



MOTION SENSOR

SMART-MS0101

User Manual



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02	08.08.2018	KEV	Technical characteristics are added, new part is added
03	28.09.2018	KEV	Typo at the communication protocol was fixed
04	22.01.2019	KEV	Communication protocol changed, setting via 'air' described. Frequency plans added, specification changed, warranty changed, configurator updated. "Marking" part added, "Indication" part changed
05	24.01.2019	KEV	Inaccuracy in communication protocol fixed – packet type for packets with settings and request of settings
06	17.06.2019	KEV	Inaccuracy in the table of settings fixed – setting 43 is 1-byte size
07	15.08.2019	KEV	Added new functionality's description, it's a sending message when the device arming
08	03.10.2019	KEV	Fixed an error in the device arming setting, p.27
09	15.04.2020	KEV	Tilt angle is changed from 6 to 12° and minor changes
10	07.12.2020	KEV	Changes in specification
11	21.01.2021	KEV	Operation temperature range is changed

CONTENTS

- INTRODUCTION 4
- 1 DESCRIPTION AND OPERATION 5
 - Device description 5
 - Communication and data collection algorithm 5
 - Functional 6
 - Marking 6
- 2 SPECIFICATION 7
- 3 OPERATION 8
 - Indication 8
 - Initial startup 9
 - Sensor mounting recommendations 11
 - Connecting via USB 12
- 4 VEGA LORAWAN CONFIGURATOR 14
 - Interface of the application 14
 - Connection to the device 16
 - “Device info” tab 17
 - “LoRaWAN settings” tab 19
 - “Smart-MS0101” tab 23
- 5 COMMUNICATION PROTOCOL – 2.0 VERSION 24
 - SMART-MS0101 transmits the following types of packets 24
 - SMART-MS0101 transmits the following types of packets 26
- 6 STORAGE AND TRANSPORTATION REQUIREMENTS 28
- 7 CONTENT OF THE PACKAGE 29
- 8 WARRANTY 30

INTRODUCTION

This manual is designated for Vega Smart-MS0101 motion sensor (hereinafter – device, sensor) manufactured by Vega-Absolute OOO and provides information on powering and activation procedure, control commands and functions of the device.

This manual is targeted at specialists familiar with installation work fundamentals for electronic and electrical equipment.



To provide the stable radio between the gateway and the end device it is recommend 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

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

Infrared motion sensor Vega Smart-MS0101 is designed to detect penetration into the protected area.

The sensor alternately operates in two modes: «Guard» and «Neutral». In the «Guard» mode, the device sends an alarm message to the LoRaWAN network when motion is detected, after which it switches to the «Neutral» mode for a while. In the «Neutral» mode, the sensor does not send alarm messages when motion is detected.

If the movement in the protected area has ceased, then the device switches back to the «Guard» mode after a certain configurable period. There is an option of message sending when the device switched to the "Guard" mode (configurable through the «Vega LoRaWAN Configurator»)

The device arming time interval is setting up by the «Vega LoRaWAN Configurator» application and may vary from 1 to 60 minutes.

Vega Smart-MS0101 can be used to protect premises, buildings and structures, as well as in Smart Home systems, built on LoRaWAN technology.

The sensor is powered by a CR123A 1400 mAh replaceable battery.

The adjustable data transfer period can be from 5 minutes to 24 hours. Data transferring in random point in time during set period.

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

COMUNICATION AND DATA COLLECTION ALGORITHM

The device forming a data packet with a configurable period from 5 minutes to 24 hours. The data saving in device memory and transmitting during the next communication session with the LoRaWAN network.

If there is no alarm mode, then 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.

When alarm situation appears, the device forming alarm packet and transferring it immediately.

With the "Confirmed uplinks" option turned on, the device will send the next packet only after receiving a confirmation of the delivery of the previous one. If such confirmation has not received after the fulfilled in the settings uplink number of transmissions, device

completes the communication session until the next one according to the schedule. In this case, the device continues to form packets according to the communication period and store it in memory. Non-transmitted packets remain in the device memory until the next communication session.

With the "Confirmed uplinks" option turned off, the device just sends all accumulated packets to the network in order from the earliest to the latest. There are no checks of package delivery in this mode. There are no non-transmitted messages in the device memory.

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

FUNCTIONAL

Vega Smart-MS0101 motion sensor is class A device (LoRaWAN classification) and has the following features:

- ADR support (Adaptive Data Rate)
- Sending of confirmed packets (configurable)
- Extra communication in case of alarm event
- Message sending when the device arming
- Two working modes "Neutral" and "Guard"
- Temperature measurement by the internal temperature sensor
- Battery charge measurement (%)
- Sensitivity: up to -138dBm

MARKING

Device marked with sticker that contain the next information:

- Device model;
- DevEUI;
- Month and year of manufacture;
- QR-code containing DevEUI for automatized count.

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

Main

USB-port	mini-USB, type B
Operating temperatures	0...+50 °C
Maximum detection range	not less than 10 m
Range of velocities of the intruder	0.3...3 m/s
Sensor mounting height	2.1 m
Sensor tilt angle in the vertical plane	12°
Sensor viewing angle in the horizontal plane	88,2°
Resistance to external light	6500 lux
Built-in temperature sensor	yes

LoRaWAN

LoRaWAN class	A
Quantity of LoRa channels	16
Frequency plan	RU868, EU868, IN865, AS923, AU915, KR920, US915, KZ865, custom (EU868 based)
Activation type	ABP or OTAA
Communication period	5, 15, 30 minutes, 1, 6, 12 or 24 hours
Memory amount for storing packets	200 packets
Antenna	internal
Sensitivity	-138 dBm
Radio coverage in restrained urban conditions	max 5 km
Radio coverage within line of sight	max 15 km
Transmitter power by default	25 mW (configurable)

Power

Replaceable battery	CR123A 3V, 1400 mAh
Warranty number of packets sent by the device, not less	9 000

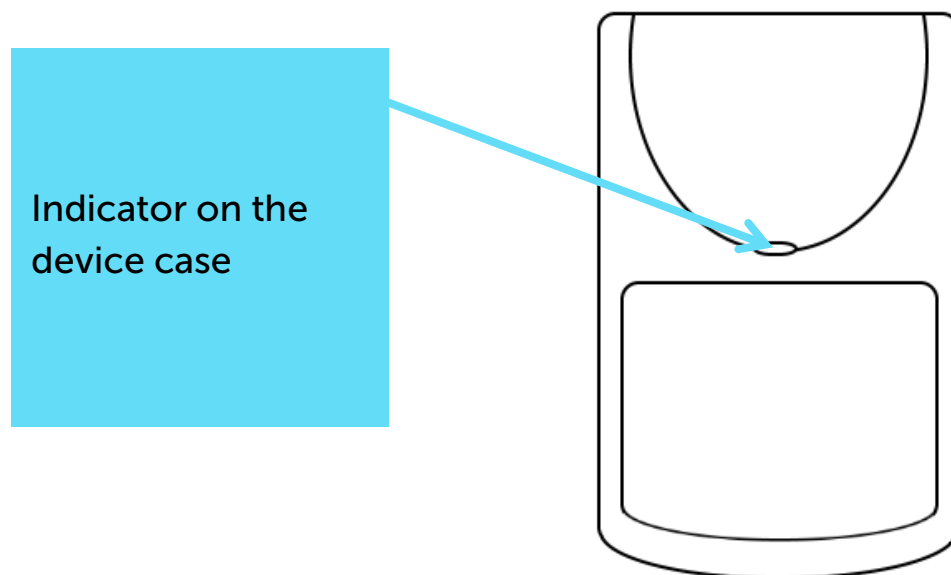
Case

Housing dimensions	35 x 50 x 70 mm
Ingress protection rating	IP41

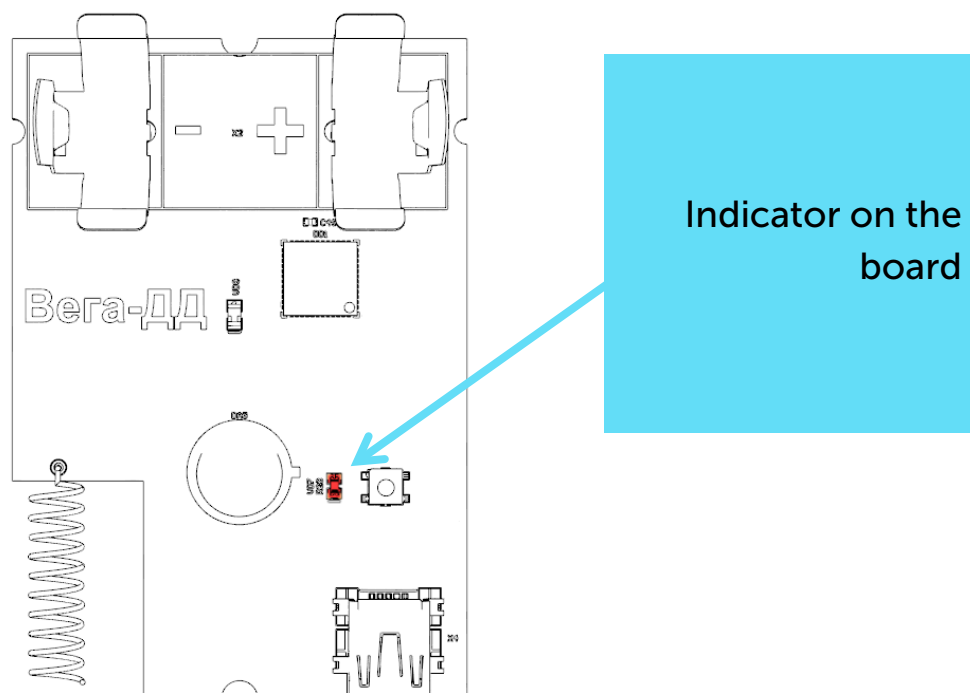
3 OPERATION




INDICATION

A double color indicator is located on the front of the sensor case and it flashes red when detect motion in the protected area.



One more indicator is located on the board and it shown only when cover off and displays a linking to the network state.



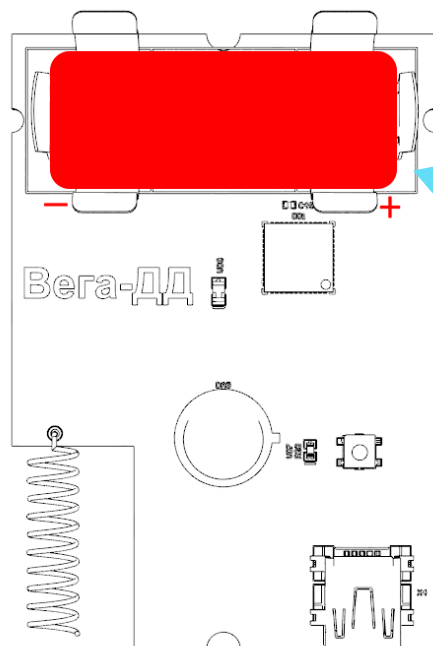
LED signal		Meaning
	Series of short flashings	Linking to the network
	One long flashing	The device connected to the network and is in active mode
	Three long flashings	Linking to the network is unsuccessful or the device switched to the «Storage» mode



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

INITIAL STARTUP

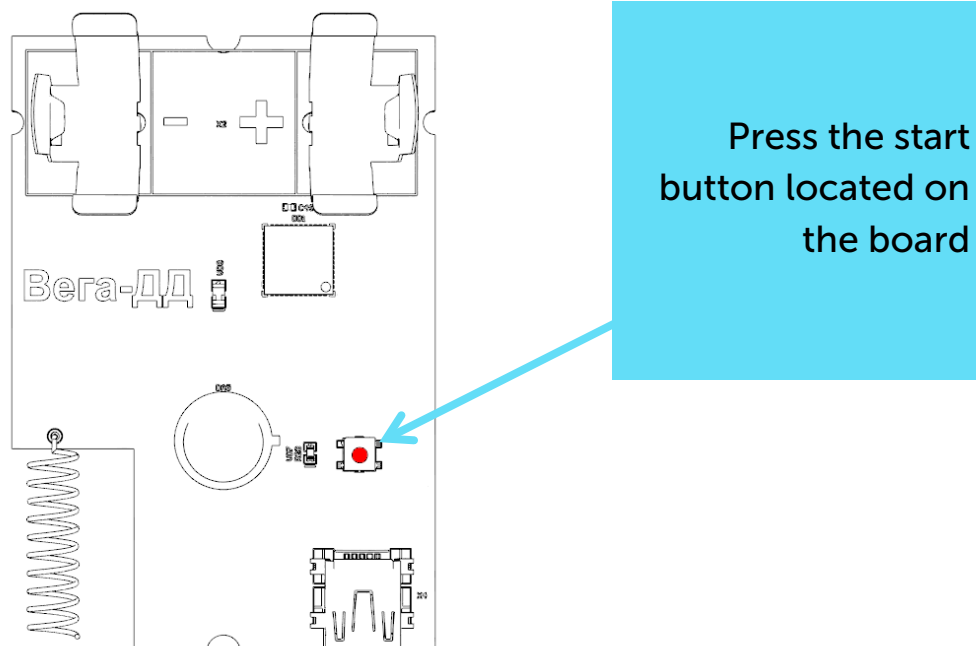
Motion sensor is powered by the CR123A 3V 1400 mAh replaceable battery. You need to insert the battery observing the polarity before start.



Place the CR123A battery in the battery compartment

The sensor supports two activation methods in the LoRaWAN network - ABP and OTAA. Select one of the methods using "Vega LoRaWAN Configurator" application (See part 4).

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



2. OTAA. After pressing the start button, the device makes three attempts to connect to the network within the set frequency plan. After the activation request is confirmed by LoRaWAN network, the device sends a signal and switches to the "Active" mode. If all attempts fail, the sensor will continue to accumulate data and will attempt to connect to the network every 6 hours.

To manually switch the device from the "Active" mode to the "Storage" mode, you can use the long press of the start button (more than 5 seconds).



Before connecting the device, make sure that its registration data is entered in the network - Device EUI, Application EUI and Application Key for OTAA, or Device address, Application session key and Network session key for ABP

SENSOR MOUNTING RECOMMENDATIONS

The sensor must be installed in such a way that the probable penetration paths of the intruder cross the central axis of the detection zone.

Recommended mounting height of the sensor is 2...2,5 m.

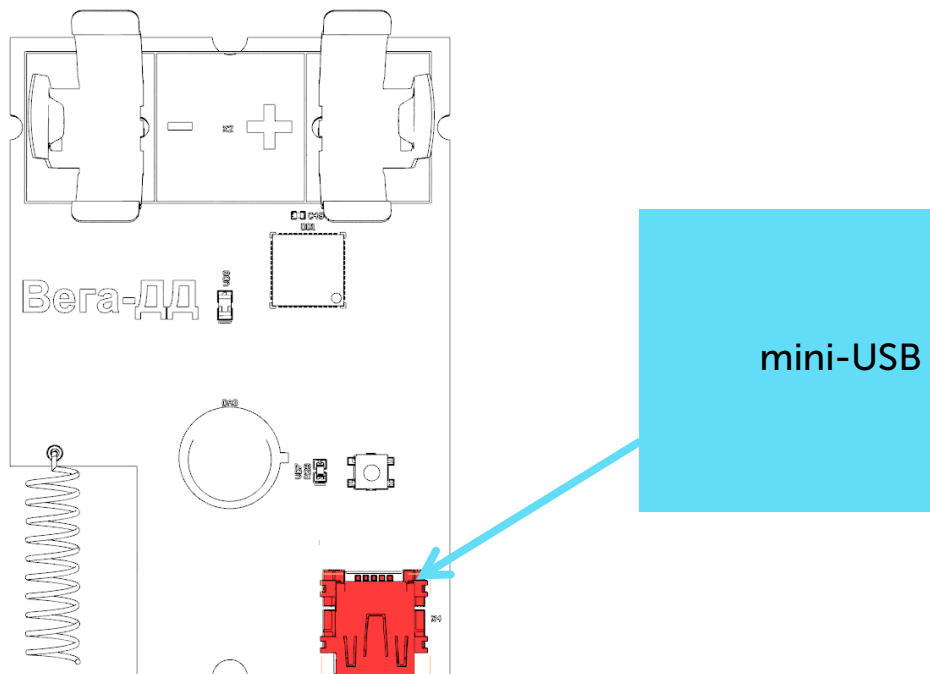
Do not install the sensor near objects that are powerful sources of heat or having the ability to quickly change their temperature (fireplaces, stoves, air conditioners, radiators, etc.), in places with strong air currents or the possibility of direct sunlight.

The wall on which the sensor is mounted should not be subjected to strong vibrations.

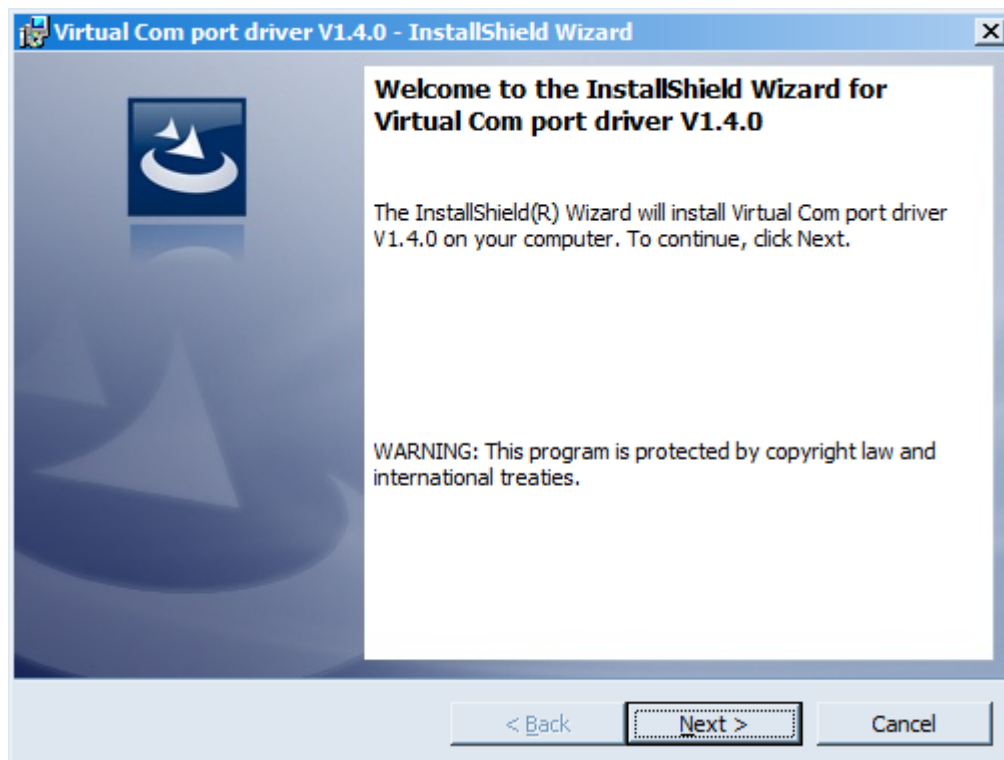
The presence in the detection zone of objects (curtains, screens, large objects, furniture, plants, etc.) creates behind them "dead zones", the detection of the offender behind these objects may not occur.

CONNECTING VIA USB

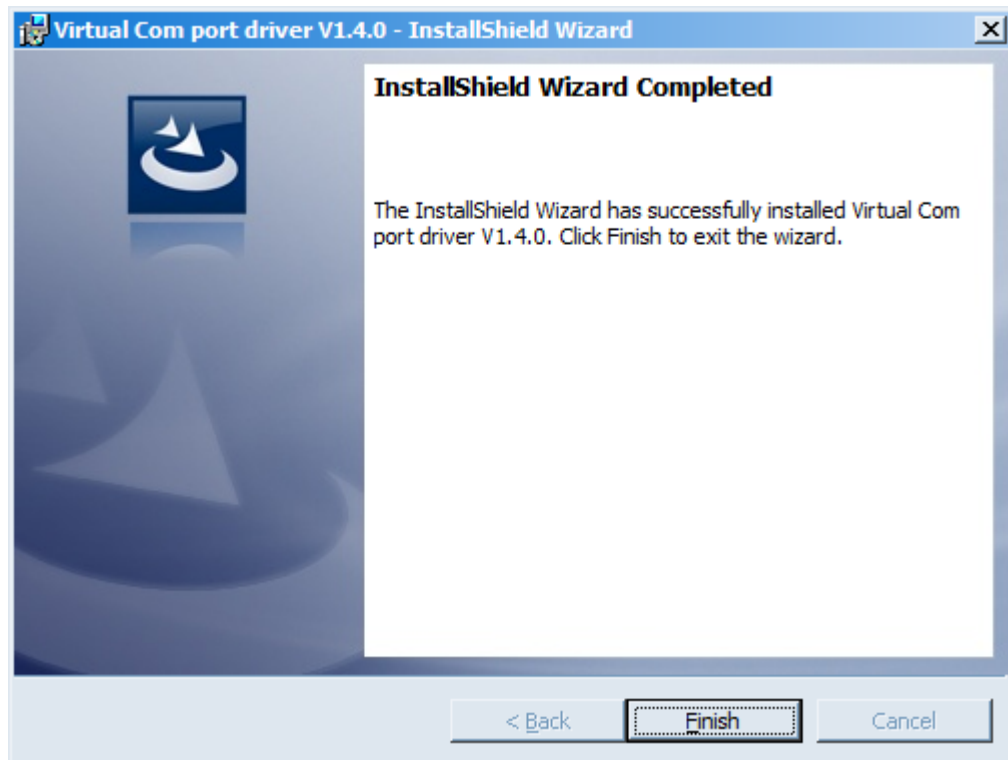
The device Smart-MS0101 can be configured with the "Vega LoRaWAN Configurator" application (See part 4).



Before connecting the device to the computer for the first time, you must install the driver for the COM port `stsw-stm32102`, which can be downloaded from iotvega.com. After running the executable file `VCP_V1.4.0_Setup.exe`, the installer window will appear:



In this window, you need to click **Next**, then **Install**, and then the installation will begin. When the installation is completed successfully, the following screen appears:



After pressing **Finish** the driver is ready for operation, - it is possible to connect the device via USB.

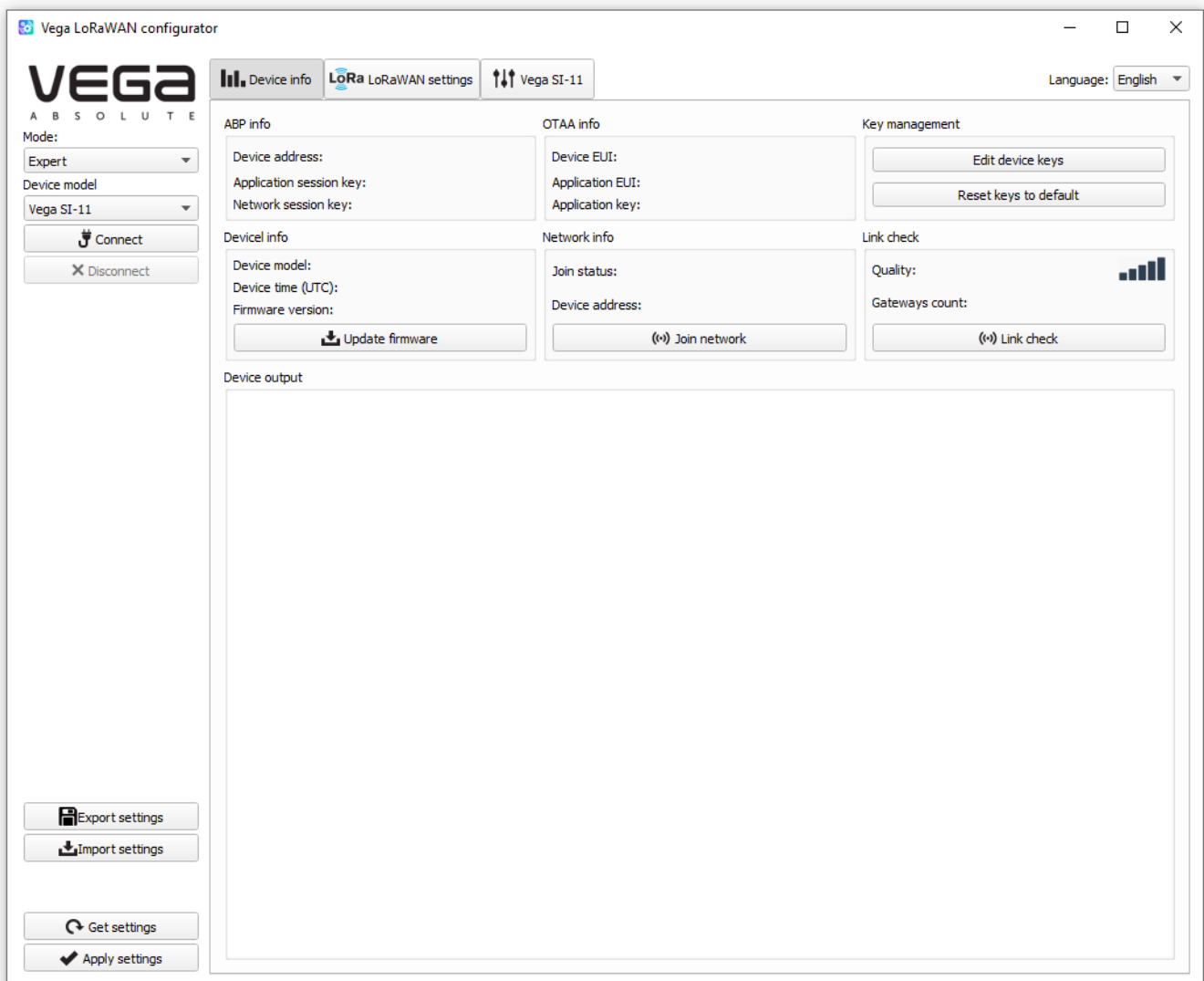
4 VEGA LORAWAN CONFIGURATOR

The "Vega LoRaWAN Configurator" application (hereinafter referred to as the configurator) is intended for setting up the device via USB.

The configurator has two modes of operation - "Simple" and "Expert". In the "Simple" mode, only basic settings are available. In the "Expert" mode the basic settings, advanced settings and the ability to check the coverage area of the signal from the gateways are available. Next, the work of the configurator is considered in the "Expert" mode.

INTERFACE OF THE APPLICATION

The "Vega LoRaWAN Configurator" application does not require the special installation. When the executable file is launched, the window for working with the application appears.



The left side menu allows you to switch between the "Simple" and "Expert" operating modes, select a device model, connect to, or disconnect from a device.

The buttons "Export settings" and "Import settings" allow you to save a set of settings to a file and then load them from a file.

The buttons "Get settings" and "Apply settings" are needed to display the current device settings in the program and to save the changed settings in the device memory, respectively.

The application window contains three tabs – Device info, LoRaWAN settings and device settings.

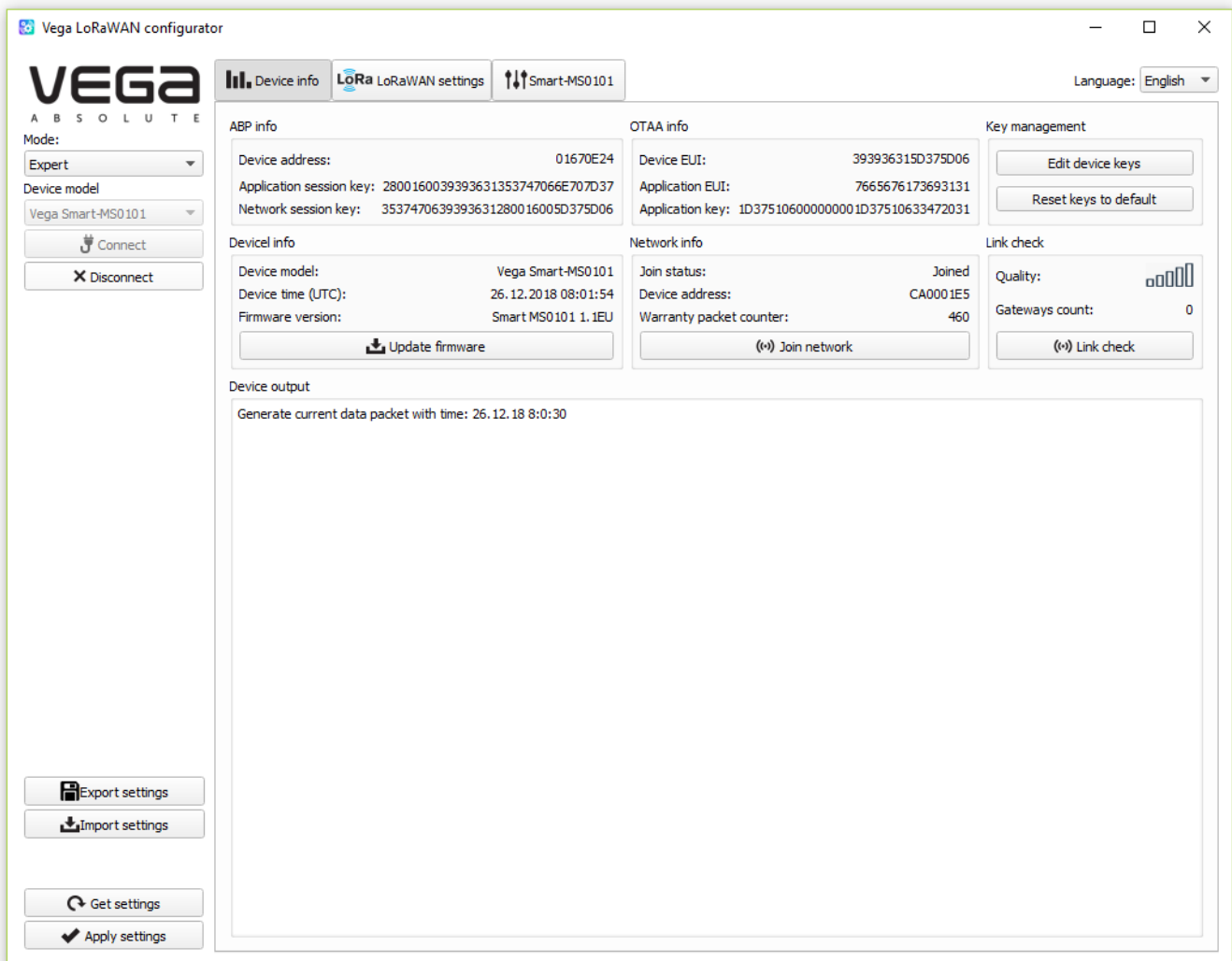
The language selection menu is in the upper right corner.

CONNECTION TO THE DEVICE

For the connection to the device, perform the following steps:

1. Connect the USB cable to the device.
2. Start the "Vega LoRaWAN Configurator" application.
3. Click the "Connect" button in the menu on the left.

The configurator automatically recognizes the type of device, and the device selection menu becomes inactive.

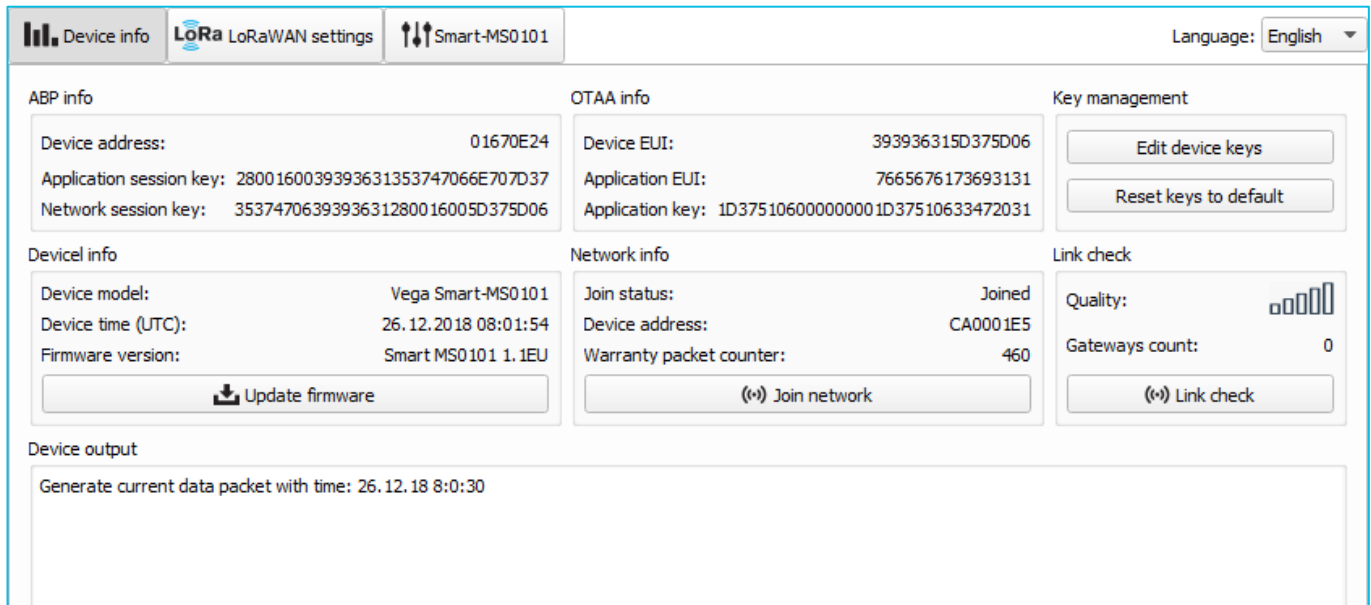


To read the settings from the device, you need to click the "Get settings" button, until this point the application will display the default settings or from the last connected device.

After making the necessary changes to the settings, you should click the "Apply settings" button and only then disconnect from the device with the "Disconnect" button.

"DEVICE INFO" TAB

The "Device info" tab displays information about the device, its current status, and the data needed to register the device in the LoRaWAN network.



The screenshot shows the 'DEVICE INFO' tab with the following content:

- ABP info:** Device address: 01670E24; Application session key: 2800160039393631353747066E707D37; Network session key: 3537470639393631280016005D375D06.
- OTAA info:** Device EUI: 393936315D375D06; Application EUI: 7665676173693131; Application key: 1D375106000000001D37510633472031.
- Key management:** Buttons for 'Edit device keys' and 'Reset keys to default'.
- Device info:** Device model: Vega Smart-MS0101; Device time (UTC): 26.12.2018 08:01:54; Firmware version: Smart MS0101 1.1EU. Includes an 'Update firmware' button.
- Network info:** Join status: Joined; Device address: CA0001E5; Warranty packet counter: 460. Includes a 'Join network' button.
- Link check:** Quality: (signal strength indicator); Gateways count: 0. Includes a 'Link check' button.
- Device output:** Generate current data packet with time: 26.12.18 8:0:30.

ABP info - displays the data necessary to register the device in the LoRaWAN network with ABP method (Activation By Personalization).

OTAA info - the data required to register the device in the LoRaWAN network with OTAA method (Over The Air Activation) is displayed.

Key management (not displayed in the "Simple" mode) - allows you to change the factory keys to register the device on the network and reset the keys back to the factory settings.

Device info - the configurator reads information about the device model, its firmware and automatically corrects the device's time when connected to it.

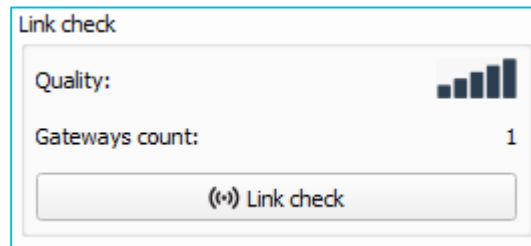
Update firmware - allows you to select the firmware file from your computer's hard drive and load it into the device. The device will automatically disconnect from the configurator when the download is complete. The current version of the device firmware can be downloaded from iotvega.com.

Network info - shows whether the device is connected to the LoRaWAN network and its network address.

Join network button - launch the LoRaWAN network connection procedure with the previously selected ABP or OTAA method. If the device is already connected to the network, reconnection procedure will occur.

Link check (not displayed in the "Simple" mode) - when pressed, the device sends a special signal to the LoRaWAN network, in response to which the network informs it of the

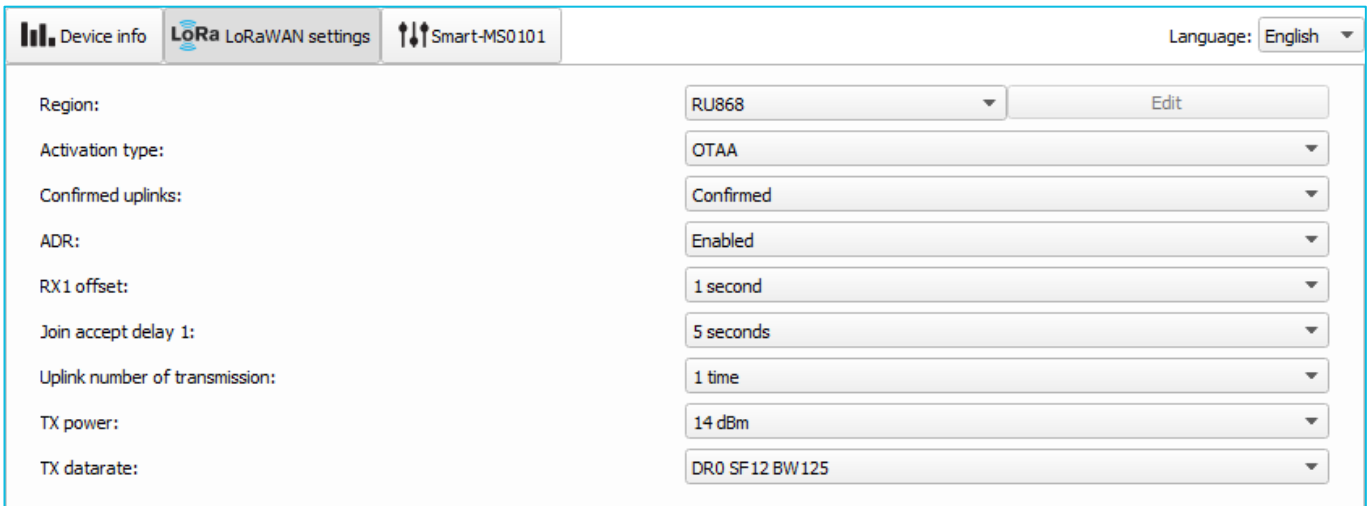
number of gateways that received this signal and the signal quality. This button only works when the device is connected to the network.



Device output (not displayed in the "Simple" mode) - monitoring the device status, all events in real time are displayed.

"LORAWAN SETTINGS" TAB

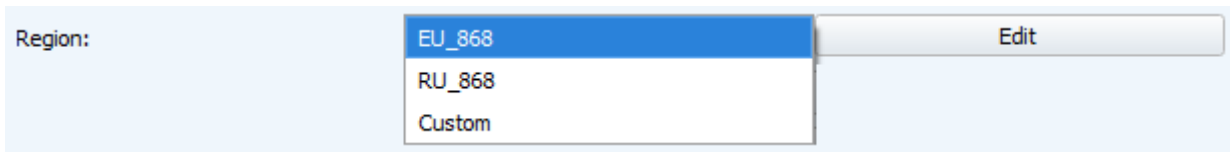
The "LoRaWAN Settings" tab allows you to configure various parameters of the LoRa network.



The screenshot shows the "LoRa LoRaWAN settings" tab for device "Smart-MS0101". The language is set to "English". The settings are as follows:

- Region: RU868 (with an "Edit" button)
- Activation type: OTAA
- Confirmed uplinks: Confirmed
- ADR: Enabled
- RX1 offset: 1 second
- Join accept delay 1: 5 seconds
- Uplink number of transmission: 1 time
- TX power: 14 dBm
- TX datarate: DR0 SF12 BW125

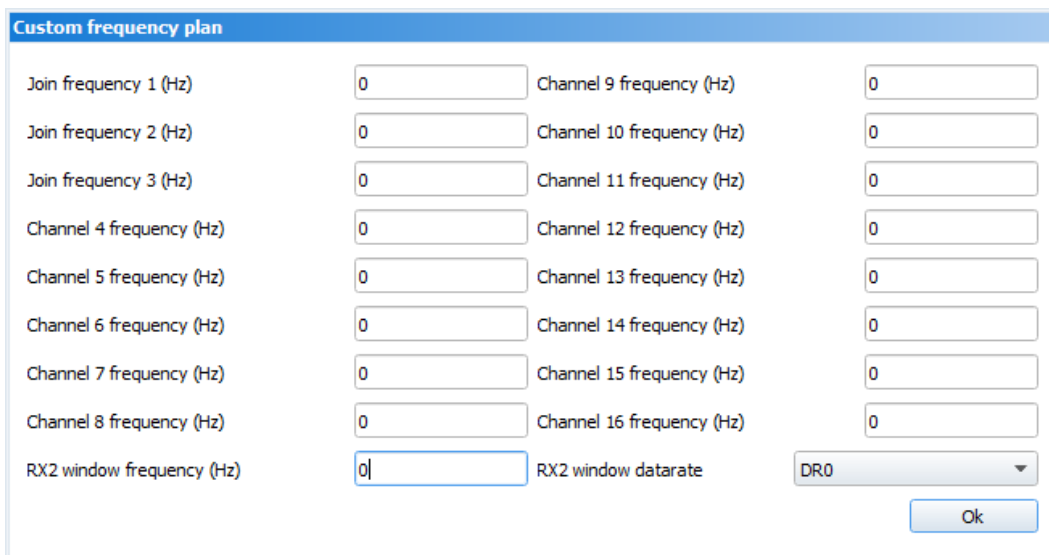
Region - allows you to select one of installed frequency plans or specify a custom frequency plan. Custom frequency plan is EU-868 based.



The "Region" dropdown menu is open, showing three options: "EU_868" (highlighted), "RU_868", and "Custom". An "Edit" button is visible to the right of the dropdown.

In the device frequency plan, only those channels are active by default, on which sending requests for connection to the network (join channels). The remaining channels (that the device should use) can be transferring by the LoRaWAN network server during the device activation procedure (only OTAA).

If you select "Custom" in the "Region" field, you must manually specify the frequencies that the device will use. To do this, click the "Edit" button, the channel frequency editing window will appear:



The "Custom frequency plan" dialog box is shown. It contains the following fields:

- Join frequency 1 (Hz): 0
- Join frequency 2 (Hz): 0
- Join frequency 3 (Hz): 0
- Channel 4 frequency (Hz): 0
- Channel 5 frequency (Hz): 0
- Channel 6 frequency (Hz): 0
- Channel 7 frequency (Hz): 0
- Channel 8 frequency (Hz): 0
- RX2 window frequency (Hz): 0
- Channel 9 frequency (Hz): 0
- Channel 10 frequency (Hz): 0
- Channel 11 frequency (Hz): 0
- Channel 12 frequency (Hz): 0
- Channel 13 frequency (Hz): 0
- Channel 14 frequency (Hz): 0
- Channel 15 frequency (Hz): 0
- Channel 16 frequency (Hz): 0
- RX2 window datarate: DR0

An "Ok" button is located at the bottom right of the dialog.

This frequency plan allows you to set up to 16 channels, as well as the frequency and speed of the second receiving window.



The first three channels and the second receiving window parameters are mandatory. Without these parameters the custom frequency plan will be considered empty.

Activation type – selecting ABP or OTAA device activation method.

Activation type:	<input type="text" value="OTAA"/>
	<input type="text" value="ABP"/>

Confirmed uplinks – when you choose "confirmed", the device will retry sending the packet until it receives the server confirmation, or until the "Uplink number of transmission" is over (see below).

Confirmed uplinks:	<input type="text" value="Confirmed"/>
	<input type="text" value="Unconfirmed"/>

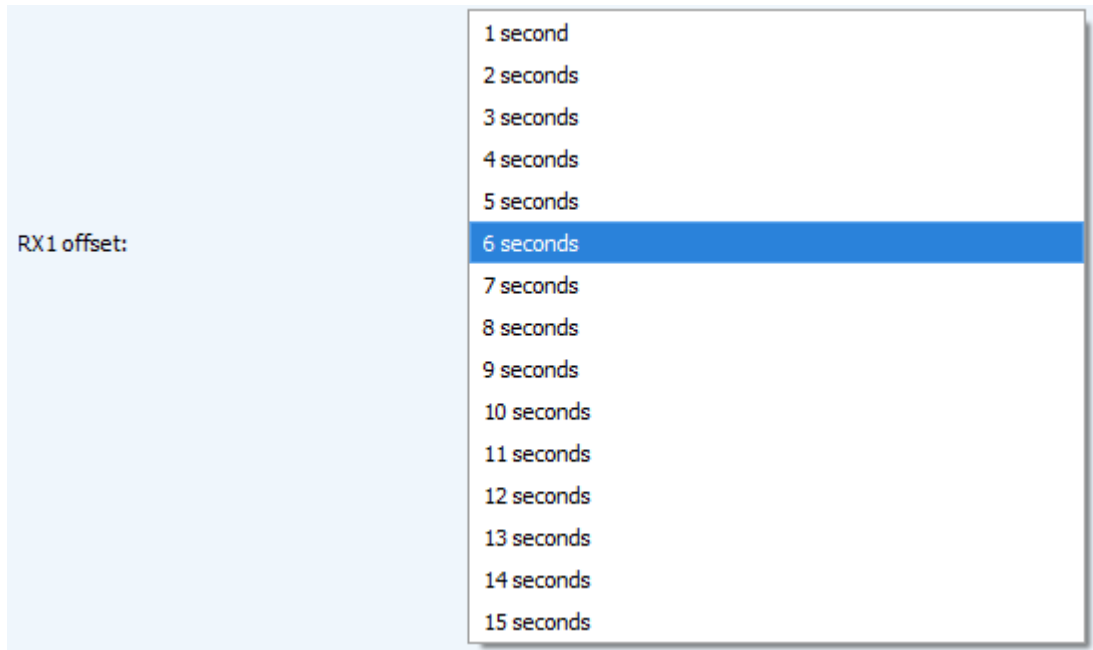


If you choose to send packets without confirmation, the modem will not know whether the packet delivered or not

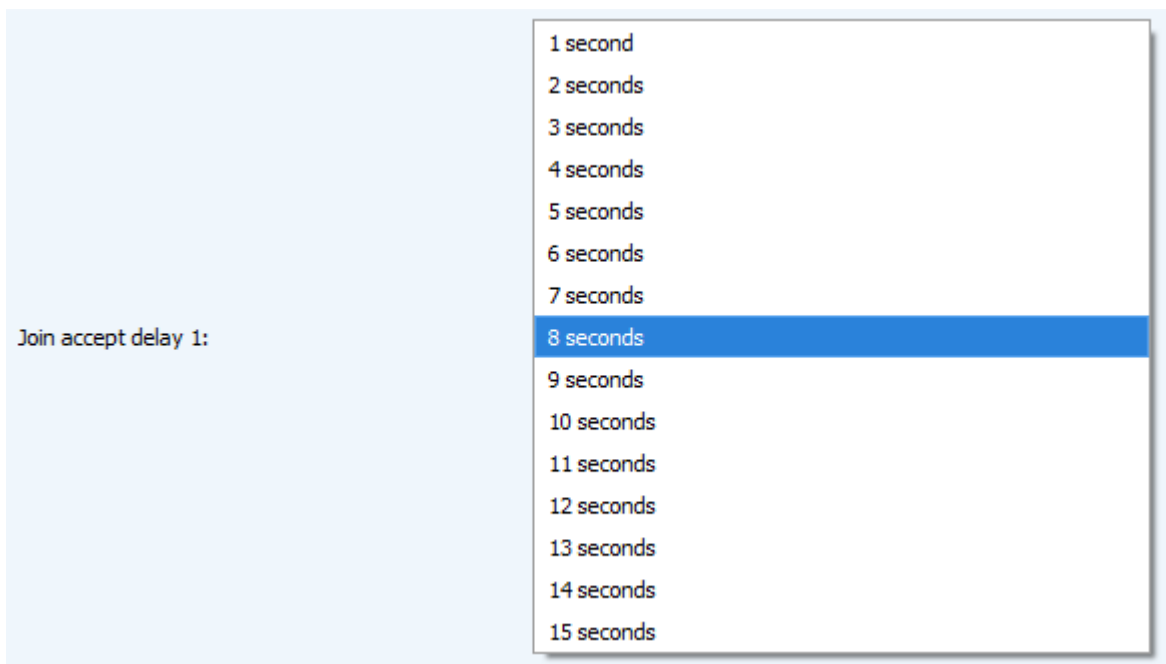
ADR – this option activates the Adaptive Data Rate algorithm for automatic control of the data transfer rate from the LoRaWAN network server side. The higher the quality of the signal received by the network, the higher the speed will be installed on the device. This option is recommended only on permanently installed devices.

ADR:	<input type="text" value="Enabled"/>
	<input type="text" value="Disabled"/>

RX1 offset (not displayed in the "Simple" mode) – specifies the time between end of packet transmission and first receiving window opening. The second receiving window always opens after 1 second after the first.



Join accept delay 1 (not displayed in the "Simple" mode) – sets the time that the device will open the first receiving window to receive confirmation for the join request from the LoRaWAN network while OTAA mode active. The second window always opens after 1 second after the first.



Uplink number of transmission (not displayed in the "Simple" mode) – if the "Confirmed uplinks" function is disabled, the device will simply send each packet as many times as specified in this option. If "Confirmed uplinks" is enabled, the device will send packets until it receives a confirmation or until it sends as many packets as specified in this option.

Uplink number of transmission:	1 time
	2 times
	3 times
	4 times
	5 times
	6 times
	7 times
	8 times
	9 times
	10 times
	11 times
	12 times
	13 times
	14 times
	15 times

TX power (not displayed in the "Simple" mode) – the device RF transmitter power is adjusted to this value when sending packets to the LoRaWAN network. This option can be changed by the network server.

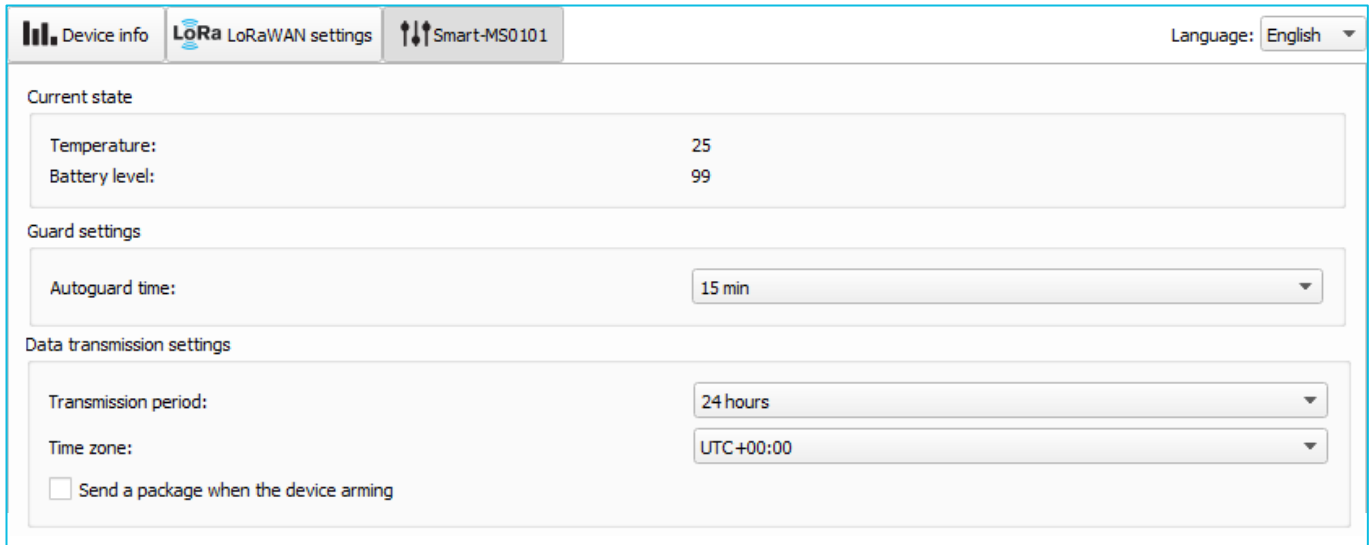
TX power:	2 dBm
	5 dBm
	8 dBm
	11 dBm
	14 dBm
	20 dBm

TX datarate (not displayed in the "Simple" mode) – the device transmission data rate at which it will transfer packets to the LoRaWAN network. This speed can be changed by the network server if the ADR algorithm is enabled.

TX datarate:	DR0 SF12 BW125
	DR1 SF11 BW125
	DR2 SF10 BW125
	DR3 SF9 BW125
	DR4 SF8 BW125
	DR5 SF7 BW125

"SMART-MS0101" TAB

The "Smart-MS0101" tab contains the settings of the connected device.



Section	Parameter	Value
Current state	Temperature:	25
	Battery level:	99
Guard settings	Autoguard time:	15 min
Data transmission settings	Transmission period:	24 hours
	Time zone:	UTC+00:00
Send a package when the device arming		<input type="checkbox"/>

Current state – displays the current parameters of the device - the internal temperature of the device and the battery level.

Guard settings – allows setting the time interval of auto-post to the "Guard" mode from 1 to 60 minutes.

Data transmission settings – the transmission period which the packet with the current data is transmit (See part 5, packet 1) and time zone settings.

Send a package when the device arming – if that option is active then the device will send the current data packet (part 5, packet 1, reason == 2) when its arming.

5 COMMUNICATION PROTOCOL – 2.0 VERSION

This part describes the Smart-MS0101 communication protocol with LoRaWAN network.



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

SMART-MS0101 TRANSMITS THE FOLLOWING TYPES OF PACKETS

1. Packet with current readings, sent regularly, and every time alarm event occurs on LoRaWAN port 2

Size in bytes	Field description	Data type
1 byte	Packet type (for that packet == 1)	uint8
1 byte	Battery charge, %	uint8
1 byte	Values of basic settings (byte field)	uint8
2 bytes	Temperature in ⁰ C, multiplied by 10	int16
1 byte	Sending reason (0 – by the time, 1 – by the alarm, 2 – by the arming)	uint8
4 bytes	Time of forming this packet (unixtime UTC)	uint32

"Values of basic settings" bit field decoding

Bits	Field description
0 bit	Activation type 0 - OTAA, 1 – ABP
1 bit	Query for packet confirmation 0 – off, 1 – on
2,3 bit	Communication period: 2 == 0 3==0 4==0 - 5 minutes 2 == 1 3==0 4==0 - 15 minutes 2 == 0 3==1 4==0 - 30 minutes 2 == 1 3==1 4==0 - 1 hour 2 == 0 3==0 4==1 - 6 hours 2 == 1 3==0 4==1 - 12 hours 2 == 0 3==1 4==1 - 24 hours
5 bit	reserve
6 bit	reserve
7 bit	reserve

2. 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 the packet sending moment (unixtime UTC)	uint32

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

3. 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	
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 bytes	Parameter value	-----
...
2 bytes	ID of parameter	uint16
1 byte	Data length (len)	uint8
len bytes	Parameter value	-----

SMART-MS0101 TRANSMITS THE FOLLOWING TYPES OF PACKETS

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	int64

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

2. Packet with request of settings – sent by application on LoRaWAN port 3

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

Answering that packet, the device sends the packet with settings.

3. Packet with settings is identical to such packet from device

Size in bytes	Field description	Data type
1 byte	Packet type, this packet == 0	
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 bytes	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 Smart-MS0101 parameters and these possible values

ID of parameter	Description	Data length	Possible values
4	Confirmed uplinks	1 byte	1 – confirmed 2 – unconfirmed
5	ADR (Adaptive Data Rate)	1 byte	1 – enabled 2 – disabled
8	Uplinks number of transmissions	1 byte	from 1 to 15
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
43	Time interval of auto-post to the "Guard" mode	1 byte	1, 2, 3, 4, 5, 10, 15, 30, 60 minutes
55	Time zone, in minutes	2 bytes	from -720 to 840
124	Send the packet when the device arming	1 byte	0 – disabled 1 – enabled

6 STORAGE AND TRANSPORTATION REQUIREMENTS

The Smart-MS0101 sensor shall be stored in the original packaging in heated room at temperatures $+5^{\circ}\text{C}$ to $+40^{\circ}\text{C}$ and relative humidity less than 85%.

The sensor shall be transported in covered freight compartments of all types at any distance at temperatures -40°C to $+70^{\circ}\text{C}$. After transportation at low temperatures, it is recommended to leave the device in a room temperature place for 48 hours before start of operation.

7 CONTENT OF THE PACKAGE

The sensor is delivered complete with:

Motion sensor Vega Smart-MS0101 – 1 pc.

CR123A battery – 1 pc.

Factory certificate – 1 pc.

8 WARRANTY

The warranty period for the device is 5 years from the date of sale.

The manufacturer is obligated to provide repair services or replace the failed device during the entire warranty period.

The consumer undertakes to comply with the terms and conditions of transportation, storage and operation specified in this user manual.

Warranty does not apply to:

- power supplies of devices sending more than 9,000 packets;
- the device with mechanical, electrical and / or other damages and defects caused by violation of the transportation, storage and operation requirements;
- the device with traces of repair performed not by the manufacturer's service center;
- the device with traces of oxidation or other signs of liquids leaking inside the device.

In the event of a warranty claim, contact the service center:

113/1, Kirova Str., Novosibirsk, 630008, Russia.

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



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