PULSE COUNTER

WITH RS-232/RS-485 INTERFACE

VEGA NB-13 REV.3

USER MANUAL

DOCUMENT REVISION	FIRMWARE VERSION
08	3.1

CONTENTS

INTRODUCTION

This manual is designated for Vega NB-13 rev.3 pulse counter with RS-232/RS-485 interface (hereinafter – the pulse counter) 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 rev.3 pulse counter 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 rev.3 can be used as a security device – two additional inputs operate in security mode, there is also a Hall sensor.

The pulse counter 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 rev.3 has an external NB-IoT antenna and ingress protection rating IP67. Also, pulse counter has an output for external devices powering with 8 V.

The counter is powered by an external supply with power 9...48 V.

OPERATION ALGORITHM

During operation, the pulse counter accumulates data in non-volatile memory (black box) according to the data collection schedule and connects to the server according to the transmission schedule to send all accumulated data.

Data collection and transmission can be flexibly configured by selecting the desired schedule type:

Hourly — at 00, 05, 10, 15, 20, 25, 30, 35, 40, 45, 50, and 55 minutes of each hour;

Daily — at 00:00, 01:00, 02:00, ..., 23:00;

Monthly — on the 1st, 2nd, 3rd, ..., 30th, 31st day of the month, and on the last day of the month;

Weekly — Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday.

At the next communication session, the device starts sending accumulated packets with readings, from the earliest to the latest. If there is no NB-IoT/GPRS 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 pulse counter 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, and is also updated from the operator's network if this option is enabled.

FUNCTIONAL

Vega NB-13 rev.3 pulse counter has the following features:

- RS-232 or RS-485 interface;
- Requests through ModBus protocol;
- Polling of external equipment using a custom protocol;
- 1-Wire interface for connection of temperature sensors (up to 10) in 'data collection' mode;
- Two inputs configurable either in "security" mode for connecting external leak detectors, security sensors, etc., or in "pulse" mode for counting input pulses.
- 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/pulse	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 33 000
CELLULAR COMMUNICATIONS	
Supported Cellular Standards	LTE Cat NB2 (NB-IoT), GPRS
Data transfer protocol	MQTT
LTE NB-IoT antenna type	external
POWER	
External power	9...48 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 (type of schedule: daily, transmission at 00:00)
Data collection period	24 hours (type of schedule: daily, data collection at 00:00)
Time zone	UTC +00:00
Guard inputs operate	on short
Hall sensor	OFF
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

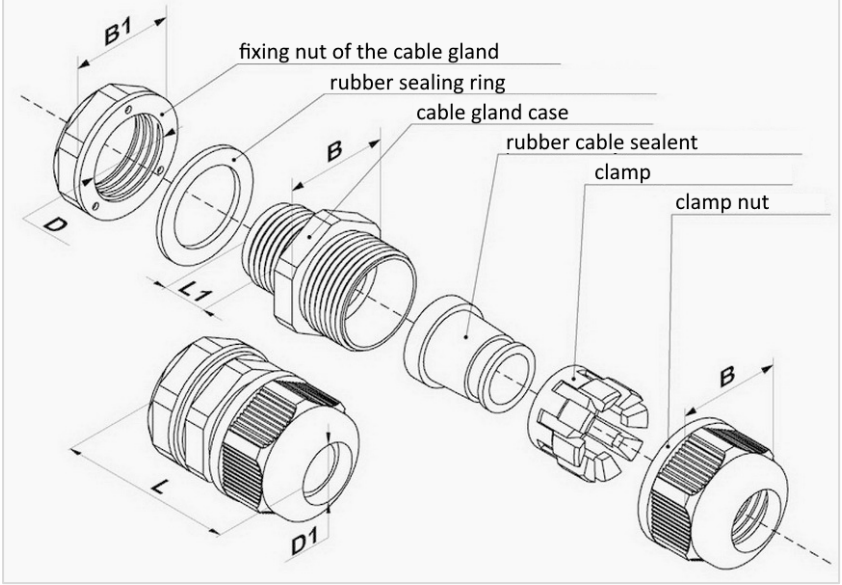
Vega NB-13 rev.3 is represented in gray plastic case which has six screws and mounting for DIN-rail. The device case is equipped with a hermetic gland of M12 size. A sealant is installed inside the gland, ensuring compliance with the declared Ingress Protection rating of the device case.

1 – screw ø 4 mm x 27 mm, cross ⊕

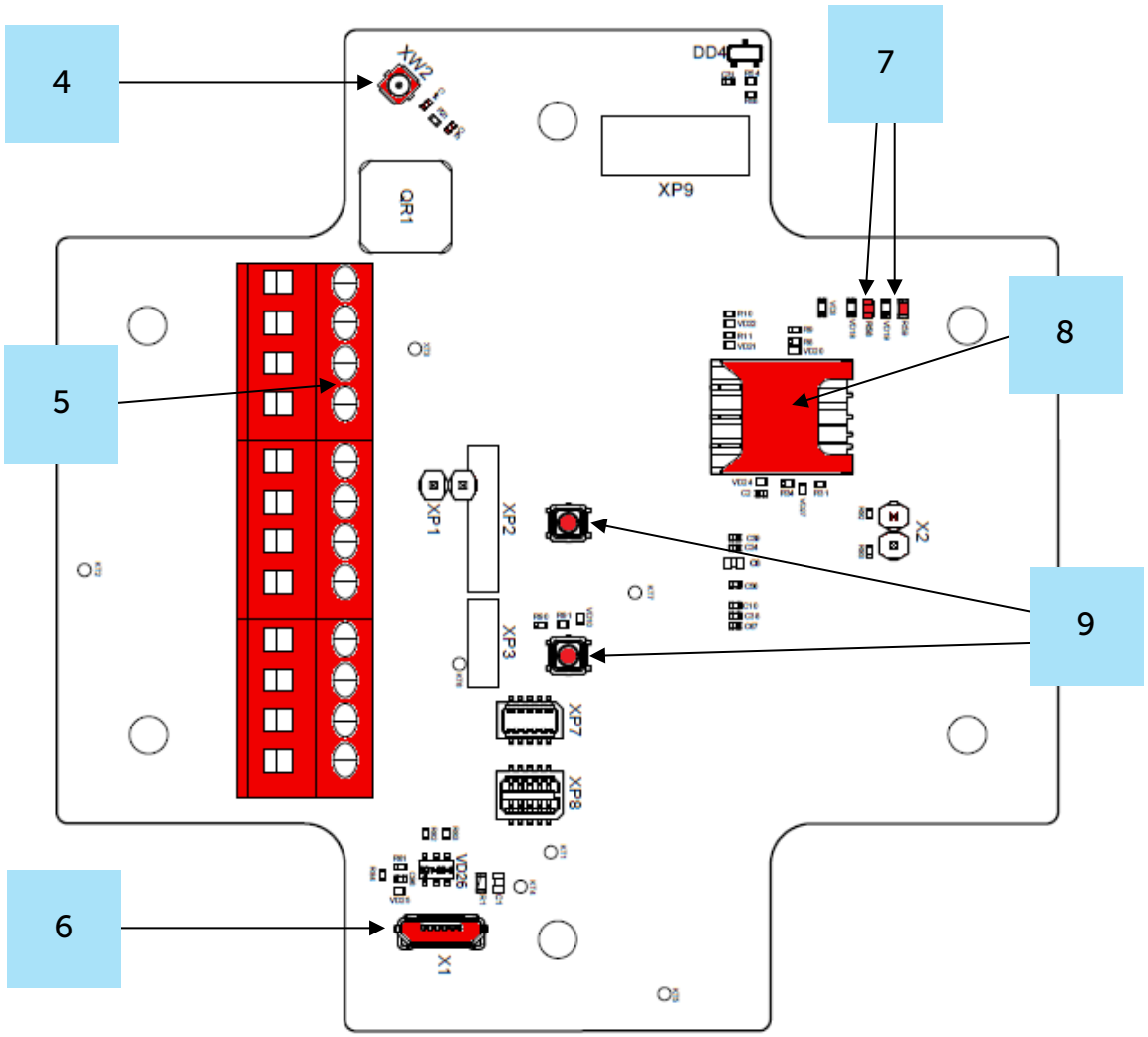
2 – cable gland of M12 size for installing the cables and wires with circular cross-section with a diameter of 5...6 mm

3 – input of external antenna

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

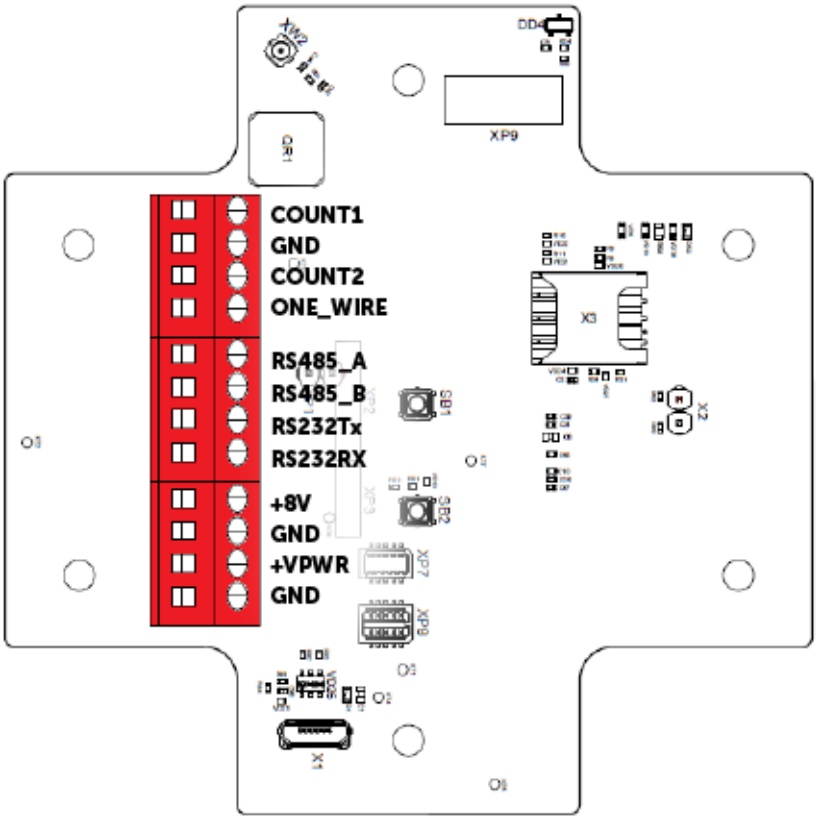
6 – USB-port

7 – LED indicators

8 – SIM holder

9 – manage buttons

CONTACTS

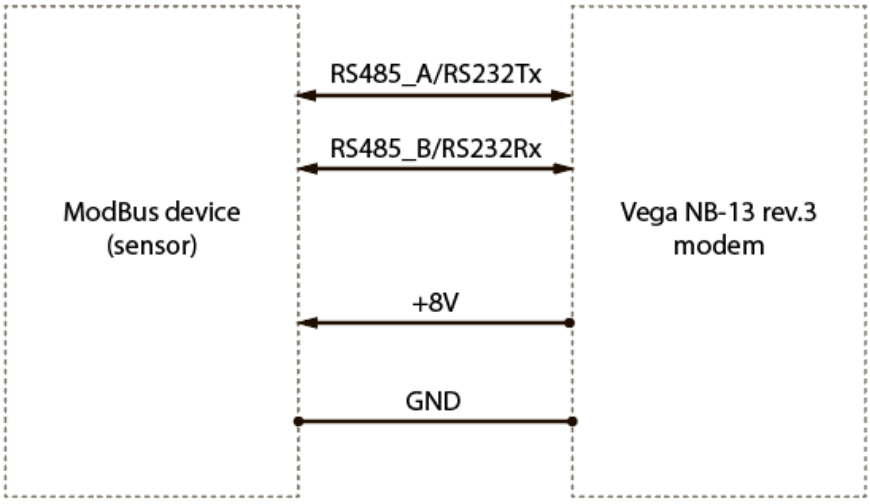


Contacts description is in the table below.

Contact	Naming on the board	Description
1	COUNT1	Security/pulse input 1
2	GND	Ground
3	COUNT2	Security/pulse input 2
4	ONE_WIRE	Interface 1-Wire
5	RS485_A	Interface RS-485 A
6	RS485_B	Interface RS-485 B
7	RS232Tx	Interface RS-232 Tx
8	RS232Rx	Interface RS-232 Rx
9	+8V	Output power 8 V for external devices
10	GND	Ground
11	+VPWR	External power 9...48 V
12	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.



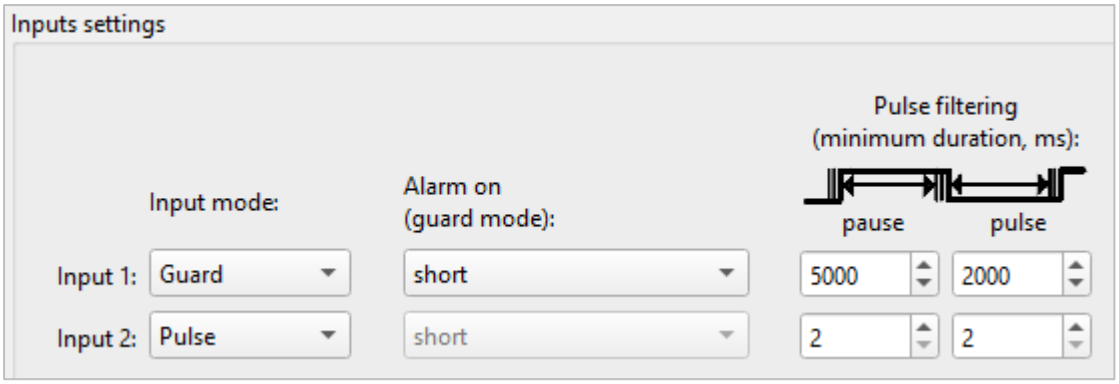
The pulse counter can power up the ModBus device connected to it before polling it, for this use the "+8V" contact.

1-Wire interface allows to connect there up to 10 temperature sensors (see details in part 4).

The board also features two security inputs that can be configured as pulse inputs for counting incoming pulses. 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.

For inputs configured in "Security" mode, contact bounce filtering can be configured. This function allows setting the minimum duration of positive and negative pulses, above which an alarm event is generated. The bounce filtering function improves the reliability of security inputs when connecting mechanical sensors and in conditions of high electromagnetic interference. Bounce filter settings are configured using the Vega NB-IoT Configurator software.

Example (alarm on contact closure):



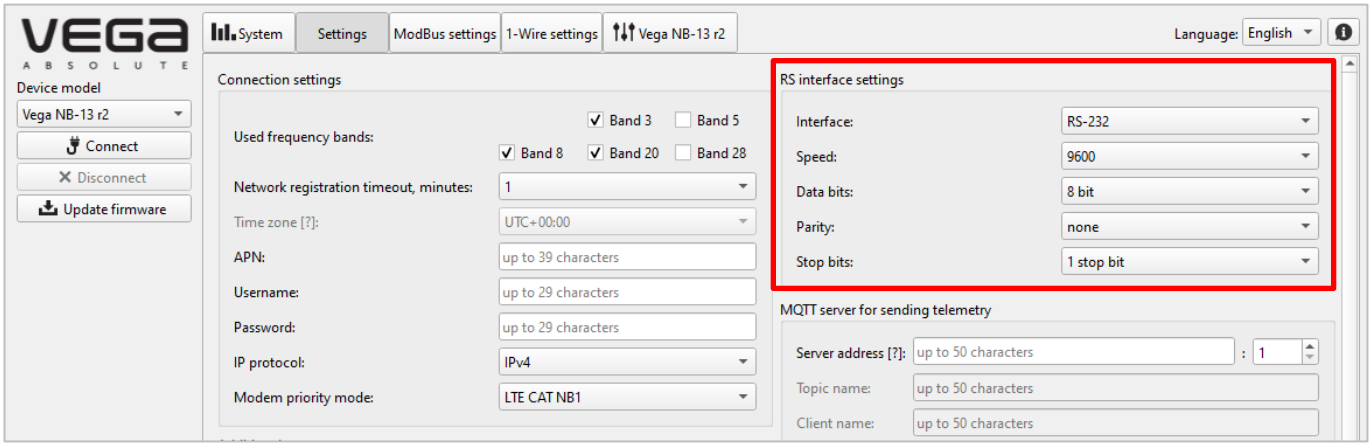
This setting means that an alarm on "Input 1" will be triggered only if the security input was in a logical "1" state for at least 5 seconds before the closure, and after the closure, the logical "0" level remains continuously for at least 2 seconds.

MODBUS SETTINGS

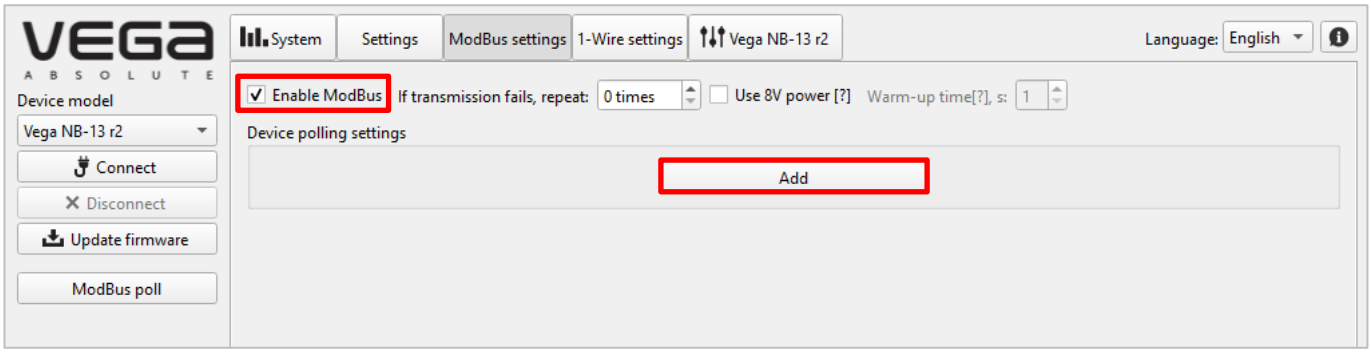
ModBus settings are configured using the Vega NB-IoT Configurator software when connecting ModBus devices.

On the "ModBus Settings" tab in Vega NB-IoT Configurator, you can enable, disable, or configure data transmission via the ModBus protocol.

To use the ModBus protocol, the RS interface must first be configured, which is done on the "Settings" tab, in the "RS Interface Settings" section.

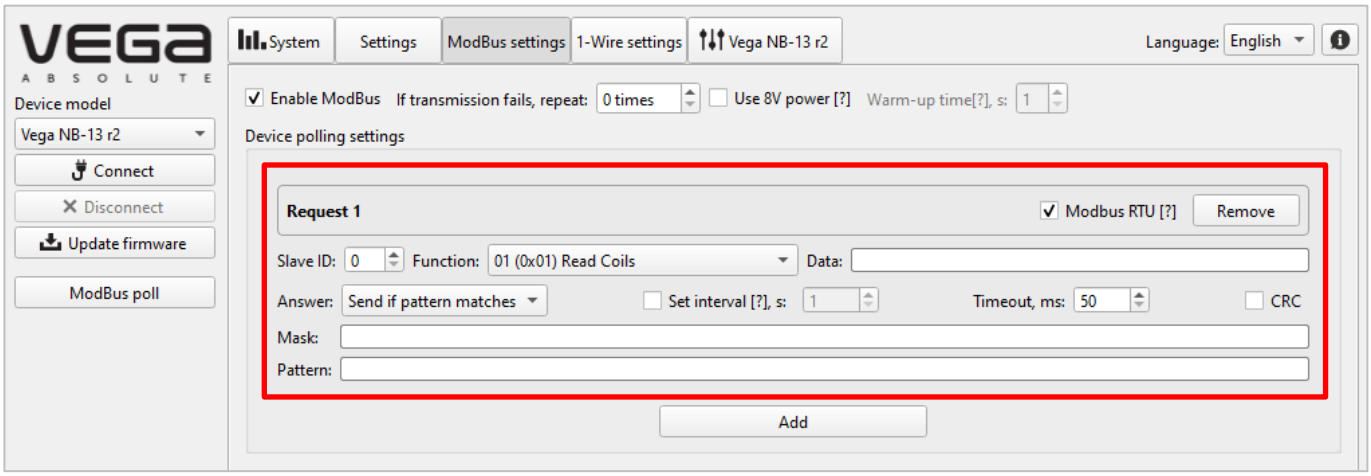


After that, go to the "ModBus Settings" tab, enable the "Enable ModBus" option, and click the "Add" button.



After completing these actions, "Request 1" will appear, along with fields for its further configuration.

The NB-13 rev.3 supports connecting up to 20 devices via RS485/RS232 interfaces, with independent requests configured through the "Vega NB-IoT Configurator" software.
Each request can be configured either using the Modbus RTU protocol or a custom user-defined protocol.



ModBus Configuration Example

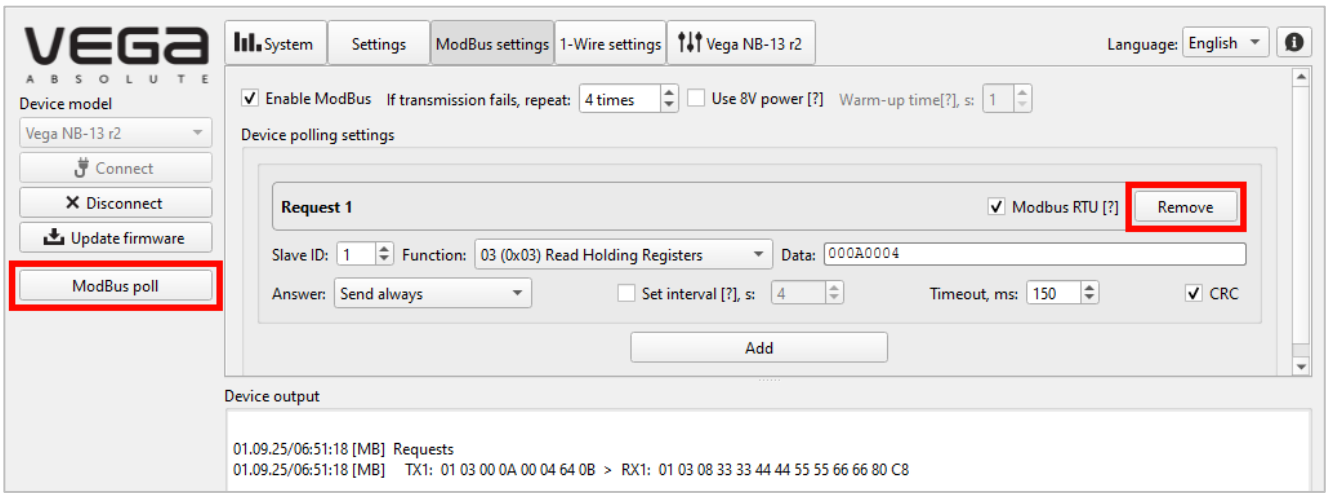
Consider an example of configuring a request to read four registers from a Modbus device, starting at address 0x000A. The device address on the RS485/RS232 bus is 1.

To configure this, set the following parameters: in the Slave ID field, enter the device address — 1; in the Function field, select operation 0x03 (Read Holding Registers); in the Data field, enter: starting register address — 0x000A, number of registers to read — 0x0004 (in accordance with the Modbus RTU format).

The CRC value does not need to be entered manually — it is automatically calculated and added to the packet.

After completing these steps, click the Apply Settings button to save the request.

To test the request, click the Modbus Poll button. The communication result will be displayed in the configurator log (Device Output). To delete the request, click the Delete button next to the corresponding request.



Example of a sent request (TX1):

01 03 00 0A 00 04 64 0B

01 — device address (Slave ID)

03 — function (Read Holding Registers)

00 0A — address of the first register to read (big endian)

00 04 — number of registers to read (big endian)

64 0B — CRC, automatically added by the modem in ModBus RTU mode

Example of a response from the device (RX1):

01 03 08 33 33 44 44 55 55 66 66 80 C8

01 — Slave ID

03 — function

08 — number of bytes read (4 registers × 2 bytes)

33 33 — value of register 0x000A

44 44 — value of register 0x000B

55 55 — value of register 0x000C

66 66 — value of register 0x000D

80 C8 — CRC, automatically verified by the device in ModBus RTU mode

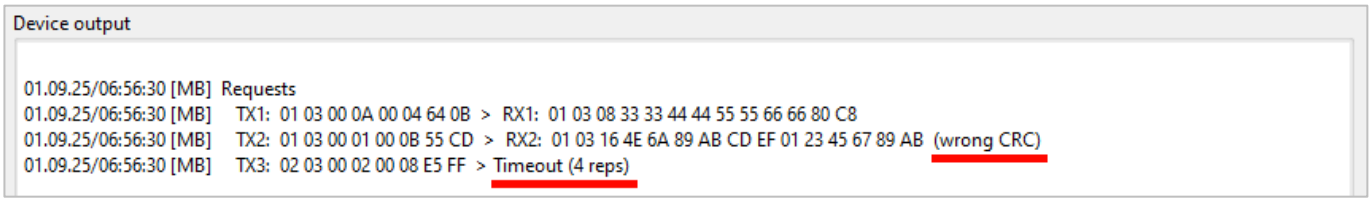
To configure additional requests — for example, to poll other registers or devices — click the **"Add"** button, set the parameters of the new request, and click **"Apply Settings"** again.

The configurator log displays information about retries:

(1 rep) — the request was retried once

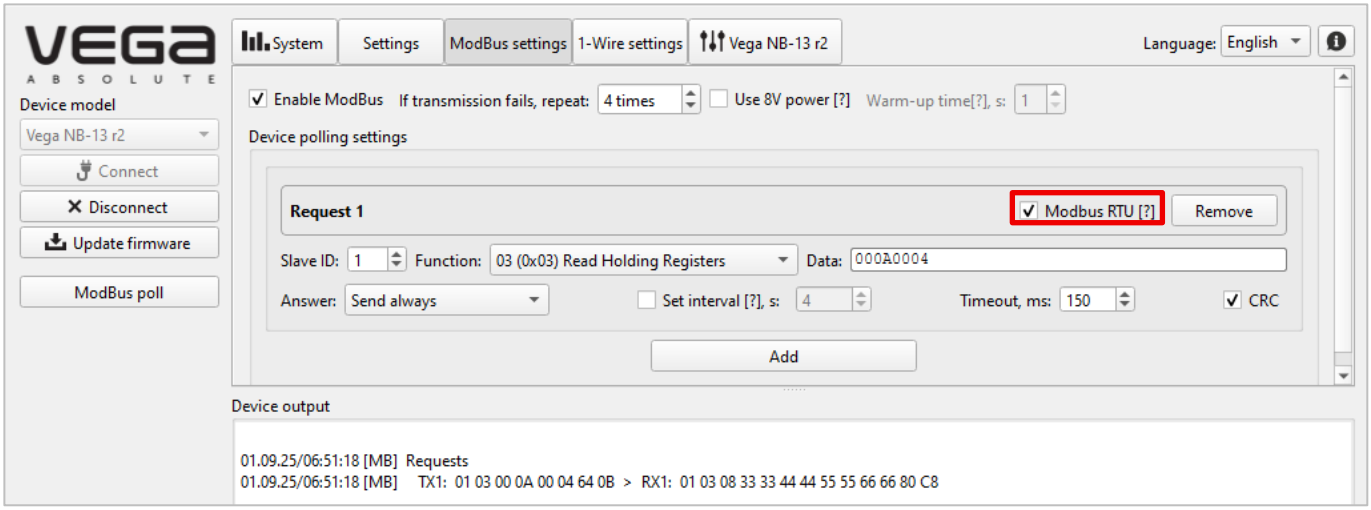
Timeout (4 reps) — no response received, the request was retried 4 times

If the request fails after all retries, it terminates with an error, and the counter proceeds to the next request.



Configuring operation with a custom protocol

To use a custom protocol, disable the "Modbus RTU" mode and enter the required request packet into the "Request" field in HEX format. After clicking "Apply Settings", the NB-13 rev.3 will send the contents of this field directly to the RS485/RS232 bus.



Description of ModBus Settings interface elements:

Enable ModBus — a parameter that activates ModBus protocol functionality; when enabled, it allows polling of ModBus devices upon events, and the received response data is saved into the "black box"; all accumulated data is transmitted within a JSON message during the next communication session with the server, where the response to the first request is marked with the key "mb1", the second with "mb2", and so on; if this option is disabled, ModBus polling is not performed, no data is accumulated, and the "mb" key is absent from the JSON message.

If transmission fails, repeat — a parameter defining the number of retry attempts for sending a request in case of failure. If the first ModBus request fails, for example due to no response within the set timeout (configured in the "Timeout" field) or a CRC check error in the received packet, the pulse counter automatically re-sends the request the specified number of times. If a valid response is received, the process completes successfully and the data is saved to the black box. If no successful response is received after all retry attempts, the counter proceeds to the next request.

Use 8V power — when enabled, the pulse counter supplies power to the "+8V" terminal, waits for the time specified in the "Warm-up time" field, and then proceeds to poll the connected device.

Warm-up time — time interval (from 1 to 60 seconds) between power application and the start of polling.

Slave ID — the address of the ModBus device to which the request is sent.

ModBus poll — a button that allows real-time polling of a ModBus device without saving data to the black box. Can be used for debugging ModBus connections. The configurator log displays the communication process: request packets and corresponding response packets from the ModBus device.

Modbus RTU — this parameter enables Modbus RTU protocol request configuration mode. If inactive, the custom (user-defined) request mode is activated.

When Modbus RTU mode is selected, the following fields become available: "Slave ID", "Function", and "Data".

In custom request mode, you can define a unique request to be sent to the connected device interface. This mode allows manual specification of any byte sequence, providing full flexibility in device interaction. In the "Request" field, enter a fully user-defined request, including the CRC checksum if required by the protocol.

Function — function for reading/writing registers according to the ModBus protocol.

Data — a field where the PDU (Protocol Data Unit) must be entered according to the ModBus RTU protocol (available when "Modbus RTU" mode is enabled).

Request — a field for entering a custom protocol request (available when "Modbus RTU" mode is disabled).

Set interval — enabling this parameter allows flexible configuration of the request transmission interval to the connected device interface, beyond the standard data collection schedule. The request execution period can be set from 1 to 65535 seconds.

Timeout, ms — a parameter that defines the waiting time for a response from the connected device after sending a request. If no response is received within the specified interval, the pulse counter proceeds to the next request. It is recommended to set the timeout value considering the time required by the device to process the request and send a response. The lower the communication speed (bitrate), the higher the timeout value should be.

Timeout settings also allow introducing a delay between requests, which can be useful when working with devices that require additional actions before data can be read. For example, when working with a pressure sensor, it may be necessary to first send a command to start measurement (which updates data in the sensor's corresponding register), and then read the measurement result. In this case, two requests — to start measurement and to read

the register — are executed sequentially, and a sufficient timeout ensures correct timing between them.

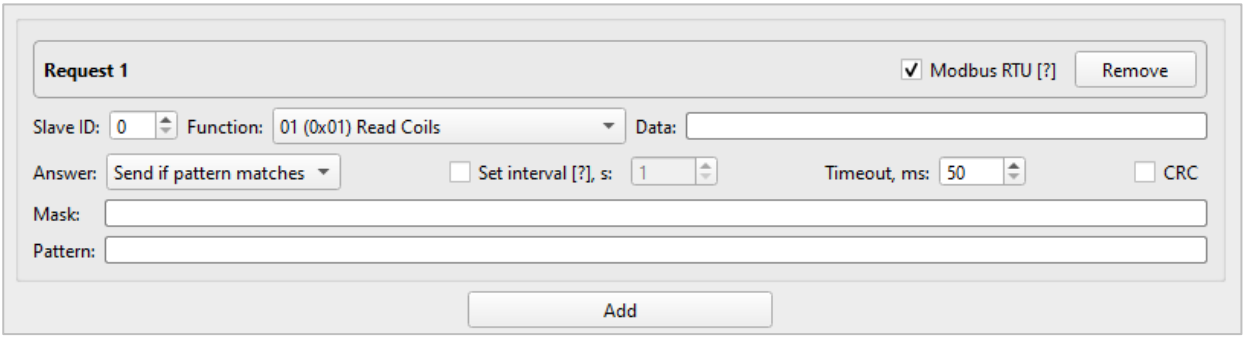
CRC — sending CRC to the server. If enabled, CRC bytes are transmitted along with the data in the response. This option can be disabled to reduce network traffic.

Answer — a parameter for selecting further actions with the answer to the current ModBus request. Available options:

• *Send always* — the response to the current request is saved in the black box and transmitted to the server during the next communication session. Recommended if the response contains data that needs to be sent to the server.

• *Do not send* — the response to the current request is not saved in the black box and not sent to the server. Recommended if the response does not contain information that needs to be transmitted, for example, responses to control commands or configuration changes.

• *Send if pattern matches* — this option allows sending the response to the server only if its content matches a specified pattern, for example, to detect changes in specific bits or bytes. When enabled, the configuration fields "Mask" and "Pattern" become available.



Mask — a mask applied to the response from the Modbus device.

Pattern — a byte sequence against which the response from the ModBus device is compared after applying the mask.

Using Mask and Pattern

A logical AND operation is applied between the response packet and the mask, after which the resulting value is compared with the pattern. If the values fully match, the response is sent to the server; otherwise, it is not transmitted.

In the mask, a value of FF means that the corresponding byte from the ModBus device's response is fully compared with the corresponding byte in the pattern. A value of 00 means that the byte is ignored and not compared.

Example 1 (full match):

In response to a request, the connected device sends the following data packet:

01 03 08 33 33 44 44 55 55 66 66 80 C8

The user has set the following mask:

00 00 00 FF FF 00 00 00 00 00 00 00 00

The user has set the following pattern:

00 00 00 33 33 00 00 00 00 00 00 00 00

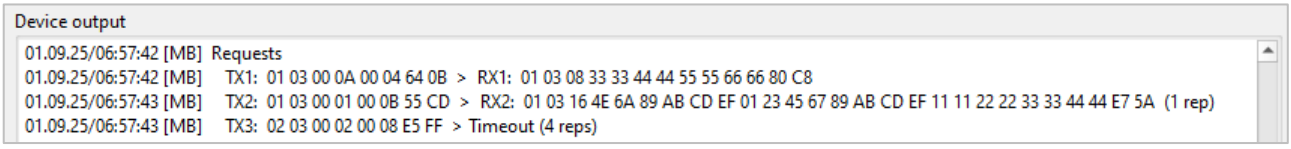
Device output – the log of communication with the connected ModBus device, which allows real-time monitoring of the device state.

Tx — the request packet in HEX format sent to the ModBus device

Rx — the response packet in HEX format sent by the ModBus device

The ModBus device polling process is displayed in the configurator log. The request packet (Tx) and its response (Rx) are shown on a single line:

Tx0: 01 03 00 00 00 02 c4 0b > Rx0: 01 03 04 30 2e 0d 60 91 82



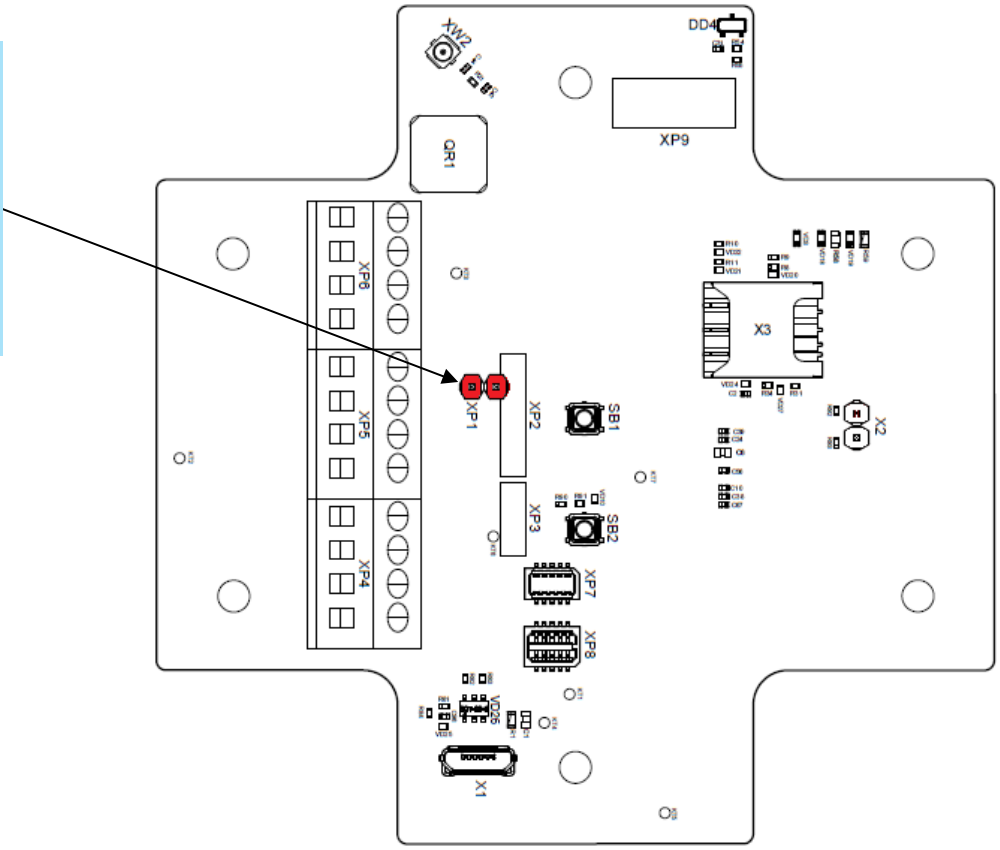
CONNECTION OF TERMINATOR

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.

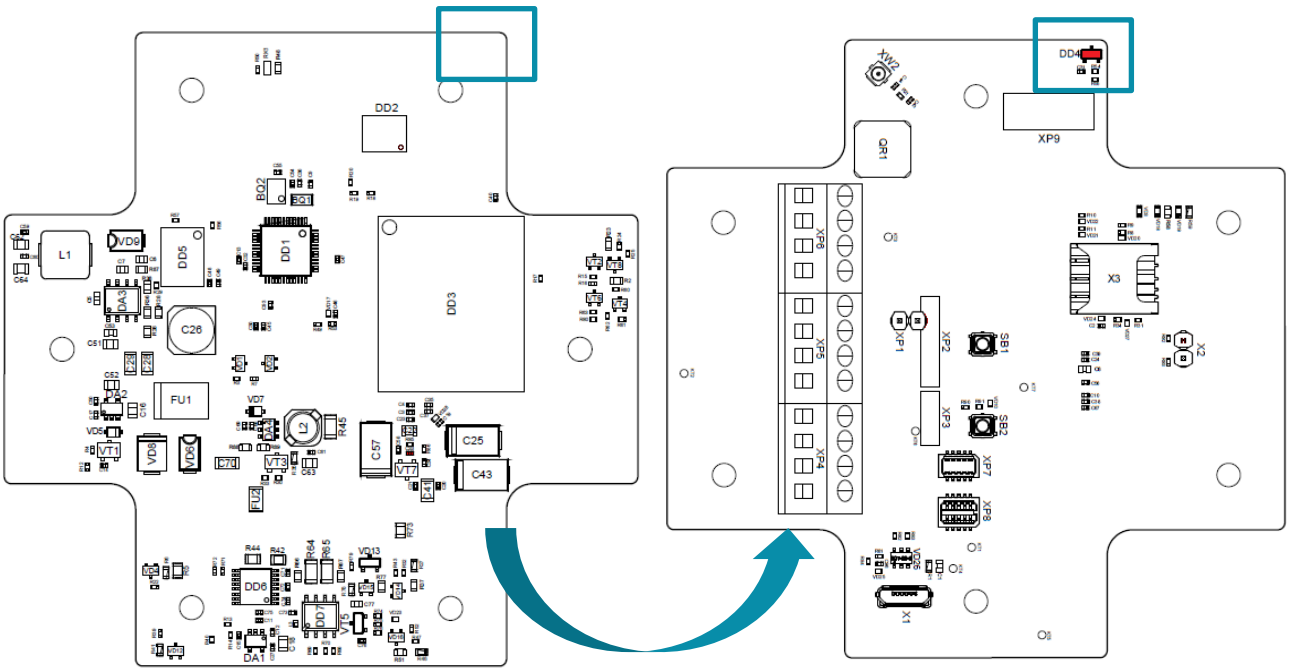
Terminator is used for defense from distortion in long transmission lines RS-485, therefore it must be activated when line is longer than 100 meters.

Location of XP1 connector on the board



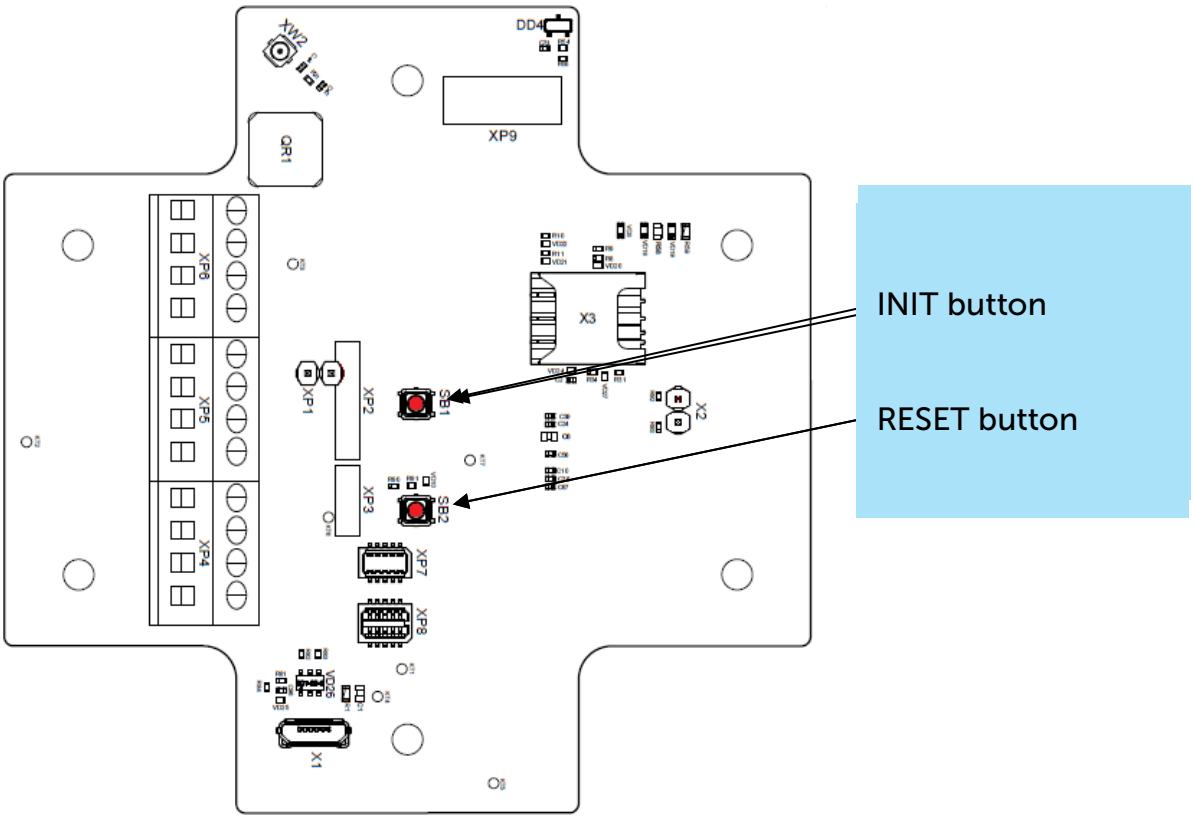
HALL SENSOR

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.

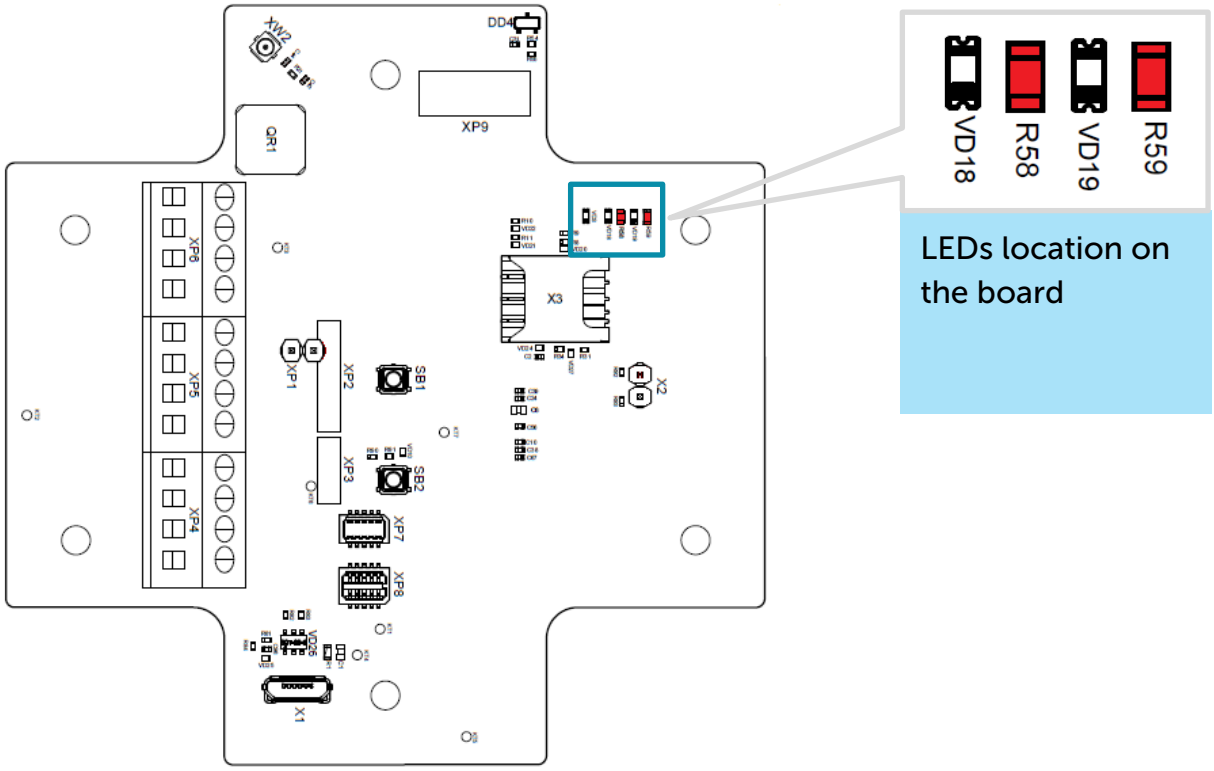


RESET	
Short pressing	Device reloading
INIT	
Pressing for 1 second	Registration at the network
Pressing for 2 seconds	Data transmitting
Pressing for 3 seconds	LTE-modem switching off

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.



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

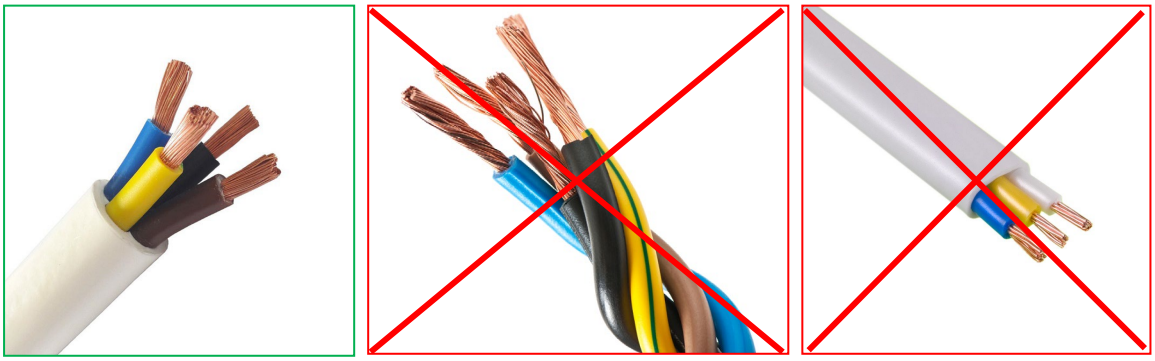
For mounting you will need:

- SIM-card;
- 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

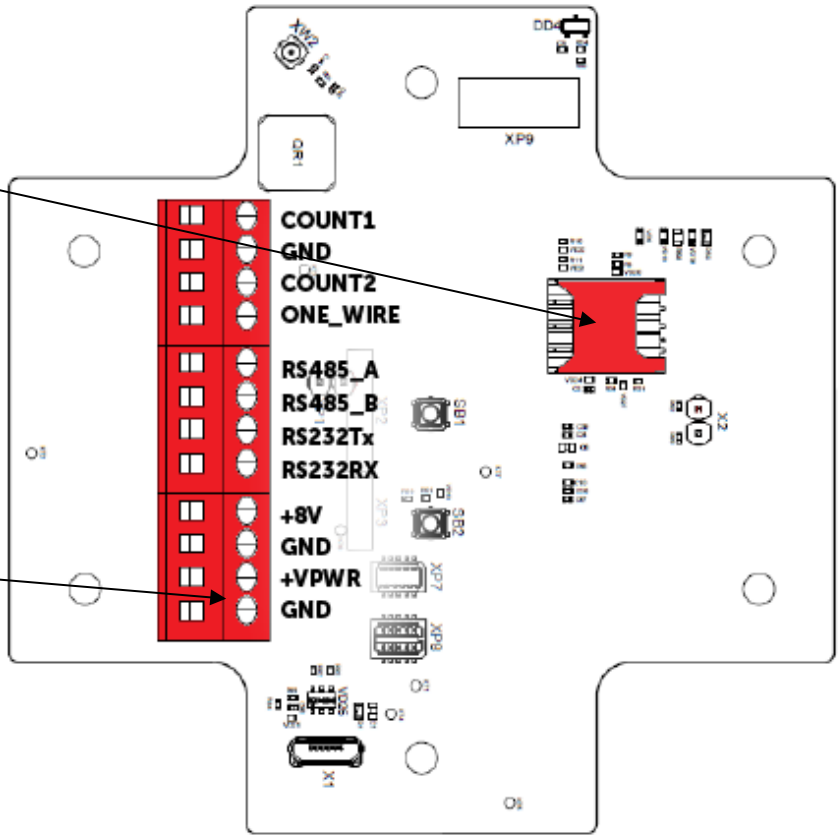
Inside the cable gland there is a sealant ensuring compliance with the declared Ingress Protection rating of the device case. When removing the sealant, as well as when installing wires of a different diameter or cross-section, device performance may deteriorate until failure due to moisture entering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

Location of the SIM card slot on the board (if present)

Power supply 9–48 V — connect here



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 rev.3 sends the message on the server as a text of JSON format. See example below.


```
{
 "Message": {
  "dev": "NB-13r3 v3.1",
  "IMEI": "861698065023367",
  "IMSI": "250023052716727",
  "ICCID": "897010230527167274FF",
  "Ubat_drop": 12.25,
  "num": 4617,
  "UTC": 1725534321
 },
"CellStatus": {
"SQ":27,
"EARFCN":1866,
"PCID":148,
"RSRP":-77,
"RSRQ":-10.5,
"RSSI":-59,
"SNR":7
 },
 "Telemetry": {
  "reason": "time",
  "UTC": 1754915617,
  "temp": 26.7,
  "supply": 12.29,
  "pulse1": { "C": 221 },
  "pulse2": { "C": 245 },
  "mb1": "0103083333444455556666680C8",
  "mb2": "010316456789ABCDEF0123456789ABCDEF1111222233334444C1F4",
  ...
  "mb20": "0103083333444455556666680C8",
  "ow1": {"t": 30, "H":0},
  "ow2": {"t": 29.9, "H":0},
  ...
  "ow10": {"t": 20 "H":0},
  "states": {
```

```
    "I1": 0,
    "I2": 1,
    "OP": 0,
    "M": 0
   }
  }
}
```


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 decibels)

RSRQ – input signal quality (in decibels)

RSSI – indicator of the input signal power (in decibels)

SNR – signal to noise ratio

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 pulse counter 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

temp – processor temperature

supply – power voltage in Volt

pulse – number of counted pulses on the pulse input (if the input is configured as a security input, "pulse" is not displayed in the JSON)

mb – ModBus data

ow – data from the 1-Wire sensor

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

I1 – state of COUNT1 input at the time of data slice ("0" - logic zero input, "1" - logic one input)

I2 – state of COUNT2 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)

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

M — presence of an external magnetic field at the time of data snapshot ("0" — absent, "1" — present)

5 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega NB-13 rev.3 pulse counter shall be stored in the original packaging in heated room at temperatures +5 °C to +40 °C and relative humidity less than 85%.

The pulse counter 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 pulse counter is delivered complete with:

Vega NB-13 rev.3 pulse counter – 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

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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"
07	27.04.2023	KMA	Minor edits
08	22.08.2025	NEE	Change of device version

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