LORAWAN PULSE COUNTER

VEGA SI-12

USER MANUAL

DOCUMENT REVISION	FIRMWARE VERSION
14	2.3

CONTENTS

INTRODUCTION

This manual is designated for Vega SI-12 pulse counter (hereinafter – the 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 for 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 SI-12 pulse counter is designed for counting of pulses incoming to 4 independent inputs, further accumulating and transmitting of this information to the LoRaWAN® network.

In addition, Vega SI-12 can be used as a security device - all inputs can be configured as security inputs.

The counter has two open-collector digital outputs and can be used as a control device.

The pulse counter can be used for any utilities' meters and industrial equipment with pulse output of dry reed switch type or open-drain type.

> **Equipment with NAMUR pulse output is not supported**

The pulse counter has a pulse filtering function with adjustable minimum duration in ms for the pulse and for the pause separately. Counting is performed only for pulses passing the filter.

The counter is powered by a SAFT LS 17500 battery with capacity 3600 mAh. The counter also can be powered by the 5V external power supply.

> **The device is powered by a non-rechargeable lithium-thionyl chloride (LiSOCl₂) battery**
> **Attempts to charge the battery may result in fire**

COMUNICATION AND DATA COLLECTION ALGORITHM

Vega SI-12 operates in modes listed below:

"Storage" – is a mode for storing and transporting. In this mode the device does not communicate regularly with the network.

"Active" – is a main mode of device operation.

Before start using you need to switch the device out of "Storage" mode.

Vega SI-12 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 5 seconds) and switches to the "Active" mode. If all attempts fail, the counter will continue to accumulate data and will attempt to connect to the network every 6 hours.

Hold the start button pressed (min. 5 seconds) to switch the device from the "Active" mode back to the "Storage" mode.

> **When switching to the "Storage" mode, all readings from the pulse inputs accumulated in the device memory are reset**

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.

The adjustable data transfer period can be from 5 minutes to 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

Transmission period is 30 minutes, and device was started at 16:40 by the internal device clock. In random way the device calculate data transmitting time and set it at 16:41 in the half-hour period from 16:40 to 17:10. Thus, packets from this device will transmit at 16:41, at 17:11, at 17:41, at 18:11 and so on every 30 minutes by the internal device clock.

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

FUNCTIONAL

Vega SI-12 pulse counter can be either of A class or C class (LoRaWAN® classification) and has the following features:

- Automatic change from A class to C class when powered from an external power supply
- ADR support (Adaptive Data Rate)
- Sending of confirmed packets (configurable)
- Simultaneous readings from 4 independent inputs
- Configurable duration for pulse and pause for pulses filtering
- Two open-drain outputs
- Two operating modes: "Active" and "Storage"
- Inputs switching to the "Security" mode for connection of leakage, safety, and other external sensors
- 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	
Double-contact digital inputs	up to 4
Maximum input frequency	200 Hz
Security inputs	up to 4
Open-drain outputs	2
USB-port	mini-USB, type B
Operating temperatures	-40...+85 °C
Built-in temperature sensor	yes
LORAWAN®	
LoRaWAN® class	A or C depending on presence of the external power supply
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
Communication period	5, 15, 30 minutes, 1, 4, 6, 12 or 24 hours
Data collection period	5, 15, 30 minutes, 1, 4, 6, 12 or 24 hours
Memory amount for storing packets	200 packets
Type of the LoRaWAN antenna	internal
Sensitivity	-138 dBm
Radio coverage in restrained urban conditions	up to 5 km
Radio coverage within line of sight	up to 15 km
Maximum transmitter power	100 mW
POWER	
External power supply	5 V
Battery	SAFT LS 17500 3600 mAh
Calculated number of packets sent by the device with default settings	80 000
CASE	
Housing dimensions, no more than	90 x 49 x 46 mm
Ingress protection rating	IP65
Mounting	Clamp fastening to the support, DIN-rail, wall-mounting

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
Pulses filtering settings	50 ms for pulse and pause

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 SI-12 is represented in small plastic case which has four screws and mounting for DIN-rail.

1

2

3
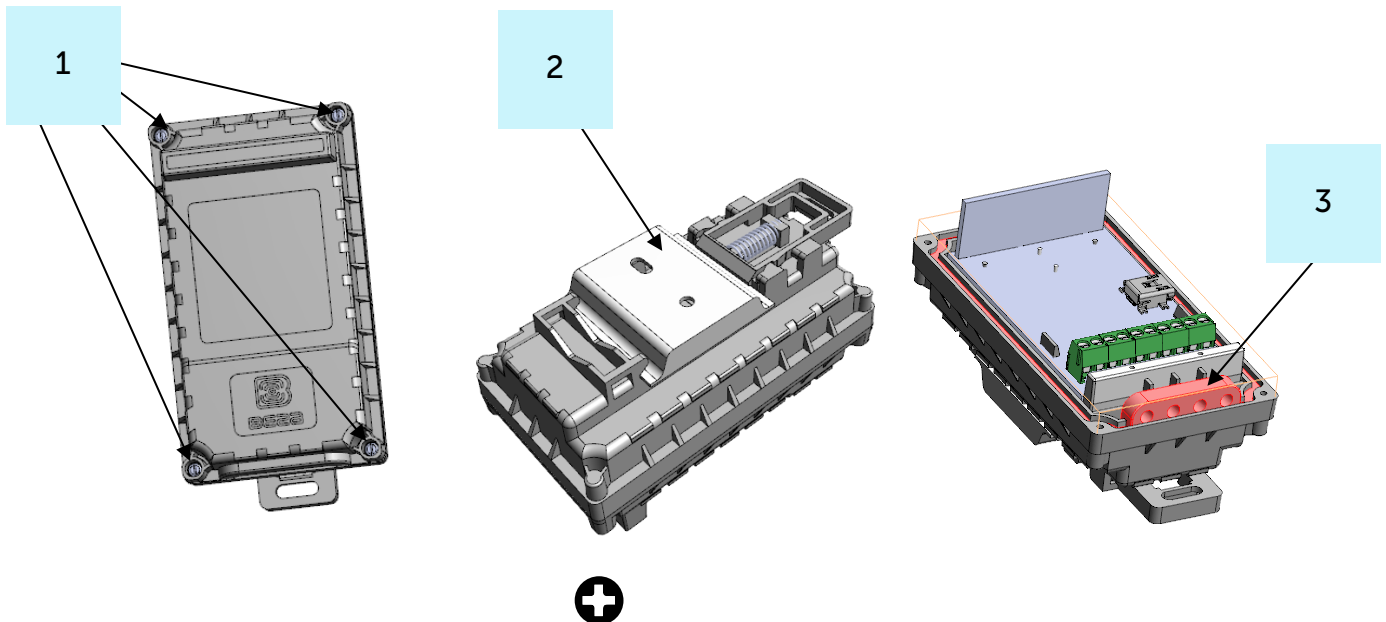
2 – DIN-rail with mounting holes ø 3 mm

3 – silicone gasket without through holes, ensuring the protection rating of the device case IP65.

All of elements for manage and indication as well as connecting contacts are placed on the board inside the case.
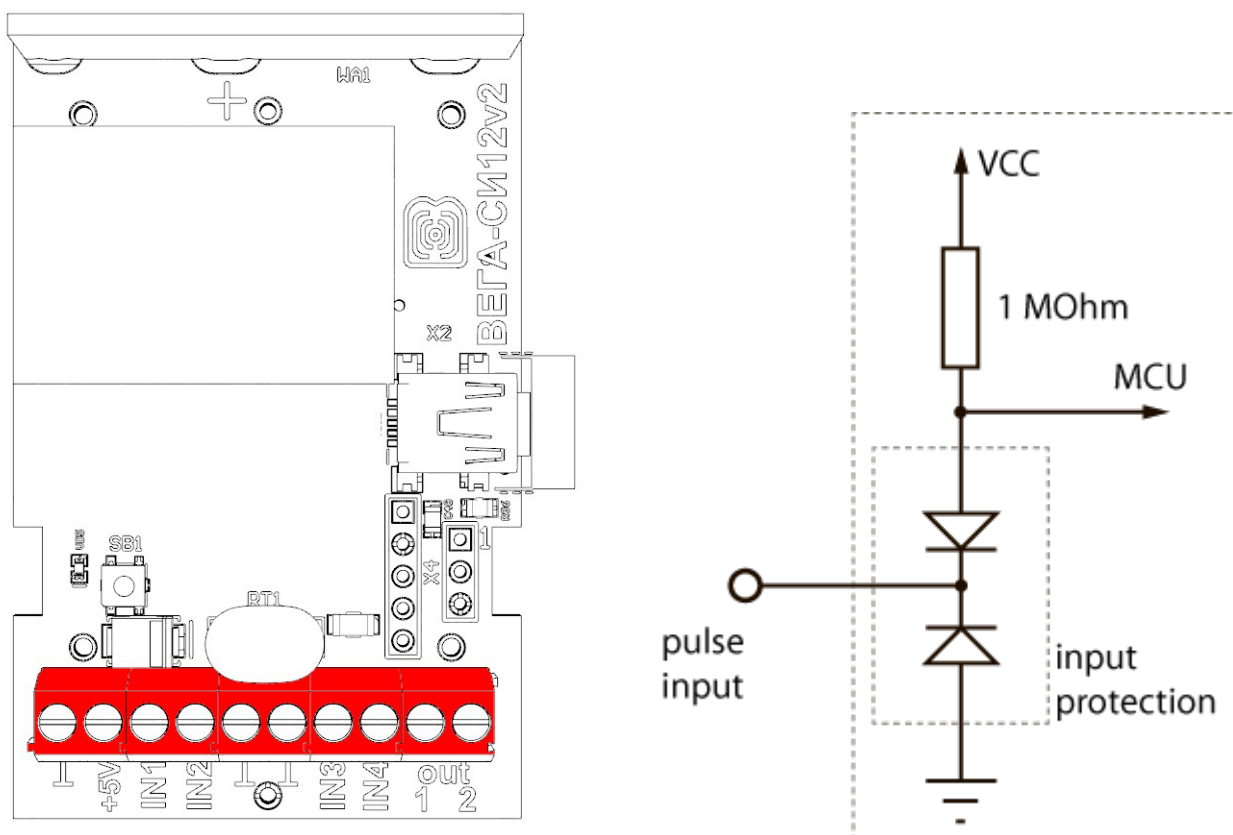
4

5

7

6
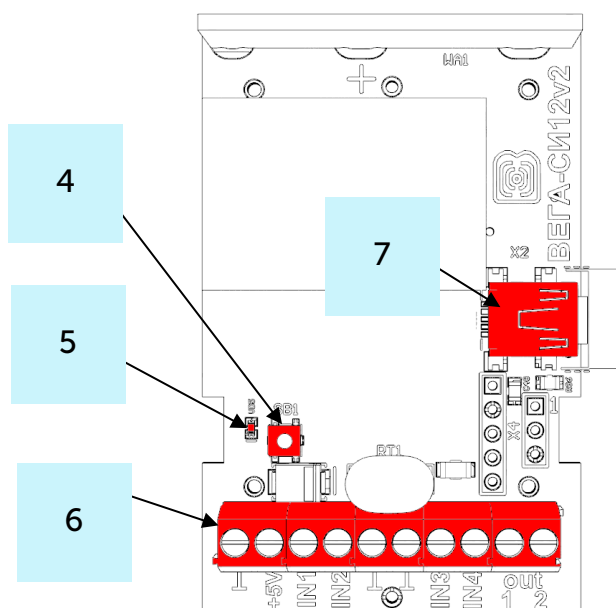
4 – launch button

5 – LED indicator

6 – contacts

7 – USB-port

CONTACTS DESCRIPTION

When connecting a radio modem to external devices, consider the internal circuitry of its pulse inputs shown below.

CONTACT	DESCRIPTION
⊥	Power -
+5V	Power +
IN1, IN2, IN3, IN4	Pulse inputs
⊥ , ⊥	Signal ground
out 1 out 2	Open-collector outputs 1 and 2

Ground contacts (⊥,⊥) are used for connection of pulse inputs IN1, IN2, IN3 and IN4.

The pulse counter has a pulse filtering function with adjustable minimum duration in ms for the pulse and for the pause separately. Counting is performed only for pulses passing the filter.

The pulse counter has 4 pairs of contacts that is allows to connect circuits with the following types of NO contacts:

- ⊙ reed switch;

- ⊙ mechanical pushbutton;

- ⊙ open-collector output.

> **Equipment with NAMUR pulse output is not supported**

Polarity effects only "open collector" circuits.

To reset all readings from the pulse inputs accumulated in the device memory you need to switch the device to the "Storage" mode by holding the start button pressed (min. 5 seconds).

Pulse inputs can be configured for work in the "Security" mode via the "Vega LoRaWAN Configurator" application. In this mode, the device does not count pulses at the "Security" input, but only monitors its status. Should the "Security" input trigger, the device is activated and sends an alarm message to the network.

The maximum possible frequency of sending alarm packets is one per 1 second.

The actuators are connected to the counter via outputs out 1 и out 2, which are of the type "Open-drain".

> **Permissible load for each digital output is 0.2 A**

To increase the load on the device outputs, it is necessary to use an external relay. The relay connection scheme is shown below.

+(12...30) V

Direct current diode 1A and reverse voltage not less than 50 V

out 1
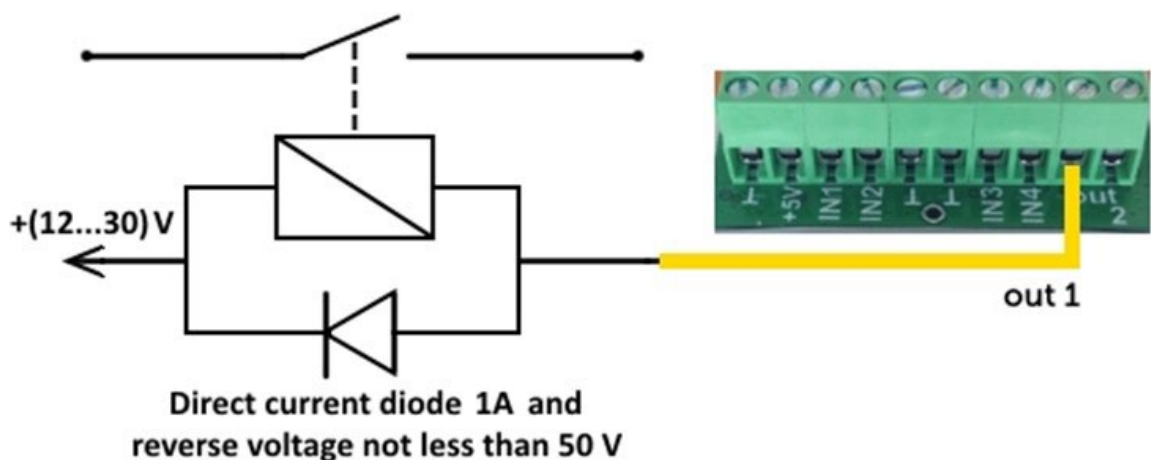
LED INDICATIONS

There is one red LED on the board. The indication is only used when the device is activating in the LoRaWAN® network and when the operating modes are changing.

LED location on the board
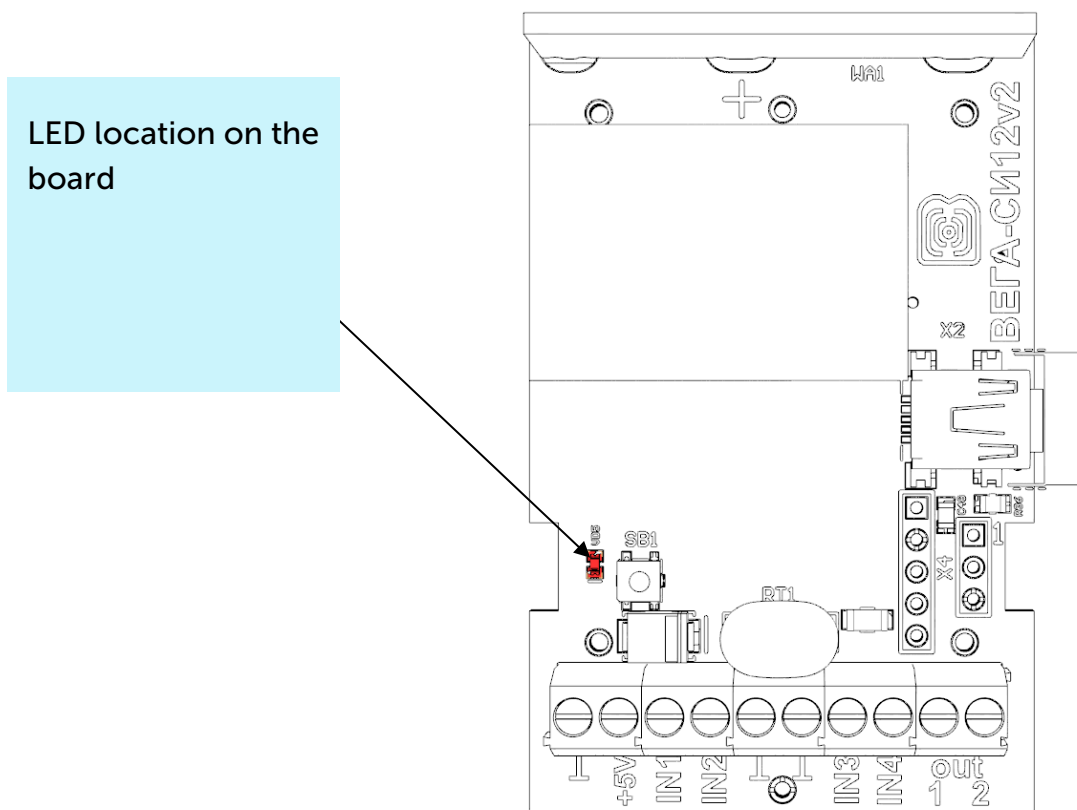
LED SIGNAL		MEANING
▮▮▮▮▮▮▮▮▮	Short flashings	Linking to the network in progress
▬▬▬▬▬	One long flashing during 5 sec	The device has been successfully connected to the network and is in active mode
▮▮▮▯▯▯	Three flashings each by 1 sec	Linking to the network has been failed or the device switched to the "Storage" mode

In case of connection attempt fail, the device will continue to accumulate data and will attempt to connect to the network every 6 hours

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:

- ◉ cross-shaped screwdriver ✚;
- ◉ awl;
- ◉ 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. Making holes in the silicone gasket for wires - strictly according to the number of wires. It must be remembered that the wire must be of circular cross-section and no more than 3 mm in diameter.

> **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 SI-12 contacts.
6. Device launching – switching to the "Active" mode and registration in the network.

Location of the launch button on the board
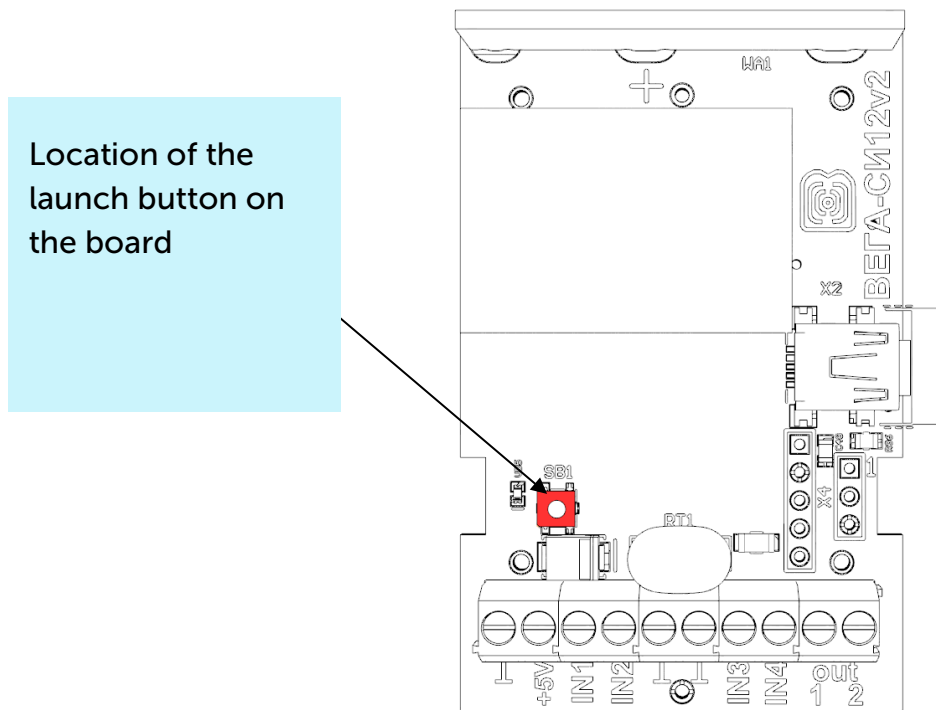
7. By the laptop you can make sure that the device successfully sends the data.
8. Before assembling the device, it is necessary to reset the pulses accumulated during testing and connection by switching the device to the "Storage" mode by pressing the button for 5 seconds.
9. Start the device by pressing launch button.
10. Assembling the device.
11. DIN-rail mounting or another available way to mount the device on the object.

4 COMMUNICATION PROTOCOL

This part describes the SI-12 communication protocol with LoRaWAN® network.

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

VEGA SI-12 PULSE COUNTER TRANSMITS THE FOLLOWING TYPES OF PACKETS

1. Packet with current readings

Sent regularly on LoRaWAN® port 2.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 1	uint8
1 byte	Battery charge, %	uint8
1 byte	Values of basic settings (bit field)	uint8
4 bytes	Reading time for values in this packet (unixtime UTC)	uint32
1 byte	Temperature, °C	int8
4 bytes	Input 1 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	Input 2 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	Input 3 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	Input 4 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32

The counter has internal clock and calendar; time and date are factory set. When sending a packet with the current readings, the device uses the data taken at the nearest time, which is multiple to the interval according to data collection period:

- ◉ 1 hour period: the readings of the beginning of the current hour are sent;
- ◉ 6 hours period: 00:00, 06:00, 12:00, 18:00 readings are sent;
- ◉ 12 hours period: 00:00, 12:00 readings are sent;
- ◉ 24 hours period: the readings of 00:00 of the current day are sent.

"Values of basic settings" bit field decoding

Bit	Meaning
0 bit	Activation type: 0 - OTAA, 1 – ABP
1, 2, 3 bits	Communication period: |1 == 0|2==0|3==0| - 5 minutes |1 == 1|2==0|3==0| - 15 minutes |1 == 0|2==1|3==0|- 30 minutes |1 == 1|2==1 |3==0|- 1 hour |1 == 0|2==0|3==1|- 6 hours |1 == 1|2==0|3==1|- 12 hours |1 == 0|2==1|3==1|- 24 hours
4 bit	First input type: 0 – pulse, 1 - security
5 bit	Second input type: 0 – pulse, 1 - security
6 bit	Third input type: 0 – pulse, 1 - security
7 bit	Fourth input type: 0 – pulse, 1 - security

2. "Alarm" packet

Packet sent in case of security input closure on LoRaWAN® port 2.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 2	uint8
1 byte	Battery charge, %	uint8
1 byte	Values of basic settings (bit field)	uint8
1 byte	Input No, where the alarm is detected (1...4)	uint8
4 bytes	Time of the modem at a moment of the packet transmission (unixtime UTC)	uint32
4 bytes	Input 1 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	Input 2 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	Input 3 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32
4 bytes	Input 4 reading (depending on the type – number of pulses or status: 0 – open, 1 - closed)	uint32

When sending alarm packet, the device uses the data taken at moment of alarm triggers.

3. External power information packet

Sent in case of change external power status on LoRaWAN® port 2.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 4	uint8
1 byte	Battery charge, %	uint8
1 byte	Values of basic settings (bit field)	uint8
1 byte	External power state (0 – off, 1 - on)	uint8
4 bytes	Generation packet time (unixtime UTC)	uint32

4. Output state information packet

Sent in case of change output state on LoRaWAN® port 2.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 5	uint8
1 byte	Battery charge, %	uint8
1 byte	Values of basic settings (bit field)	uint8
1 byte	Output number (1-2)	uint8
1 byte	New output state (0 – off, 1 - on)	uint8
4 bytes	Generation packet time (unixtime UTC)	uint32

5. Packet with digital inputs state

Sent by device on LoRaWAN® port 2 when the packet with request.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 6	uint8
4 bytes	Time of the modem at a moment of the packet transmission (unixtime UTC)	uint32
2 bytes	Inputs state (bit field)	uint16
2 bytes	Outputs state (bit field)	uint16
4 bytes	Input 1 state (pulse number if the input is configured as pulse, or 0xFFFFFFFF if the input is configured as security)	uint32
4 bytes	Input 2 state (pulse number if the input is configured as pulse, or 0xFFFFFFFF if the input is configured as security)	uint32
4 bytes	Input 3 state (pulse number if the input is configured as pulse, or 0xFFFFFFFF if the input is configured as security)	uint32
4 bytes	Input 4 state (pulse number if the input is configured as pulse, or 0xFFFFFFFF if the input is configured as security)	uint32
1 byte	External power flag (00 – external power is disconnected, 01 – external power is connected)	uint8

"Inputs state" bit field decoding

Bit	Meaning
0 bit	First input type: 0 – pulse, 1 - security
1 bit	Second input type: 0 – pulse, 1 - security
2 bit	Third input type: 0 – pulse, 1 - security
3 bit	Fourth input type: 0 – pulse, 1 - security
4...7 bits	*Reserved*

"Outputs state" bit field decoding

Bit	Meaning
0 bit	First output state: 0 – OFF, 1 - ON
1 bit	Second output state: 0 – OFF, 1 - ON
2...7 bits	*Reserved*

6. Packet with time correction request

Sent every seven days on LoRaWAN® port 4.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 255	uint8
4 bytes	Time of the modem at a moment of the packet transmission (unixtime UTC)	uint32

After receiving this type of package, the application can send to modem the packet with time correction.

7. Settings packet

Transmitting on LoRaWAN® port 3 when settings request command received, or device connected to the network.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 0	uint8
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len byte	Parameter value	-----
...	...	...
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----

VEGA SI-12 PULSE COUNTER RECEIVES PACKETS OF THE FOLLOWING TYPES

1. Real-time clock adjustment

   Sent by application on LoRaWAN® port 4.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 255	uint8
8 bytes	The value in seconds for which you need to adjust the time. Can be positive or negative	int64

   When receiving the packet, the pulse counter sets its internal clock and calendar in compliance with the received packet.

2. Output on command

   Sent by application on LoRaWAN® port 2.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 3	uint8
1 byte	Output no. (1 or 2)	uint8
1 byte	Output on time in seconds (1...255, 0 - forever).	uint8

3. Output off command

   Sent by application on LoRaWAN® port 2.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 4	uint8
1 byte	Output no. (1 or 2)	uint8

4. Packet with request of digital inputs state

   Sent by application on LoRaWAN® port 2.

Size in bytes	Field description	Data type
1 байт	Packet type, this packet == 6	uint8

   Answering this packet, the device sent the packet with digital inputs state.

5. Packet with request of settings

   Sent by application on LoRaWAN® port 3.

Size in bytes	Field description	Data type
1 байт	Packet type, this packet == 1	uint8

   Answering this packet, the device sent the packet with settings.

6. Packet with settings

Sent by application on LoRaWAN® port 3, identical to such packet from device.

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 0	uint8
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len byte	Parameter value	-----
...	...	...
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----

The package with settings sent to the device may not contain all the settings supported by the device, but only the part that needs to be changed.

Table of ID of SI-12 parameters and these possible values

ID of parameter	Description	Data length	Possible values
4	Confirmed uplinks	1 byte	1 – confirmed 2 – unconfirmed
8	Uplinks number of transmissions	1 byte	from 1 to 15
12	Input 1 mode	1 byte	1 – pulse 2 – guard
13	Input 2 mode	1 byte	1 – pulse 2 – guard
14	Input 3 mode	1 byte	1 – pulse 2 – guard
15	Input 4 mode	1 byte	1 – pulse 2 – guard
16	Communication period	1 byte	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours 5 – 5 minutes 6 – 15 minutes 7 – 30 minutes
49	Data collection period	1 byte	1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours 5 – 5 minutes 6 – 15 minutes

			7 – 30 minutes
55	Time zone, in minutes	2 bytes	from -720 to 840

5 STORAGE AND TRANSPORTATION REQUIREMENTS

Vega SI-12 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 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 SI-12 pulse counter – 1 pc.

Screw – 4 pcs.

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 if the number of data packets sent by the product is up to 25,000.

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	Pulse Counter Vega SI-12
Document type	Manual – Translation from Russian
Document number	V02-SI12-01
Revision and date	14 of 3 February 2022

Revision History

Revision	Date	Name	Comments
01	20.03.2017	KEV	Document creation date
02	14.04.2017	KEV	Photos was added, minor edits
03	10.05.2017	KEV	New photos of appearance
04	17.06.2017	PKP	Protocol changed
05	11.07.2017	PKP	Fixed error in protocol description
06	16.08.2017	PKP	Adding's in alarm command description
07	07.09.2017	KEV	Part "Vega LoRaWAN Configurator" was added
08	18.10.2017	KEV	Warranty conditions was changed, minor edits
09	04.05.2018	KEV	Edits concerning the field of application with meters with pulse outputs, minor edits, new illustrations in the "Operation" part
10	22.01.2019	KEV	Readings reset by pressing the button described, internal circuit scheme added, communication protocol changed, setting via 'air' described. Frequency plans added, specification changed, blackbox described, warranty changed, configurator updated. "Marking" part added.
11	24.01.2019	KEV	Inaccuracy in communication protocol fixed – packet type for packets with settings and request of settings
12	03.07.2020	KEV	Scheduled revision of the document, minor changes
13	04.08.2021	PAV	Scheduled revision of documentation. New warranty conditions, new parts
14	03.02.2022	KEV	New packets with request of digital inputs state and answering this in the communication protocol (type packet is 6), new period of data collection and communication is 4 hours, anti-bounce algorithm is replaced with configurable function of pulses filtering