LORAWAN® UNIVERSAL MODEM

VEGA SH-2

USER MANUAL

DOCUMENT REVISION	FIRMWARE VERSION
07	2.0.1 and higher

CONTENTS

INTRODUCTION

This manual is designated for Vega SH-2 modem (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 DESCRIPTION AND OPERATION

DEVICE DESCRIPTION

Vega SH-2 universal modem is designed for collection the data from external connected devices, further accumulating and transmitting of this information in the LoRaWAN® network.

The modem has two digital inputs which may be configured as pulse or security. Besides the device has two analog inputs, 1-Wire and RS-485 interfaces.

The modem is powered by a one or two 6400 mAh built-in battery or an external power supply 5...55 V.

The internal clock is set automatically when device connected to the "Vega LoRaWAN Configurator" via USB, also adjustable via LoRaWAN®.

The modem can transmit collected data via LoRaWAN[1] technology.

COMUNICATION AND DATA COLLECTION ALGORITHM

Before using the modem, it must be activated in the LoRaWAN® network.

Vega SH-2 supports two activation methods in the LoRaWAN® network - ABP and OTAA.

ABP method. After pressing the start button, the device immediately starts working in the "Active" mode.

OTAA method. After pressing the start button, the device makes three attempts to connect to the network within the set frequency plan. After the activation in the LoRaWAN® network is confirmed, the device sends a signal (LED flashing for 3 seconds) and switches to the "Active" mode. If all attempts are fail, the modem will go into a low power mode for a day, after which it will try to register in the network again. The modem will try again once a day until it registers successfully.

The device forms the data packet with current state with a configurable period from 5 minutes to 24 hours. The packets stored in the device memory and transmitting during the next communication session with the LoRaWAN® network.

Examples

If the data collection period is set to 24 hours the packet is formed at 00.00 on the internal clock of the device

If the data collection period is 12 hours then at 00.00 and at 12.00, and so on.

[1] The device can operate using NB-IoT technology. To do this, you need to install the firmware for the NB-15 on the device. For details, see the NB-15 "User manual".

The adjustable data transfer period can be 5, 15, 30 minutes and 1, 6, 12 and 24 hours. When beginning of communication session, the device starts sending packets with readings from the earliest packet. The time of data transmitting cannot be specified, it's defined in random way for every device in chosen period of transmission from the moment of connection to the network.

Example

The data transmission period is set to 30 minutes, the settings are applied at 16:40. The device randomly selects the packet transmission time in a half-hour period from 16:40 to 17:10, for example, 16:41. Thus, packets from this device will be transmitted at 16:41, 17:11, 17:41, 18:11, and so on every 30 minutes according to the device's internal clock.

The internal clock is set automatically when you connect to the device through USB, also can be adjust via LoRaWAN® network.

FUNCTIONAL

Vega SH-2 universal modem is an A class device (LoRaWAN® classification) and has the following features:

- ADR support (Adaptive Data Rate)
- Sending of confirmed packets (configurable)
- Inputs switching to the "Security" mode for connection of external sensors etc.
- Saving non-transmitted packets in device memory
- Time referencing readings by internal clock
- Communication in case of security inputs actuation
- Temperature measurement
- Charge measuring of the built-in battery (%)

MARKING

Device marked with sticker that contain the next information:

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

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

Besides, there is an additional sticker located on the packing box and contains:

- Information about firmware version;
- QR-code containing DevEUI and keys for device registration in network via OTAA method.

2 SPECIFICATION

DEVICE SPECIFICATION

MAIN	
Digital inputs	2
Analog inputs	2
Interface	1-Wire / RS-485 (modbus)
USB-port	micro-USB, type B
Operating temperatures	-40...+85 °C
Communication channels	LoRaWAN®
Internal temperature sensor	yes
Communication period	5, 15, 30 minutes, 1, 6, 12 or 24 hours
Data collection period	5, 15, 30 minutes, 1, 6, 12 or 24 hours
Memory amount for storing packets	100 packets
LoRaWAN®	
LoRaWAN® class	A
Quantity of LoRaWAN® channels	16
Frequency plans supported by default	RU868, EU868, KZ865, custom (EU868 based)
Frequency plans available as order option	IN865, AS923, AU915, KR920, US915
Activation type	ABP or OTAA
Type of the LoRaWAN® antenna	external
Sensitivity	-138 dBm
Radio coverage in restrained urban conditions	up to 5 km
Radio coverage within line of sight	up to 15 km
Transmitter power by default	25 mW (configurable)
POWER	
Built-in battery	6400 /12800 mAh
External power supply	5...55 V
CASE	
Housing dimensions (without cable gland and SMA-connector)	96 x 96 x 50 mm
Ingress protection rating	IP67
PACKAGE	
Package dimensions	165 x 118 x 57 mm
Weight	0,410 kg

DEFAULT DEVICE SETTINGS

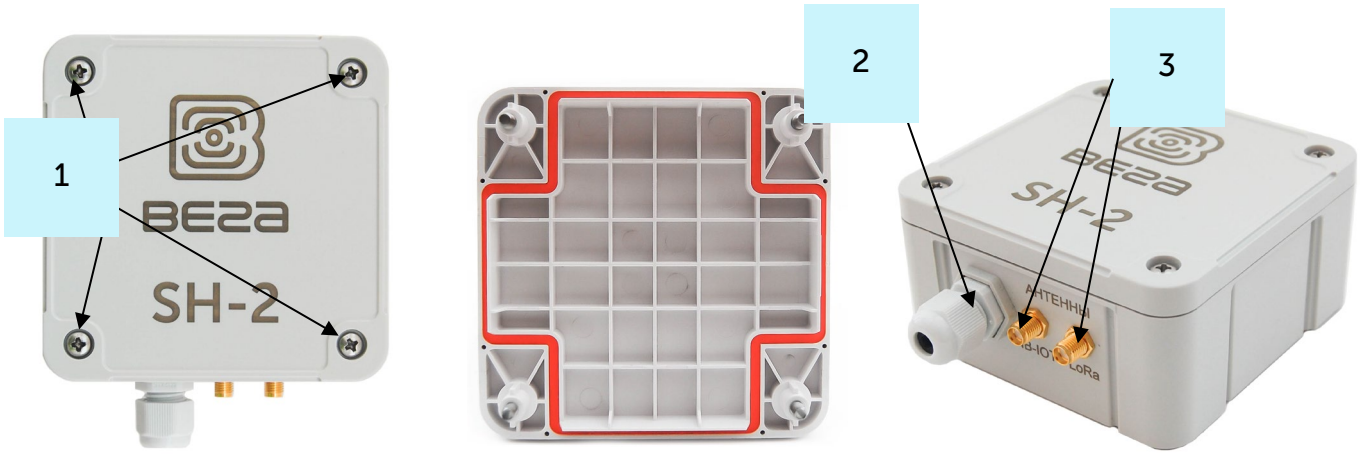
PARAMETER	VALUE
Frequency plan	RU868
Activation type	OTAA
Adaptive Data Rate	ON
Confirmed Uplinks	OFF
Rx 1 Delay	1 second
Join Accept Delay	5 seconds
Uplink number of transmissions	1
Data rate	DR0
Power	14 dBm
Communication period	24 hours
Data collection period	24 hours
Time zone	UTC +00:00
Inputs operate in mode	pulse

For changing the device settings, you need to connect to it with "Vega LoRaWAN 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 SH-2 is represented in gray plastic case screwed together. The case of the device is equipped with a cable gland of standard size M12. A seal is installed inside the gland, which ensures compliance with the declared degree of protection of the device case.

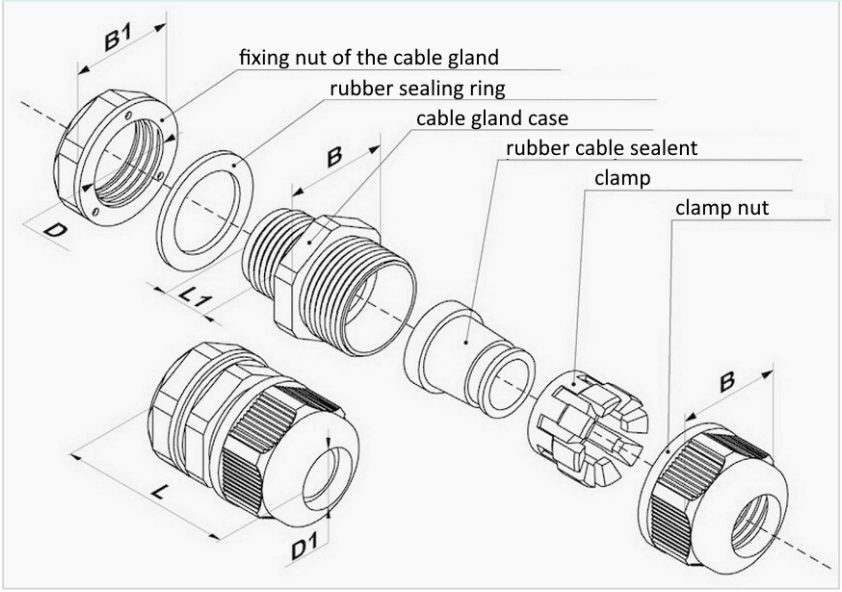


1 – screw ø 4 mm x

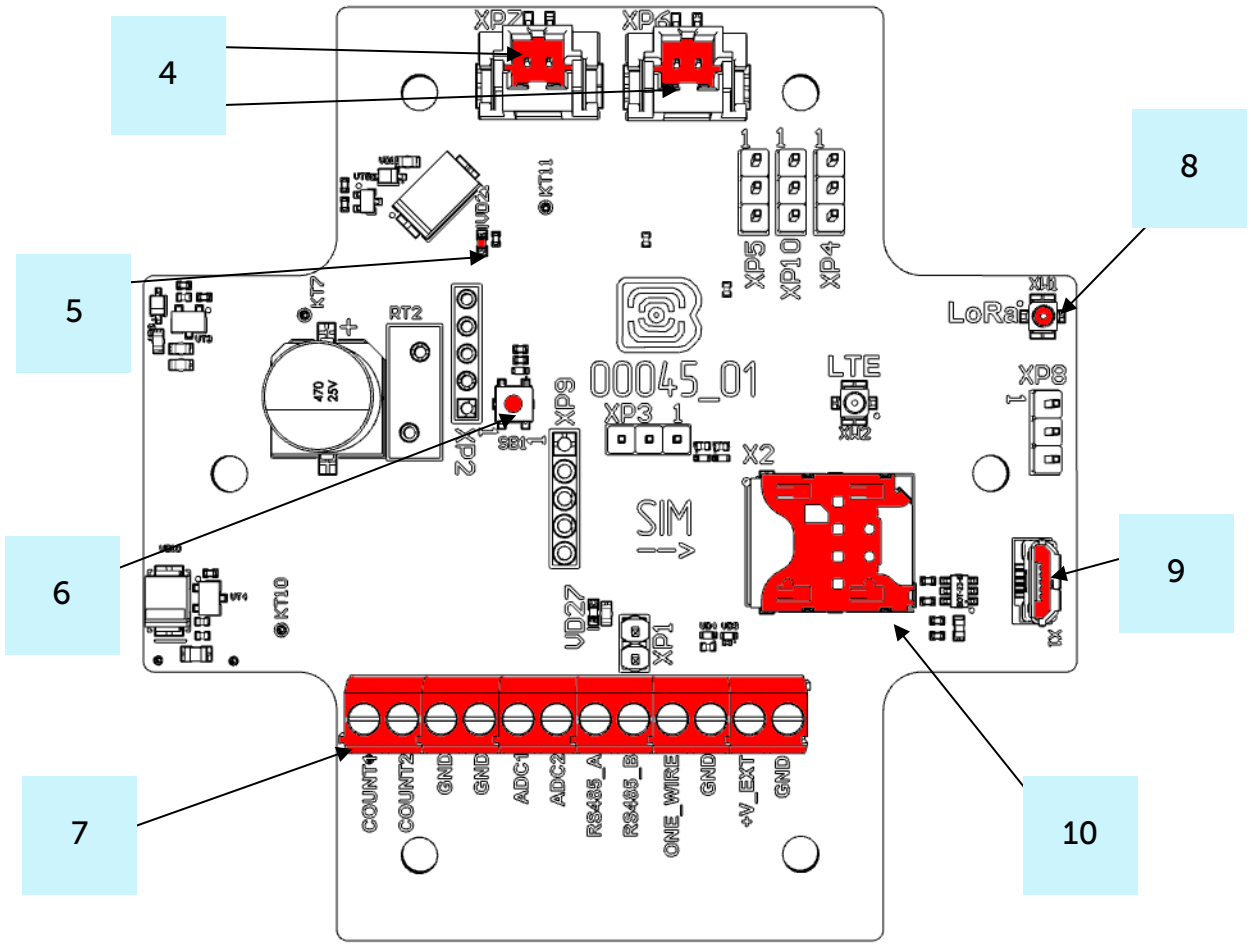
2 – cable gland of standard size M12 for installation of round cable ø 5-6 mm

3 – external antennas input

Internal structure of the cable gland



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



4 – connector for battery

5 – LED indicator

6 – launch button

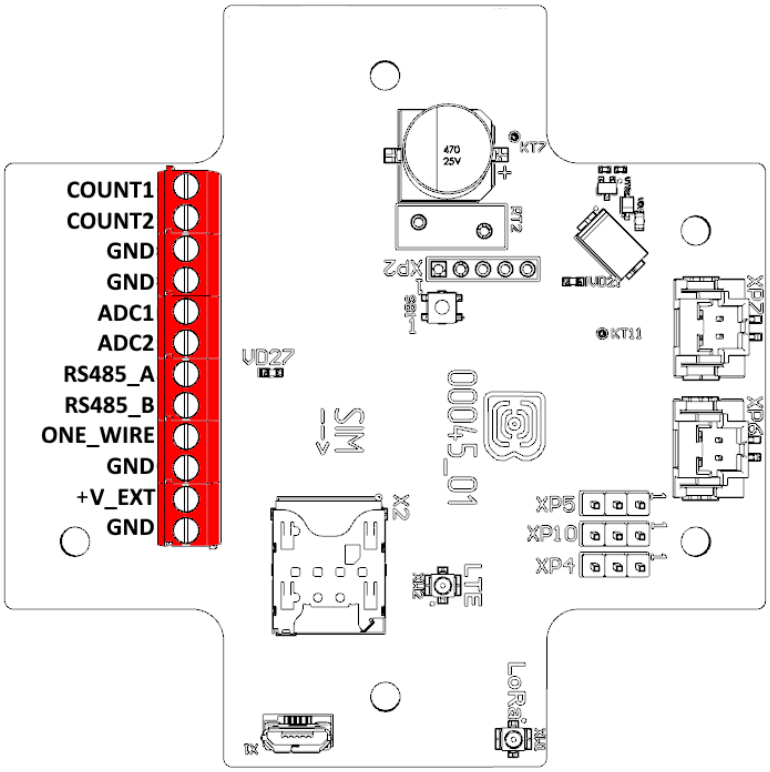
7 – contacts

8 – input for connecting an external antenna

9 – USB-port

10 – SIM slot

CONTACTS



Description of contacts in the table below.

Contact	Name on the board	Description
1	COUNT1	Digital input 1
2	COUNT2	Digital input 2
3	GND	Ground
4	GND	Ground
5	ADC1	Analog input 1 (0...21 B)
6	ADC2	Analog input 2 (0...21 B)
7	RS485_A	RS-485 Interface A
8	RS485_B	RS-485 Interface B
9	ONE_WIRE	1-Wire Interface
10	GND	Ground
11	+V_EXT	External power +
12	GND	External power -

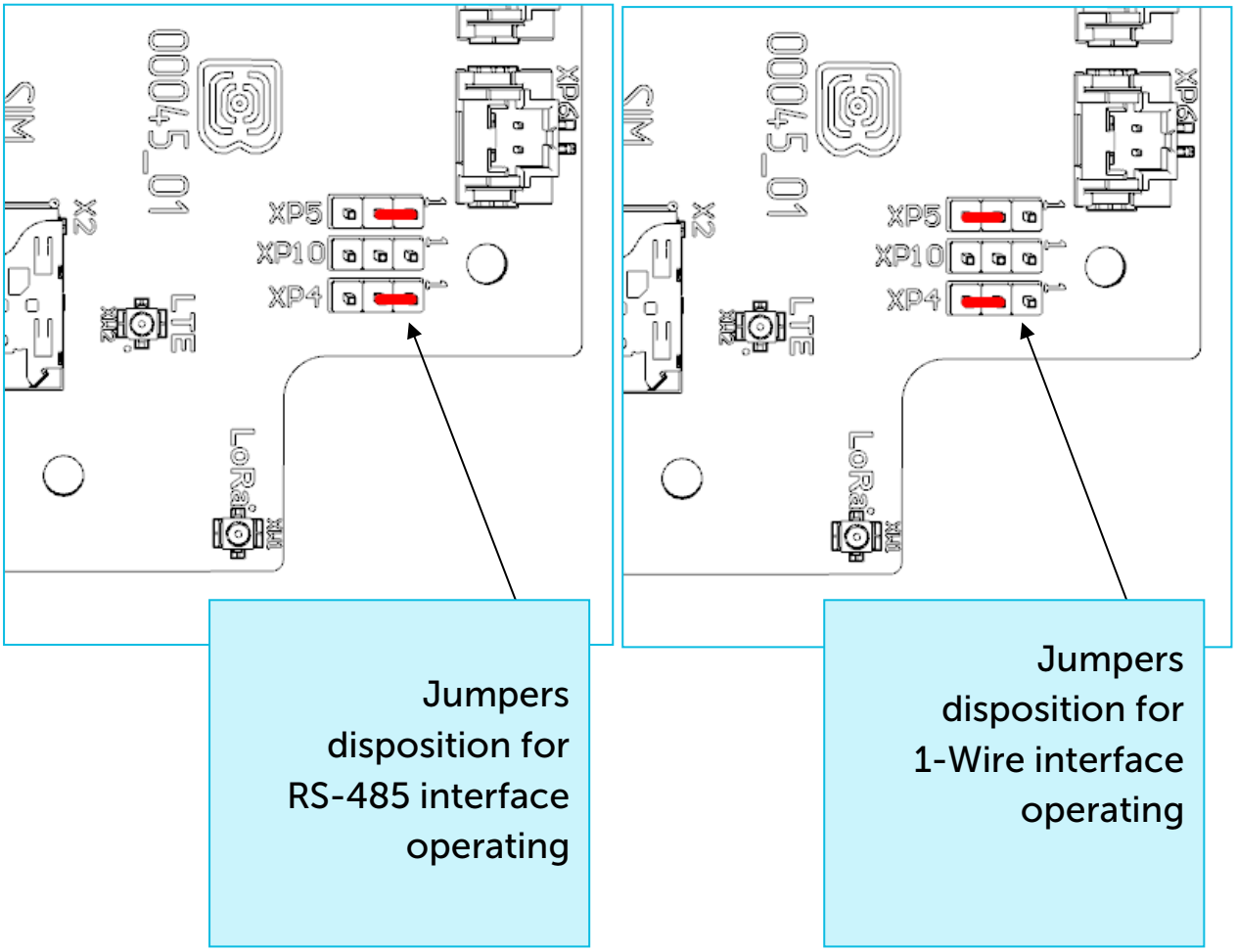
Digital inputs COUNT1 and COUNT2 may operate in pulse or security mode. If the input has not connected there is a logic '1'.

In the pulse mode the modem counts the number of pulses at the input. Fixation is by the impulse slump. In the security mode the modem monitors the input state change and send an alarm message into the network by the one of events: security circuit close, unclose

or both of it. You can choose the event for security input triggering via the “Vega LoRaWAN Configurator” application.

Analog inputs ADC1 and ADC2 may be used for measuring an external voltage from 0 to 21 V.

RS-485 (modbus) and 1-Wire interfaces cannot connecting at the same time. Switching between two interfaces carried out with jumpers on the XP4 and XP5 connectors on the board. In addition, in the LoRaWAN® configurator, go to the “Interface settings” section and select the 1-Wire / ModBus input mode.

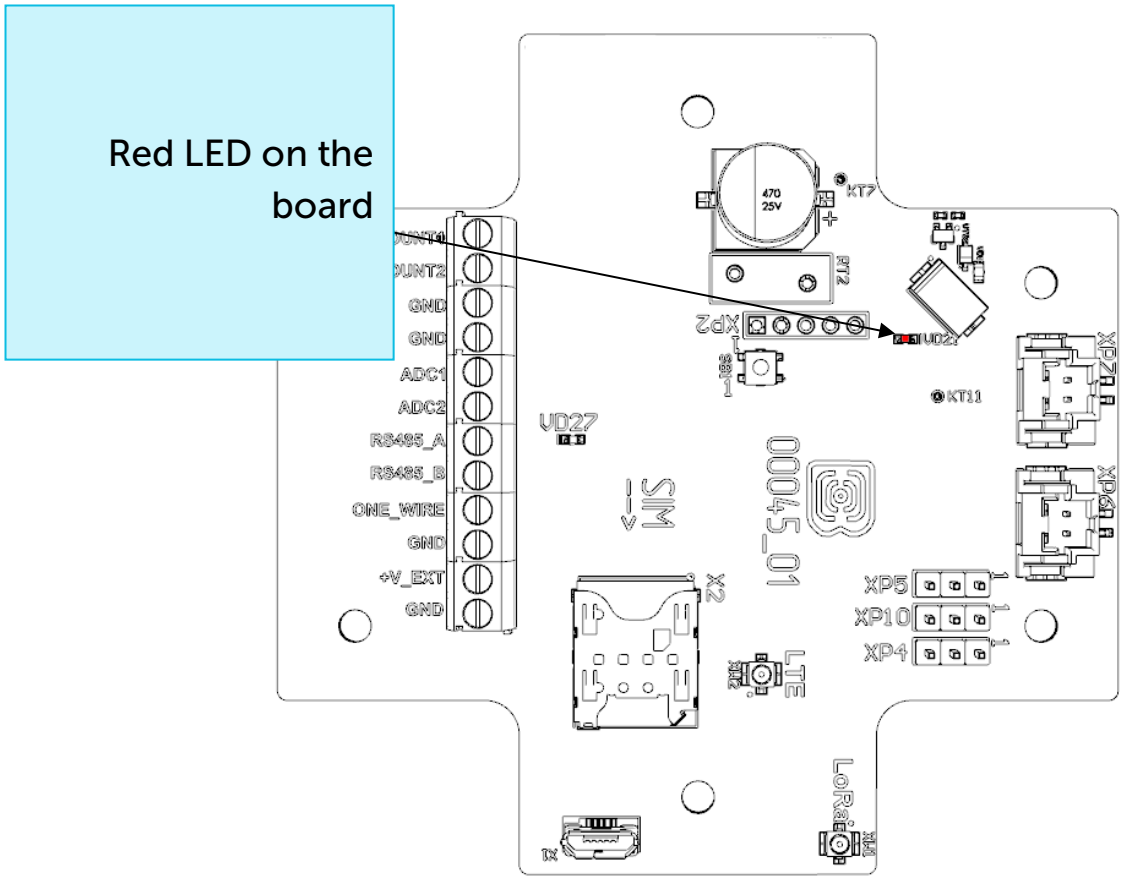


The 1-Wire interface allows you to connect up to 10 external temperature sensors. To add a sensor in the Vega LoRaWAN® Configurator program in the "states" tab, click the "Add one sensor" button, or click the "Add all sensors" button to add all sensors present on the 1-Wire line at a time.

Each sensor is assigned a number - in the order of addition, if the sensors are added to the bus one at a time, and in random order, if the sensors were added all at once. The number is used to identify the position of the sensor on the 1-Wire bus. You can set the sensor number in accordance with the ordinal position on the bus using the Configurator button "Change the order of sensors". All sensors can be deleted from memory by pressing the "Delete all sensors" button.

INDICATION

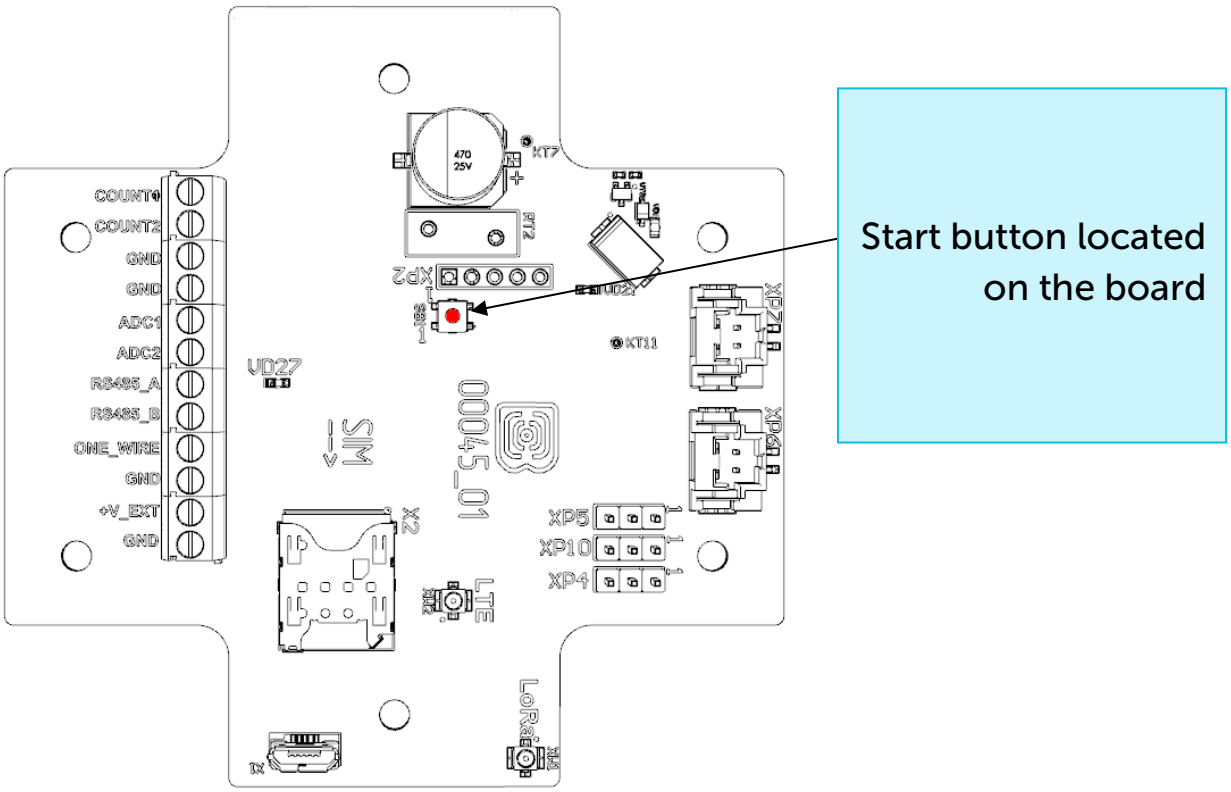
There is a red LED on the board. The indication is used when the device is activated in the LoRaWAN® network, and when the operating modes are changed.



LED signal		Meaning
	Flash every 5 seconds	Device not sleeping/USB connection
	Series of short flashings	Linking to the network
	One long flashing	The device connected to the network and is in active mode
	Three long flashings	Device switched to the «Storage» mode

BUTTON ON THE BOARD

The device has a button on the board that is responsible for switching operating modes.



The button on the device board works as follows.

Press	Value
Short press (0.5 seconds)	Switch to “Active” mode
Button hold up to 3 flashes of red LED	generating a packet into a black box
Button hold up to 5 flashes of red LED	Switch to “Storage” mode

MOUNTING RECOMENDATIONS

To provide the stable radio between the gateway and the end device is recommended avoiding the device installation in the places which are barriers for the radio signal getting through like a reinforced floors and walls, a basement, an underground facilities and wells, a metal case etc.

The necessary stage for the network deploying including a big quantity of end devices is a radio planning work with nature experiments.

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

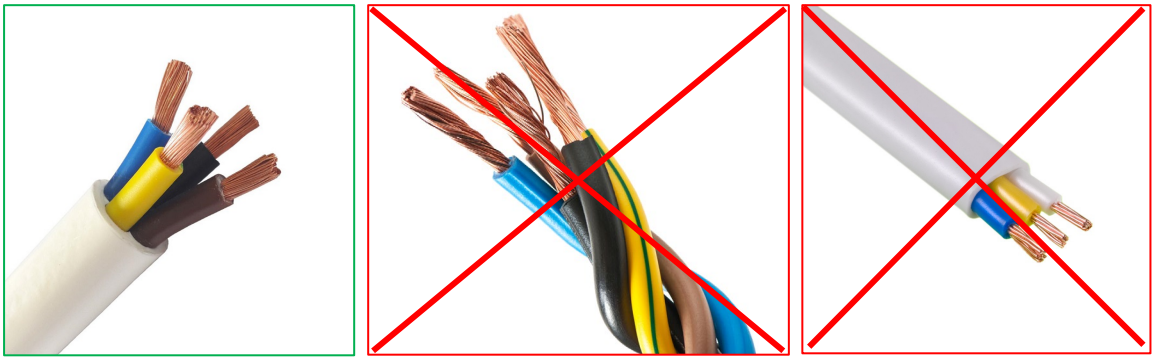
For mounting you will need:

-
- wire stripper;
- laptop.

Step by step mounting be like:

1. Setting the devices and connecting them to the network are usually carried out in the office (see Network Deployment Manual).
2. Determination of suitable places for mounting at the object with a network tester.
3. De-energizing the connected equipment, metering devices, etc.
4. Placement of wires in the cable gland. It must be remembered that the wires must be combined into a single round cable with a diameter of 5-6 mm.

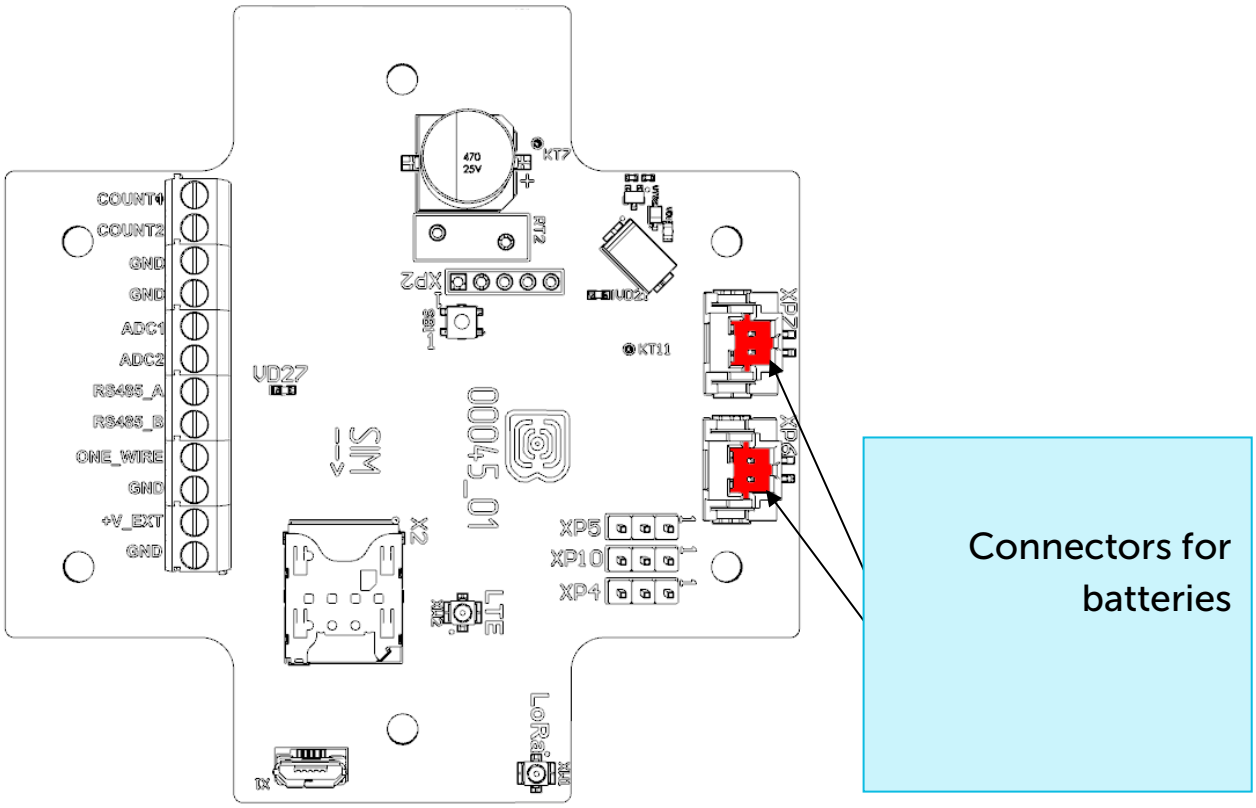
A seal is installed inside the cable gland, which ensures compliance with the declared degree of protection of the device case. When removing the seal, as well as when installing a cable of a different diameter or cross-section, the performance of the device may deteriorate up to failure due to moisture penetration into the housing



5. Connecting all necessary wires to the SH-2 contacts.
6. When the power is connected for the first time, the device automatically switches to the "Active" mode and begins to register in the network. But if the device with the connected battery was switched to the "Storage" mode by pressing the start button for a long time (more than 5 seconds) (see the section "Button on the device board"), then turning on is carried out by pressing the button.
7. By the laptop you can make sure that the device successfully sends the data.

8. Before assembling the device, it is necessary to reset the pulses accumulated during testing and connection by switching the device to the "Storage" mode by pressing the button for 5 seconds.
9. Start the device by pressing launch button.
10. Assembling the device.

The Vega SH-2 modem can be powered from either an external power source or built-in battery. To operate from the built-in battery, you must connect the battery connector to the one of power connectors on the board which XP7 or XP6 marked. In case of operation with two batteries you should use both connectors.



4 COMMUNICATION PROTOCOL

This part describes the Vega SH-2 data exchange protocol with LoRaWAN® network.

In fields consisting of several bytes, the little-endian byte order is used

VEGA SH-2 MODEM TRANSMITS THE FOLLOWING TYPES OF PACKETS

1. Packet with telemetry

Sent regularly to LoRaWAN® port 2.

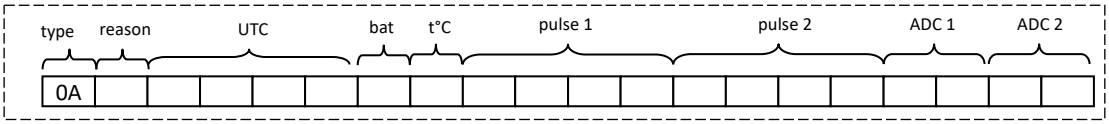
Since the amount of telematic data from the device exceeds the 51 bytes limit of the LoRaWAN® protocol, the packet is split into sub-packets. In this case, the format of the subpacket is determined by its first byte type.

The telemetry packet sent to LoRaWAN® port 2 contains the reason field, which defines the reason (event) of the packet formation. Once formed, the bag is placed in a black box. If the event belongs to alarming* (see the table below), then an unscheduled attempt to send packets is performed.

Reason	Event
1	Packet generated on schedule
2*	Alarm on the «COUNT1» input
3*	Alarm on the «COUNT2» input
4	Configurator command
5	By button on the device

1.1. Standard subpacket

UTC - collection time of data transmitted in this packet
bat - battery charge percentage
t°C - processor temperature
pulse1 and pulse2 - number of pulses at digital outputs 1 and 2, respectively
ADC 1 and ADC2 - voltage values (in mV) at analog inputs 1 and 2, respectively.
The subpacket size is 20 bytes.



Example

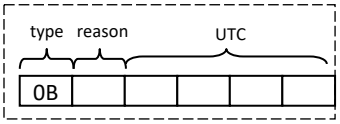
0A 04 B009E760 63 1B 100A0000 20000000 0800 1000

Reason = by Configurator command, Bat = 99%, t°C = 27, pulse 1 = 2576, pulse 2 = 32, ADC 1 = 8 mV, ADC2 = 16 mV.

1.2. Subpacket timestamp

UTC - the collection time of the data transmitted in this packet is used if the data is split into several radio packets.

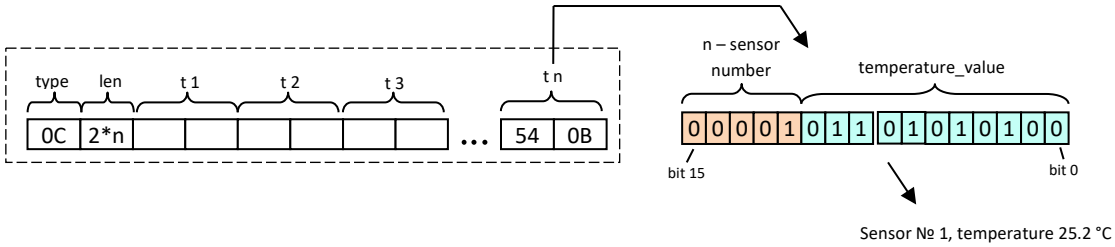
Subpacket size is 6 bytes.



1.3. Subpacket 1-Wire

Len - shows the size of the data following the len byte (size is in bytes). Information about each sensor is encoded in a 16-bit word in the Little endian format, where: 11 bits - temperature value (temperature_value), 5 bits - sensor number (assigned automatically or via the configurator).

A subpacket with 1-wire data is dynamic - its length can vary depending on the number of connected 1-wire sensors.



Formula for calculating temperature in degrees Celsius:

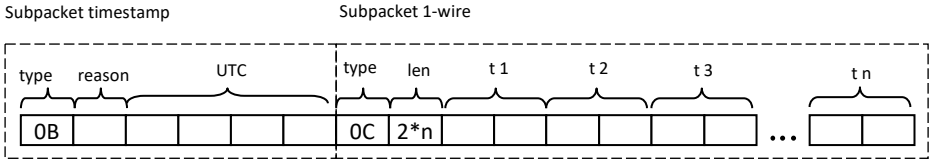
t°C = (temperature_value - 600Dec)/10

A 1-bit change in temperature_value corresponds to a 0.1 degree Celsius change.

Temperature examples:

Temperature value		Temperature (0-10 bits)
HEX	DEC	
0x000	0	– 60,0 °C
0x032	50	– 55,0 °C
0x258	600	0,0 °C
0x259	601	+ 0,1 °C
0x73A	1850	+ 125 °C
0x7FF	2047	Sensor not found

A radio packet can be composed of several sub-packets. For example, standard subpacket + 1-wire subpacket. If the 1-wire data exceeds the maximum allowable radio packet size, then the next radio packet is generated with data from the remaining 1-wire sensors, with a timestamp subpacket attached in front of it.



Radio packet with information about 1-wire sensors

1.4. Subpacket ModBus

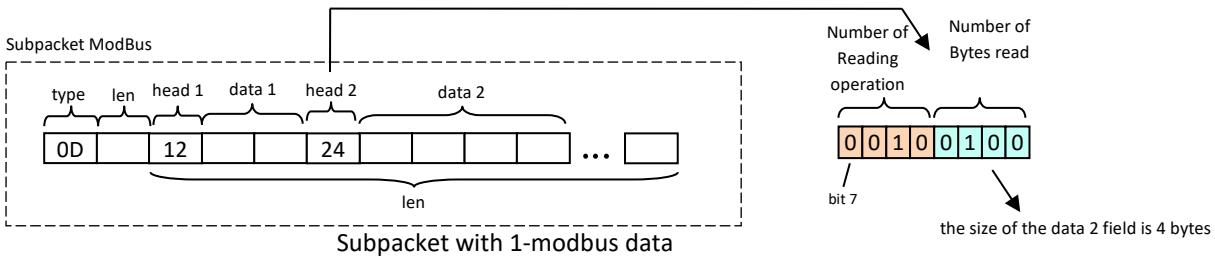
The len byte indicates the size of the data following the len byte (size is in bytes).

The upper nibble of the head byte indicates the number of the read operation, which can take values from 1 to 10. (corresponds to the order of the settings presented on the ModBus Settings tab in the LoRaWAN® configurator). The number of the read operation determines the settings: the ModBus function, the address of the start register for reading, the number of registers / bit to be read.

The least significant tetrad of the head byte indicates the number of subsequent data bytes of the data field

The data field contains the data read from the ModBus device in the specified read operation.

Attention, the format of the data field is big endian.



Subpacket with 1-modbus data

2. Settings packet

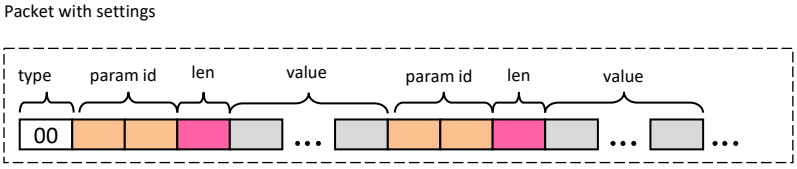
Transmitted to LoRaWAN® port 3 when receiving a command to request settings and after connecting to the network.

param id - unique identifier for the setting (2 bytes)

len - setting length (1 byte)

value - setting value (len bytes)

The device sends settings such as: to request confirmation or not, the number of packet retries, data collection period, transmission period, input mode 1, input mode 2, time zone. A description of the unique identifier codes is given in the table below.



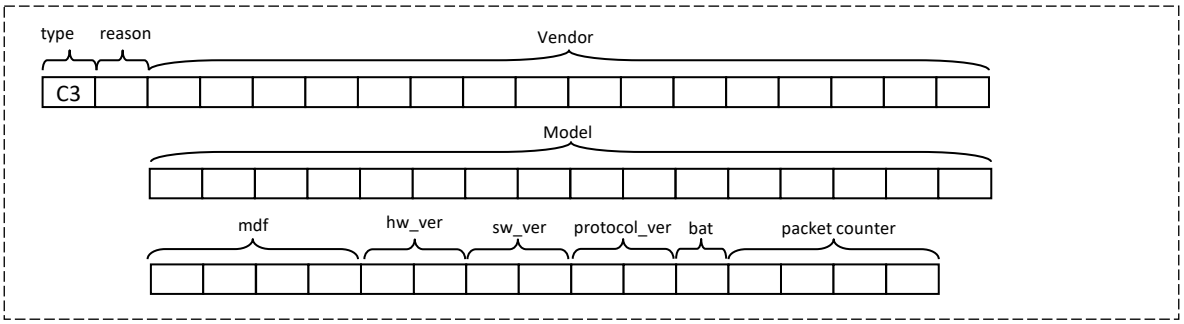
Number of parameter	Length	Description	Value
16	1 byte	Data transfer period	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours 5 – 5 minutes 6 – 15 minutes 7 – 30 minutes
46	1 byte	Data collection period	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours 5 – 5 minutes 6 – 15 minutes 7 – 30 minutes
55	2 bytes	Time zone, in minutes	from -720 to 840
12	1 byte	Input mode 1	1 – pulse, 2 – security
13	1 byte	Input mode 2	1 – pulse, 2 – security
38	1 byte	Security input triggering type 1	1 – by closing 2 – by opening 3 – by opening and closing
39	1 byte	Security input triggering type 2	1 – by closing

			2 – by opening 3 – by opening and closing
4	1 byte	Ask for confirmation	1 – inquire 2 – not inquire
8	1 byte	Number of packet retries	from 1 to 15

3. Informational packet

Sent to LoRaWAN® port 195. Packet type = 195.

vendor - device manufacturer information (16 bytes)
model - model name (16 bytes)
mdf - firmware date in UTC (4 bytes)
hw_ver - hardware version
sw_ver – software version
protocol_ver – protocol version
bat – battery charge (percentage)
packet_counter - the current value of the packet counter
The size of the information packet is 49 bytes.



In the information packet, the reason field:

Reason	Event
0	Default packet
1	Packet on request

4. Packet with time correction request

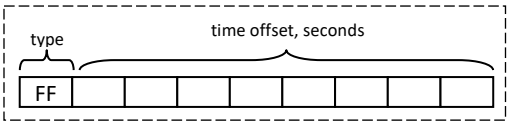
Sent to LoRaWAN® port 4, packet type 255. In response to this packet, the application will send a packet with time correction.

VEGA SH-02 MODEM RECEIVES PACKETS OF THE FOLLOWING TYPES

1. Packet with time correction

Transmitted by the application to LoRaWAN® port 4. Upon receiving the packet, the device will set its internal clock in accordance with the data from the packet. Packet type = 255.

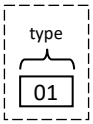
time offset - the amount by which the device time is shifted (in seconds).



The packet size is 9 bytes.

2. Packet with request of settings

Transmitted by the application to LoRaWAN® port 3, packet type 1. In response to this packet, the device will send a packet with settings.



3. Packet with settings

Sent by the application to LoRaWAN® port 3, packet type 0.

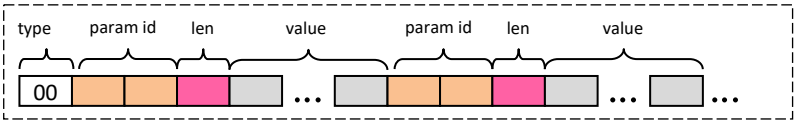
The settings packet transferred to the device may not contain all the settings supported by the device, but only the part of them that needs to be changed.

param id - unique identifier for the setting (2 bytes)

len - setting length (1 byte)

value - setting value (len bytes)

Packet with time correction



5 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega SH-2 modems 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 can lead to battery passivation

6 CONTENT OF THE PACKAGE

The modem is delivered complete with:

Vega SH-2 universal modem – 1 pc.

Antenna – 1 pcs.

6400 mAh battery – 1 or 2 pcs. [2]

Factory certificate – 1 pc.

[2] The number of delivered batteries depends on the order 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 for the battery is 36 months or 40,000 (for one battery) / 80,000 (for two batteries) packages sent, whichever comes first.

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, Bolshevistskaya Str., Novosibirsk, 630009, Russia.

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

e-mail: remont@vega-absolute.ru

DOCUMENT INFORMATION	
Title	LoRaWAN® universal modem Vega SH-02
Document type	Manual – Translation from Russian
Document number	V02-SH2-01
Revision and date	07 by 20 Sept 2021

Revision History

Revision	Date	Name	Comments
01	25.03.2019	KEV	Document creation date
02	05.04.2019	KEV	Case dimensions are changed
03	15.07.2019	KEV	Minor changes
04	09.10.2019	KEV	Description of data collection and transmission settings through the LoRaWAN® was supplemented
05	22.10.2019	KEV	Device operates only as LoRaWAN® class A device, communication protocol changed
06	06.07.2020	KEV	Scheduled revision of the document, minor changes
07	20.09.2021	KMA	Revision of the document due to the change in firmware. Scheduled revision, new sections, new warranty

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