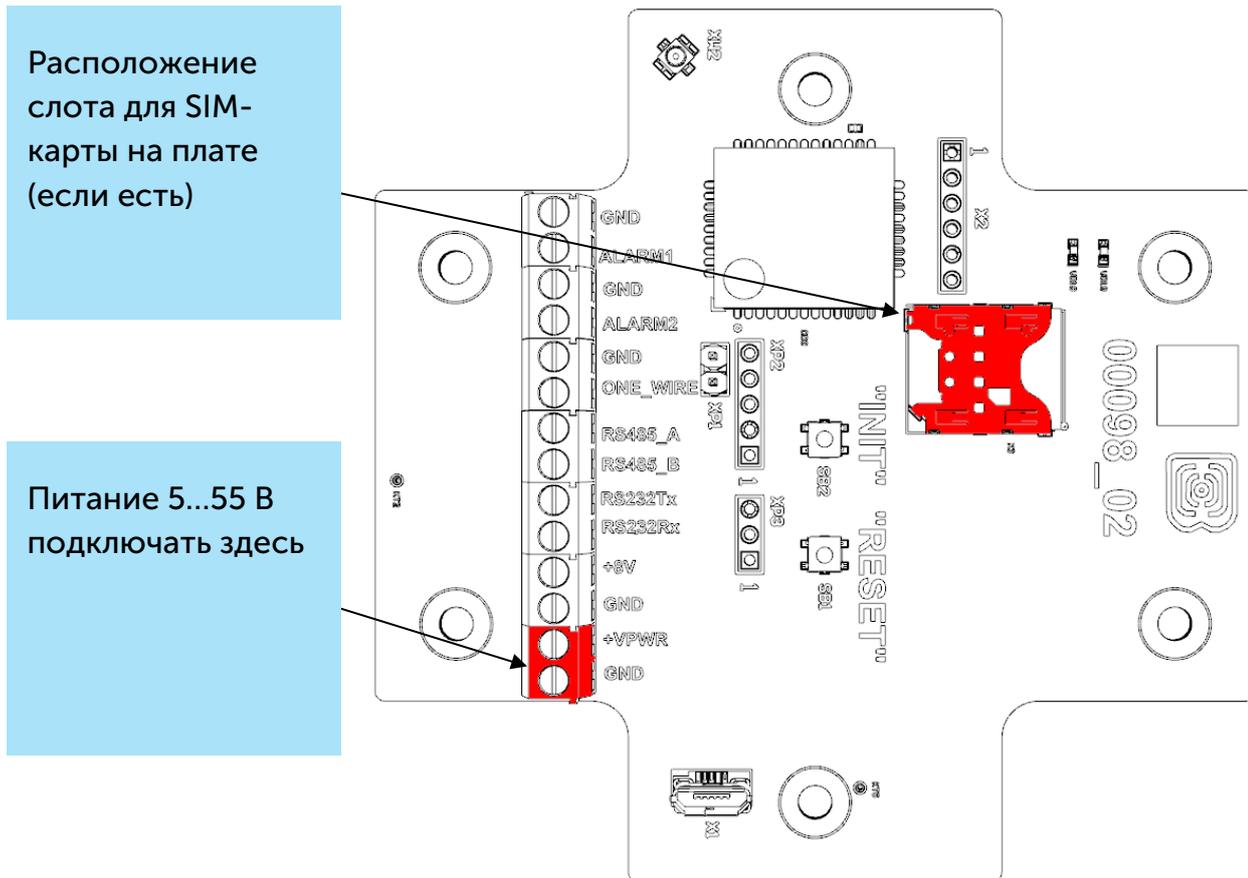
7. If you need to test the data transmitting, then press and hold the INIT button for the 2 seconds.
8. Before assembling the device, you can reset the pulses accumulated during testing and connection through the "Vega NB-IoT Configurator" if it is necessary.
9. Assembling the device.

4 COMMUNICATION PROTOCOL

DATA COLLECTION MODE

Data transmits via MQTT protocol. You should to 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 to specify in the device settings the address and port of the broker. Also, you should to 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 to deploy MQTT broker on a PC and subscribe some application on MQTT broker.

Vega NB-13 sends the message on the server as a text of JSON format. See example below.

```
{
  "Message": {
   "dev": "NB-13 v0.4",
   "IMEI": "867723030670532",
   "IMSI": "250023039331783",
   "ICCID": "897010230393317839",
   "num": 25,
   "UTC": 1576817755
  },
  "CellStatus": {
   "TAC": "13A8",
   "CID": "083DA429",
   "SQ": 27,
   "EARFCN": 3648,
   "PCID": 492,
   "RSRP": -610,
   "RSRQ": -108,
   "RSSI": -581,
   "SNR": 263
  },
  "Telemetry": {
   "reason": "time",
   "UTC": 1576760400,
   "supply": 6.49,
   "temp": 25,
   "s_alarm1": 1,
   "s_alarm2": 1,
   "s_magnet": 0,
   "s_outpwr": 0,
   "onewire": [25.3, 25.1, 24.9]
   "modbus": {
```

```
    "0": {                             // The first reading operation
     "f": 3,                           // with ModBus functionality code 0x03
     "a": 2056,                        // at the ModBus register address 2056 in DEC format
     "d": "00E30F7812345678"  // Read data in HEX format - 8 bytes
    },
    "1": {                             // The second reading operation
     "f": 3,
     "a": 4,
     "d": "1110222033304440"
    },
    "2": {                             // The third reading operation
     "f": 3,
     "a": 8,
     "d": "5550666077778880"
    },
  ...
    "9": {                             // The tenth reading operation
     "f": 3,
     "a": 36,
     "d": "9990101020203030"
    }
   }
  }
 }
```

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 – gateway identifiers
   SQ – gateway signal quality
   EARFCN – the number of radio frequency channel (absolute)
   PCID – physical network address
   RSRP – input signal power (in centibels[1])
   RSRQ – input signal quality (in centibels[1])
   RSSI – indicator of the input signal power (in centibels[1])
   SNR – signal to noise ratio

---

[1] Decibel multiplied by 10

The "Send network statistics" setting on the "Settings" tab in the Configurator is responsible for sending information about the network and is used to reduce traffic and data transfer time. If the checkbox is checked, the modem will add a section with the "CellStatus" key to the JSON message. If the box is not checked, then the "CellStatus" key is not added to the JSON message.

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

supply – power voltage in Volt

temp – processor temperature

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_outpwr – activity of power output 8 V ("0" – power output is disabled, "1" – power output is abled)

If ModBus is enabled in the modem settings and the polling is successful, then the "modbus" key is added to the "Telemetry" section of the JSON message. If ModBus is disabled in the settings, or there is no connection with the sensor, then the ModBus data is not added to the black box record and, accordingly, is not displayed in the JSON message.

Up to 10 read operations can be displayed inside the "**modbus**" key, each of which contains the following JSON keys:

Key "f" - function code

Key "a" - starting address of reading in DEC format

Key "d" - read data in HEX format. The minimum size of the read data is 1 byte, the maximum is 8 bytes.

TRANSPARENT MODE

In transparent mode, the modem opens and maintains a session with the server. During the session, the packets received from the server are transmitted by the modem to the device, the packets from the device are transmitted to the server. The device can be connected via RS485, RS232 interfaces. The exchange packets have a specific format.

1. Data transmitting format for transparent mode for server-to-device and device-to-server packets.

Offset	Size, byte	Description	Range of values
0	1	Transparent packet ID (0x05)	-
1	1	Packet type	-
2	2	Packet size (little-endian)	1...1024
4	1-1024	Transmitting data	-

Types of packets for transparent channel

Packet type	Description
0x02	Server-to-device packet
0x03	Device-to-server packet. Send data from the port RS485/RS232. S
0x0B	Identity packet includes IMEI and ICCID. Modem sends this packet to the server when communication session is open.
0x04	Server-to-device packet with packet ID and device response timeout
0x05	Device-to-server packet with packet ID

1) Example of identification packet:
050B1000C4AC018330150300CF297C4E0DD2720C

Transparent packet ID	Packet type	Data size	Modem IMEI	ICCID of SIM
0x05	0x0B	0x0010	0x000315308301ACC4	0x0C72D20D4E7C29CF

Device IMEI and ICCID in this packet are represented as hexadecimal unsigned long (64 bit) in byte format little-endian. For example, IMEI 0x000315308301ACC4 = 867723030670532 Dec.

2) Example of server-to-device packet:
0502080001030001 0001D5CA

Transparent packet ID	Packet type	Data size	Data sent to the port RS485/RS232
0x05	0x02	0x0008	0x010300010001D5CA

3) Example of device-to-server packet
050307000103024567CB3E

Transparent packet ID	Packet type	Data size	Data sent from the port RS485/RS232
0x05	0x03	0x0007	0x0103024567CB3E

2. Format of data transfer from server to device with packet ID.

The server sends a request packet with ID to the device and waits for a response from the device with the same ID within the specified timeout.

Offset	Size, byte	Description	Range of values
0	1	Transparent packet ID (0x05)	-
1	1	Packet type	-
2	2	Packet size (little-endian)	
4	2	Packet ID	0 - 0xFFFF
6	4	Timeout in ms	10 - 0xFFFFFFFF
10	2	Data length	1 - 1024
12	1 - 1024	Data	-

Packet example:
05040C00EEAAD00700000400FF1122FF

Transparent packet ID	Packet type	Packet size	Packet ID	Timeout	Data length	Data send to the device
0x05	0x04	0x000C	0xAAEE	0x000007D0	0x0004	0xFF1122FF

3. Format of data transfer from device to server with packet ID

Offset	Size, byte	Description	Range of values
0	1	Transparent packet ID (0x05)	-
1	1	Packet type	-
2	2	Packet size (little-endian)	
4	2	Packet ID	0 - 0xFFFF
6	2	Data length; it's may be equal to zero - that means the data was not received during timeout	0 - 1024
8	1 - 1024	Data	-

Packet example:
05050C00EEAA0800F0F1F2F3F4F5F6F7

Transparent packet ID	Packet type	Packet size	Packet ID	Data length	Data send to the server
0x05	0x05	0x000C	0xAAEE	0x0008	0xF0F1F2F3F4F5F6F7

5 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega NB-13 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-13 modem – 1 pc.

Antenna – 1 pc.

Factory certificate – 1 pc.

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 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	
Title	NB-IoT modem with RS-232/RS-485 interface Vega NB-13
Document type	Manual – Translation from Russian
Document number	V02-NB13-01
Revision and date	06 of 24 January 2022

Revision History

Revision	Date	Name	Comments
01	30.10.2019	KEV	The first release
02	20.01.2020	KEV	Description of operation modes is added, communication protocol is added
03	12.05.2020	KEV	"Communication and data collection algorithm" part is added, minor changes
04	14.07.2020	KEV	Minor changes
05	30.07.2020	KEV	New functionality is described, data collection mode through ModBus, new packets in transparent mode
06	24.01.2022	KMA KEV	Scheduled revision of documentation New part "Connection Of Terminator"

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