MCC BETAR Ltd

Electronic Water Meter SHVE, SGVE
with LPWAN 868 VEGA radio channel

User Manual

[ПДЕК.407223.042-01 ИС]

CONTENTS

INTRODUCTION

This manual is developed for electronic water meters SHVE, SGVE (hereafter – meter, device) and contains a description about specification, functionality, interfaces, configurator application and communication protocol and some other data which is necessary to meters exploitation.

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

ATTENTION! The meter shall be installed and adjusted by qualified specialists in order to ensure proper operation of the device.

1 TECHNICAL DESCRIPTION

1.1 PURPOSE

SHVE, SGVE meters (fig. 1) are designed to measurement of drinking flowing through the pipeline water volume according to СанПиН 2.1.4.1074-2001 with the temperature from 5 to 40 °C for cold water meters (SHVE) and from 5 to 90 °C for hot water meters (SGVE). There are pressure of water in pipeline no more than 1.0 MPa (10kg/sm) and further collection and transmitting of this data to LoRaWAN network via radio frequency band 860-1000 MHz.

SGVE meters are multipurpose and may be used as for measurement of cold as hot water volume, but SHVE meters are only for cold water.
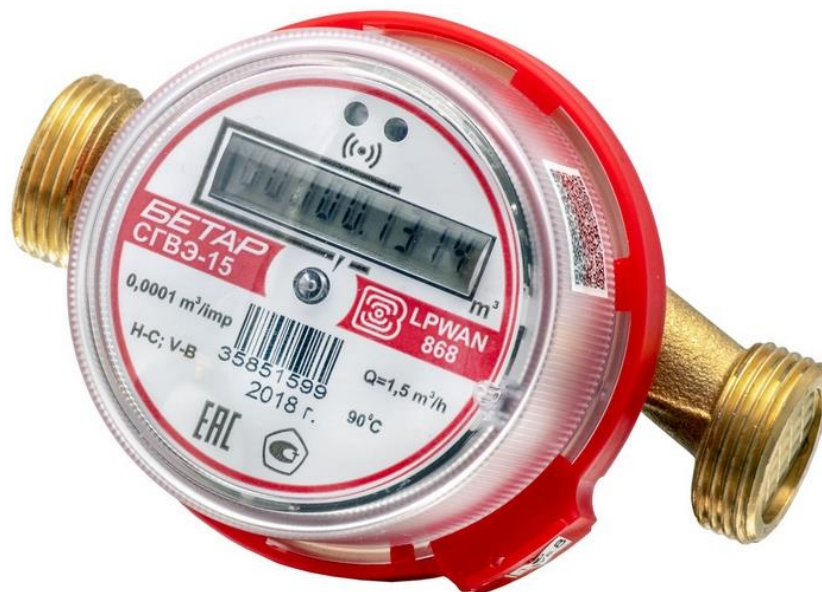
Figure 1 — Appearance of meter

1.2 FUNCTIONS

Meters support the next functions:
- displaying the counted water consumption in cubic meters via the LED indicator;
- fixation of external magnetic field influence (electronic magnetic seal);
- control of internal battery charge;
- control of temperature inside device case (reference Information);
- registration of random reverse flow of water (displaying the counted water modulo consumption in forward and the reverse direction via the LED indicator);
- leak fixation (continuous consumption < 0.3 cubic meter per hour);
- fixation of a breakthrough (continuous consumption > 0.3 cubic meter per hour);
- binding an emergency situation to the date and time and it's saving;
- testing in the manufacture and changing the parameters of the meter during operation through the optical port;
- pre-configured schedule for transmitting the collected data in the LoRaWAN network via radio communication (choice the communication period);
- pre-configured schedule for the data collection and saving in the internal memory (choice the data collection period);
- emergency transmitting of the collected data (extraordinary session);

- emergency transmitting of the alarm message in case of one of the next emergency situations:
  - fixation of external magnetic field influence;
  - low internal battery charge;
  - leak fixation (continuous consumption < 0.3 cubic meter per hour);
  - fixation of a breakthrough (continuous consumption > 0.3 cubic meter per hour).

1.3 SPECIFICATION

The main specification is shown in the table 1.

Table 1

Parameter	Value			
Basic				
Meter type	SHVE-15, SGVE-15		SHVE-20, SGVE-20	
Nominal diameter, mm	15		20	
Metrological class	Class B	Class C	Class B	Class C
Water consumption, m^3/h Minimal, q_{min} Nominal, q_n Maximal, q_{max}	0,03	0,015	0,05	0,025
	1,5	1,5	2,5	2,5
	3,0	3,0	5,0	5,0
Operating water pressure, MPa	Up to 1			
Operating water temperature, °C cold, SHVE hot, SGVE	+5…+40 °C			
	+5…+90 °C			
Operating environment temperature, °C	+5…+50 °C			
Capacity of indicator, m^3	99999,9999			
Internal temperature sensor	yes			
Interface	Optical port, LoRaWAN			
Weight of one pulse on the optical port, m^3	0,0001			
Radio				
Protocol	LoRaWAN			
Nominal transmitter power, mW	25 (configurable)			
LoRaWAN device class	A			
Number of LoRa channels	16			
Frequency plan	RU868, EU868, IN865, AS923, AU915, KR920, US915, KZ865, custom (EU868 based)			
Activation type	ABP and OTAA			

Parameter		Value	
Communication period, h	Configurable, h	1, 6, 12, 24	
	Service	By the event (Hall sensor closing)	
	Recommended, h	12	
Data collection period, h		1, 6, 12, 24	
Black box, messages		200	
LoRa antenna type		Internal	
Sensitivity, dBm		-138	
Radio coverage in restrained urban conditions, km		Up to 5	
Radio coverage within line of sight, km		Up to 15	
Power			
Built-in battery, mAh		3400	
Operating time from the battery power, years		Up to 10 (with communication and data collection periods are equal to 12 hours)	
Case			
Length, mm		110	130
Height, mm		70	75
Connecting dimensions, inch		G3/4-A	G1-A
Ingress protection rating		IP54 (ГОСТ 14254-2015)	

1.4 OPERATION PRINCIPLE

Operation principle based on measurement of the impeller turnovers number. Impeller located in a flow part of meter and rotated by water flowing. The impeller turnovers number is proportionally to water flowing volume. A bipolar magnet is molded into the impeller. Counting Hall sensor takes information about the impeller turnovers number from bipolar magnet.

Meter always on, but there is in a low power consumption mode most of the time.

2 DESCRIPTION OF BASIC FUNCTIONS

2.1 READINGS DISPLAYING

The device has LED indicator on a faceplate for visual displaying of the readings (fig. 2). Readings are displayed in cubic meters up to the fourth decimal point on a cumulative total.
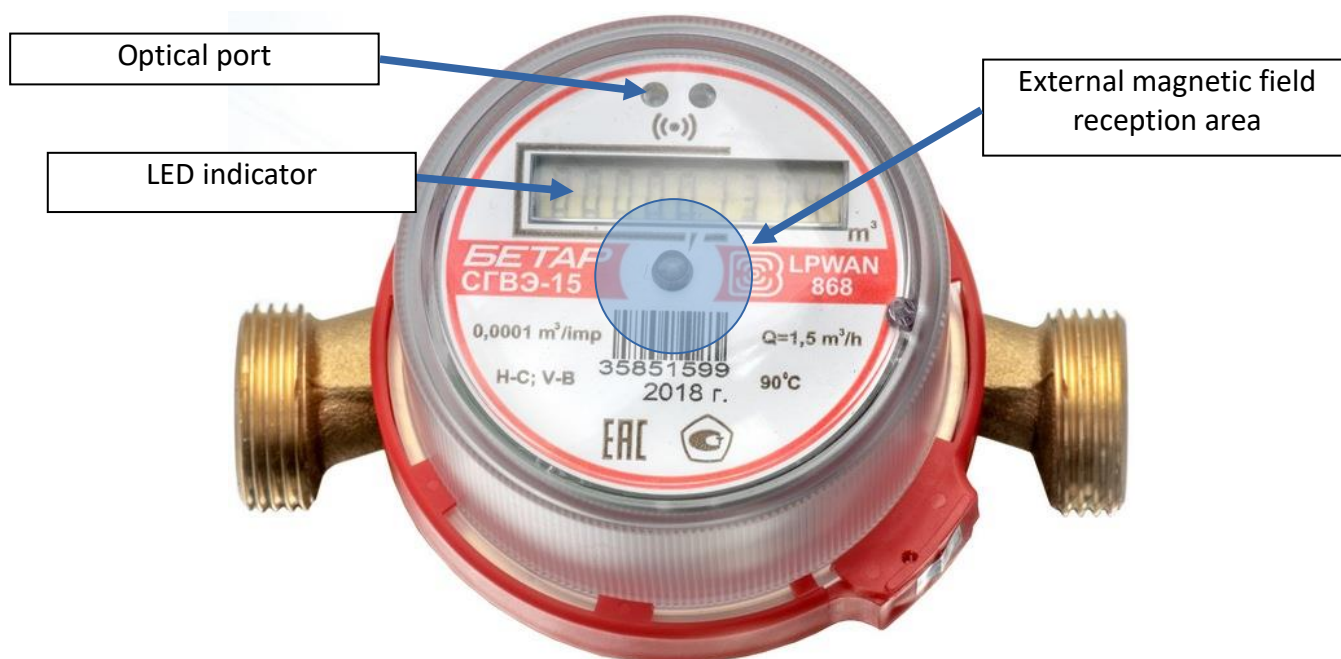
Optical port

LED indicator

External magnetic field reception area

Figure 2 — Device basic elements

2.2 OPTICAL PORT

There is an optical port (fig. 2) for connection to computer, which also used for testing. The adapter "Opticalport-USB" connected to the USB-port of computer carries out connection between the optical port and computer.

"Vega LoRaWAN Configurator" application allows reading and changing the meters parameters. See detailed application description in a part 3.

2.3 INTERNAL CLOCK

Time on internal clock may set automatically when the device connects to the "Vega LoRaWAN Configurator" application and may corrected via LoRaWAN network.

"IoT Vega TimeCorrector" application carries out an autocorrecting procedure via LoRaWAN network. The device sends time correction request every 72 hours.

2.4 ELECTRONIC MAGNETIC SEAL

The meter has a Hall sensor for fixing of the external magnetic field and it is located under faceplate of the device (fig.2). That function named as an electronic magnetic seal.

From the 1st second of external magnetic field influence, which strong enough, the meter LED indicator displays warning symbol "**b**" at the high order digit place (first index) but readings still displaying.

If the external magnetic field influence continues more than 5 minutes then device locks LED indicator and send emergency message with lock flag. Herewith, the LED indicator displays warning

symbol "**b**" but readings not displaying. Only the dispatcher via the LoRaWAN network can unblock a LED indicator using a special command.

There are device controlling functions, which activated by a magnet getting on external magnetic field reception area in table 2.

Table 2

Time of external magnetic field influence	Event	Comment
Less than 2 seconds	Optical port activation for 20 seconds	Optical port deactivated after 20 seconds
From 10 to 15 seconds	Emergency communication session	While communication session the LED indicator displays warning symbol "**b**" at the high order digit place but readings still displaying
5 minutes and more	Lock of the LED indicator	The LED indicator displays warning symbol "**b**" but readings not displaying

2.5 LORAWAN

2.5.1 CONNECTION TO THE NETWORK

Meter supports two activation methods in the LoRaWAN network:

- **ABP (Activation By Personalization)** – meter sends data to the LoRaWAN network according to pre-configured schedule (every 12 hours by default).
- **OTAA (Over The Air Activation)** – meter makes three trying to connect the network with configured frequency plan (RU868 by default). The meter will begin to send data when it receives the LoRaWAN activation confirmation. If all attempts fail, the meter will continue to accumulate data and will attempt to connect to the network every day.

Meter makes three attempts to connect to the network with OTAA method once a day by default. You can change default settings via "Vega LoRaWAN Configurator" application (see part 3.5).

You can initiate emergency communication session including activation by a magnet getting on external magnetic field reception area during 10-15 seconds (fig.2).

2.5.2 CLASS A DEVICE

Meter is class A device (by LoRaWAN classification) and has the following features:

- ADR («Adaptive Data Rate»);
- sending of confirmed messages (configurable);
- storing undelivered messages in device memory while sending messages with confirmation;
- adjustable data collection period;
- temperature measurement;
- charge measuring of the built-in battery in %.

2.5.3 COMMUNICATION AND COLLECTION PERIODS

2.5.3.1 COMMUNICATION PERIOD

Communication period may be equal to 1, 6, 12 and 24 hours. Device send data in random point in time during set period:
- If communication period equal to 1 hour then during the next hour;
- If communication period equal to 6 hours then during the next 6 hours;
- If communication period equal to 12 hours then during the next 12 hours;
- If communication period equal to 24 hours then during the next 24 hours.

2.5.3.2 DATA COLLECTION PERIOD

Data collection period may be equal to 1, 6, 12 and 24 hours. Meter saves data in the internal memory with time by the internal clock:
- at 00.00 when the period is equal to 24 hours;
- at 00.00 and at 12.00 when the period is equal to 12 hours;
- at 00.00, 6.00, 12.00 and 18.00 when the period is equal to 6 hours;
- at the beginning of current hour when the period is equal to 1 hour.

The readings are stored in the meter memory until the next communication session; maximum number of saved messages is 200. At the next communication session, the device starts sending accumulated messages, from the earliest to the latest.

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

With the "Confirmed uplinks" option turned on, the device will send the next message only after receiving a confirmation of the delivery of the previous one. If such confirmation have not received after the fulfilled in the settings uplink number of transmission, meter completes the communication session until the next one according to the schedule. In this case, the device continues to collect data according to the data collection period and store it in memory. Non-transmitted messages remain in the device memory until the next communication session.

3 "VEGA LORAWAN CONFIGURATOR" APPLICATION

3.1 OPERATING MODES

The "Vega LoRaWAN Configurator" application (hereinafter – application, 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 application is considered in the "Expert" mode.

3.2 APPLICATION INTERFACE

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 (fig. 3).
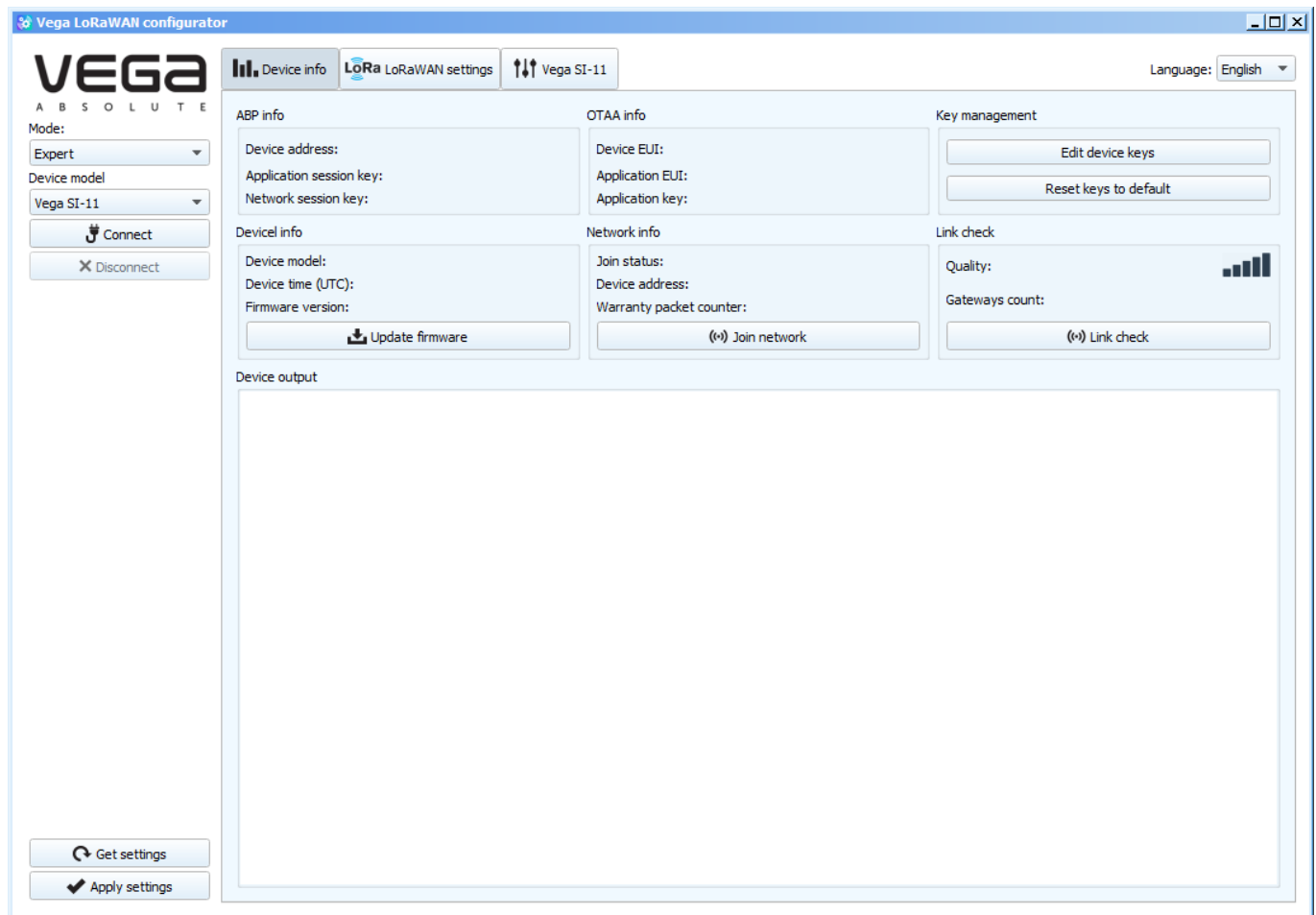
Figure 3 — Application workplace

The menu on the left allows you to switch between the "Simple" and "Expert" modes, select the device model, connect to the device or disconnect from it, get and apply settings.

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

The language selection menu is in the upper right corner.

3.3 CONNECTION OF METER TO COMPUTER

3.3.1 ADAPTER CONNECTION, DRIVER INSTALLING

Meter has the optical port for connection to computer, which also used for testing. The adapter "Opticalport-USB" connected to the USB-port of computer carries out connection between the optical port and computer.

Before connecting the device to the computer for the first time, you must install the driver for the adapter «**MCP2200 Windows Driver**», which can be downloaded from iotvega.com. After running the executable file **McphCdcDriverInstallationTool.exe**, the installer window will appear (fig. 4).
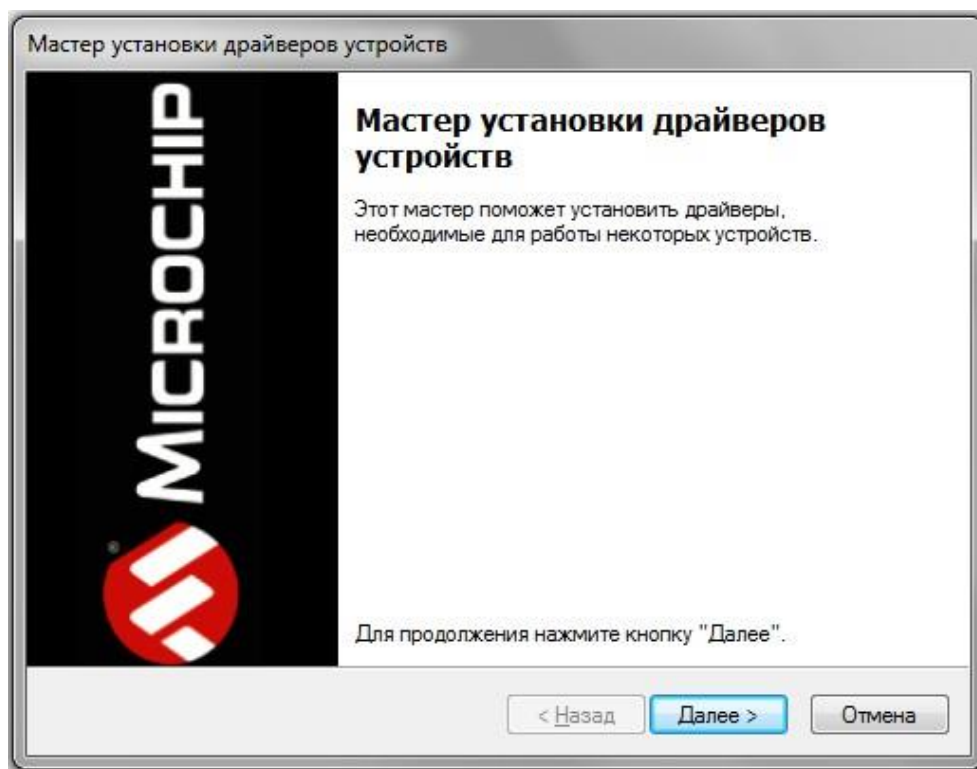
Figure 4 — Window «Мастер установки драйверов устройств»

In this window, you need to click «Далее». In the window that appears, agree to the terms of the license agreement, then «I accept» and «Далее» (fig. 5). The installation will begin after that.
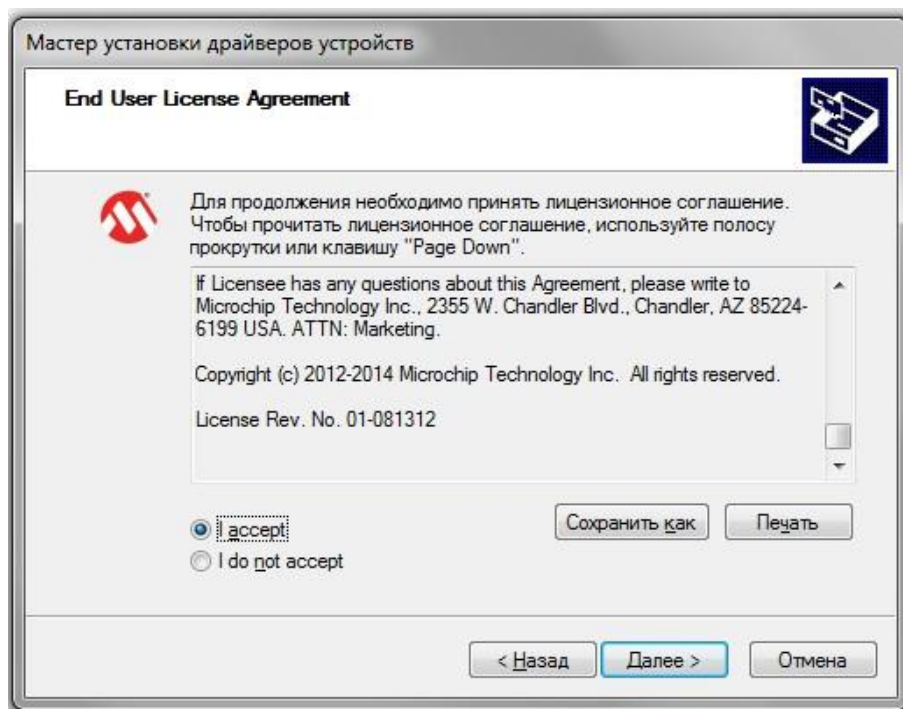
Figure 5 — Driver installing

After finish of install process the window will appears (fig. 6). After pressing «**Готово»** adapter "Opticalport-USB" is ready for operation.
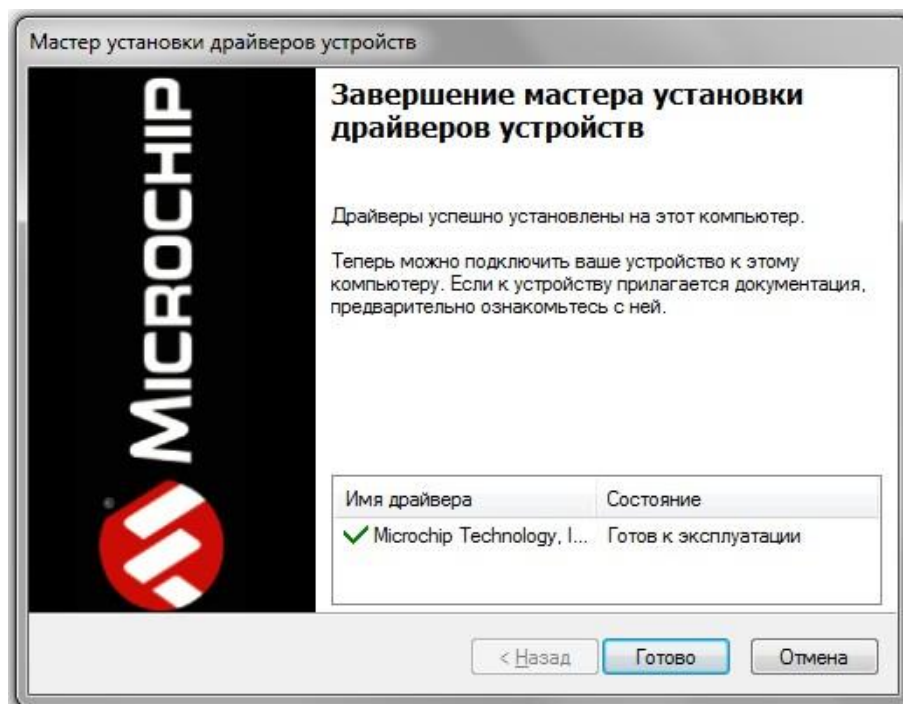
Figure 6 — Driver installing successfully

3.3.2 OPTICAL PORT ACTIVATION

Launch the program and activate optical port.

For optical port activation the magnet getting on external magnetic field reception area during short time (less than 2 seconds). Whereupon the optical port activates for the 20 seconds. "Opticalport-USB" adapter must be located and fixed for an operation time as it shown on figures 7,8.

Figure 7 — "Opticalport-USB" adapter location in relation to meter_ General view

Figure 8 — "Opticalport-USB" adapter location in relation to meter_ Close-up

At the main window of application you need to choose the device model ("Vega SHVE/SGVE"), COM-port number and press "Connect" button (fig. 9) while optical port is active.

Figure 9 — The main settings view for connection the device

Application connects to the device and device selection menu becomes inactive.

To read the settings from the device, you need to click the "Get settings" button (fig. 10), until this point the application will display the default settings or from the last connected device.
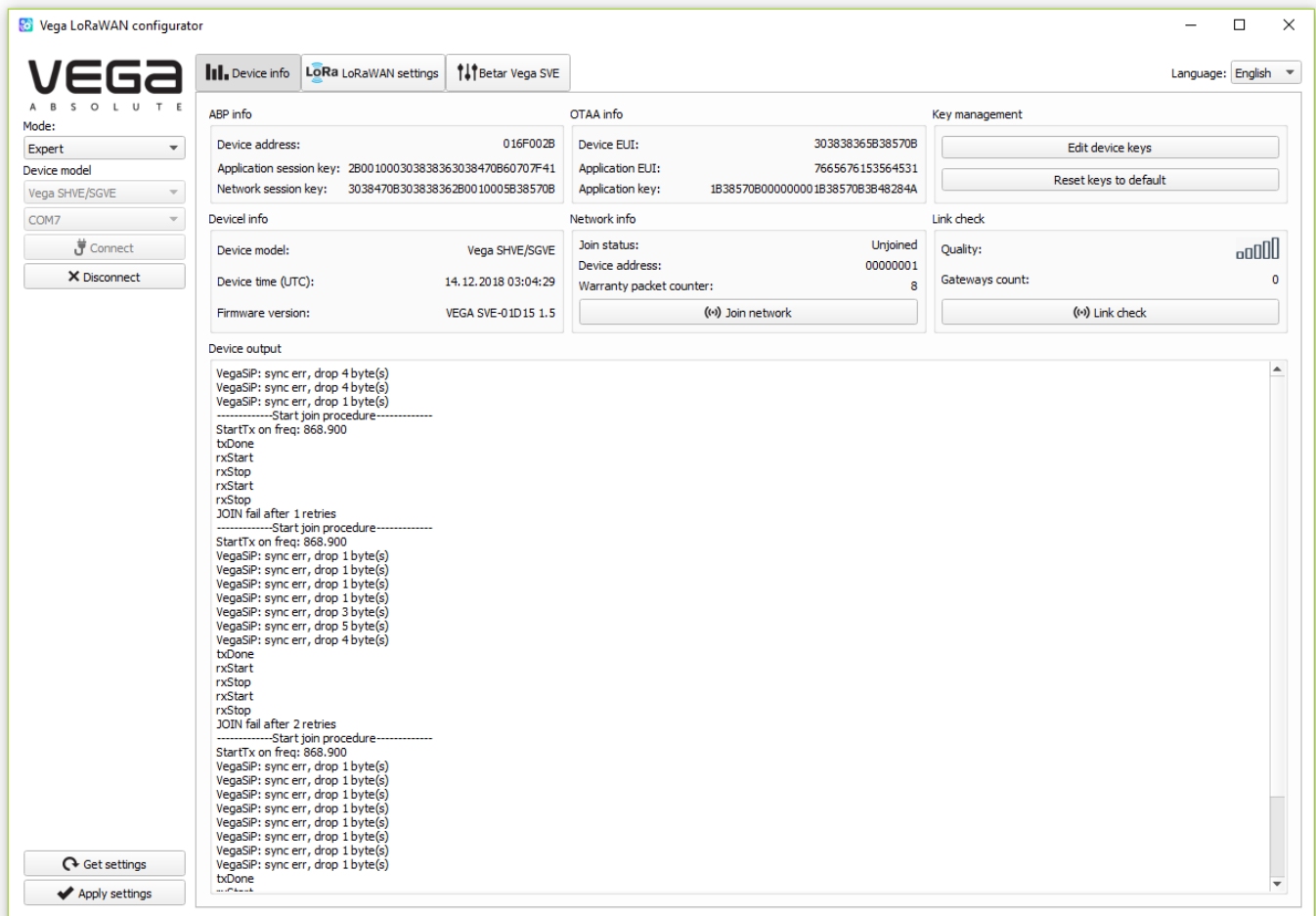
Figure 10 — "Device info" tab

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.

3.4 "DEVICE INFO" TAB

3.4.1 BASIC DESCRIPTION

The "Device info" tab displays network information about the device, - there are basic information (Device info field), current state (Network info, Link check), keys for device activation in LoRaWAN network (ABP info, OTAA info, Key managment), log (Device output).

Figure 11 — "Device info" tab

3.4.2 FIELDS DESCRIPTION

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

3.4.2.2 «OTAA info» – displays the data necessary to register the device in the LoRaWAN network with OTAA method (Over The Air Activation).

3.4.2.3 «Key management» (not displayed in the "Simple" mode) – allows you to change the factory device activation keys, or reset the keys back to the factory settings (fig. 12).

Figure 12 — "Edit device keys" window at "Key management" field

3.4.2.4 «Device info» – displays information about the device model, its firmware version and time in UTC (+0.00).

3.4.2.5 «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 you can download from iotvega.com.

ATTENTION! That function works only at manufacturing process.

3.4.2.6 «Network info» – shows whether the device connecting to the LoRaWAN network and its network address.

3.4.2.7 «Join network» button – launch the LoRaWAN network connection procedure with the previously selected ABP or OTAA method. If the device is already connecting to the network, reconnection procedure will occurs.

3.4.2.8 «Link check» button (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 about the number of gateways that received this signal and the signal quality (fig. 13). This button only works while the device is connecting to the network.

Figure 13 — "Link check" field

3.4.2.9 «Device output» (not displayed in the "Simple" mode) – monitoring the device status, displaying all events in real time.

3.5 "LORAWAN SETTINGS" TAB

3.5.1 BASIC DESCRIPTION

The "LoRaWAN Settings" tab allows you to configure various parameters of the LoRa network (fig. 14).

Figure 14 — "LoRaWAN settings" tab

3.5.2 FIELDS DESCRIPTION

3.5.2.1 «Region»

"Region" allows you to select RU-868, EU-868 or specify a custom frequency plan (fig. 15).

Figure 15 — Region choice

The meter supports the frequency plans specified in table 3.

Table 3

Frequency plan[1]	Channel	Frequency	Modulation
EU-868	1	868.1	MultiSF 125 kHz
	2	868.3	MultiSF 125 kHz
	3	868.5	MultiSF 125 kHz
	RX2	869.525	SF12 125 kHz
RU-868	1	868.9	MultiSF 125 kHz
	2	869.1	MultiSF 125 kHz
	RX2	869.1	SF12 125 kHz
Custom	Set with application		

In the EU_868 and RU_868 frequency plans by default, only those channels are active 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).

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1   By default, the device supports two frequency plans and the custom, but it is possible to order firmware for other frequency plans: IN865, AS923, AU915, KR920, US915, KZ865

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 (fig. 16).

Figure 16 — Custom frequency plan window

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

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

3.5.2.2 «Activation type» - allows setting up ABP or OTAA device activation method.

3.5.2.3 «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 p. 4.5.2.7). If the confirmation does not received then meter saves all non-transmitted messages until the next communication session.

ATTENTION! If you choose to send a packet without confirmation, the modem will not know whether the packet is delivered or not.

3.5.2.4 «ADR» – this option activates the Adaptive Data Rate algorithm for automatic control of the data transfer rate from the LoRaWAN network side. The higher the quality of the signal received by the network, the higher the speed will be installed on the device.

Figure 17 — "Adaptive Data Rate" function

3.5.2.5 «RX1 offset» (not displayed in the "Simple" mode) – specifies the time between end of packet transmission and first receiving window opening (fig. 18). The second receiving window always opens after 1 second after the first.
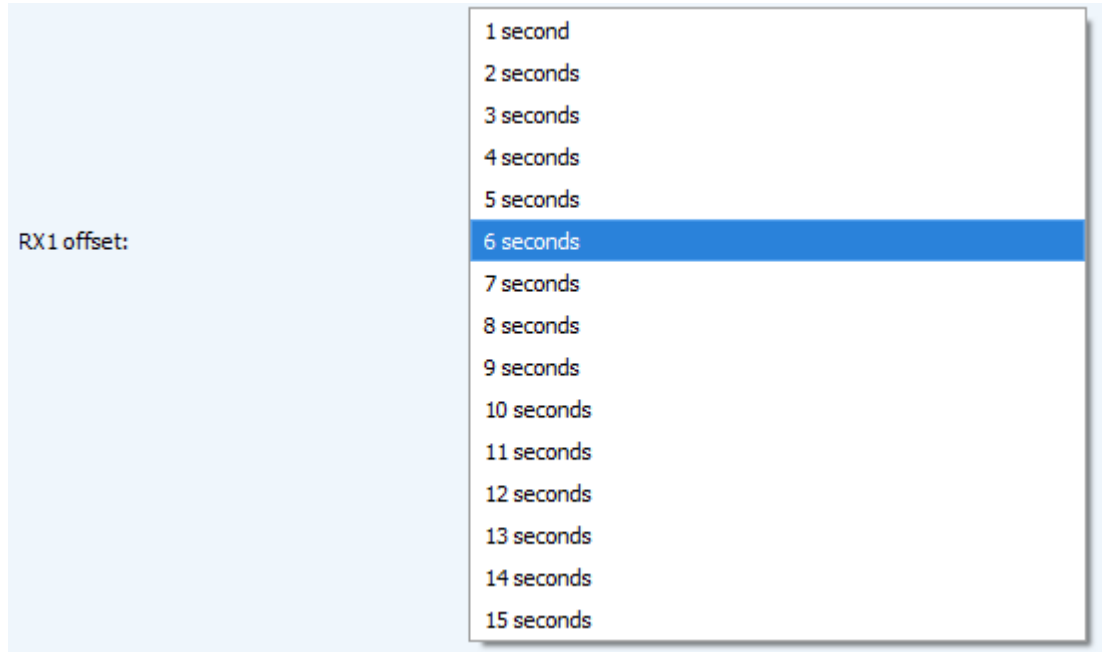

Figure 18 — Choice of the time for opening the first receiving window

3.5.2.6 «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 (fig. 19). The second window always opens after 1 second after the first.
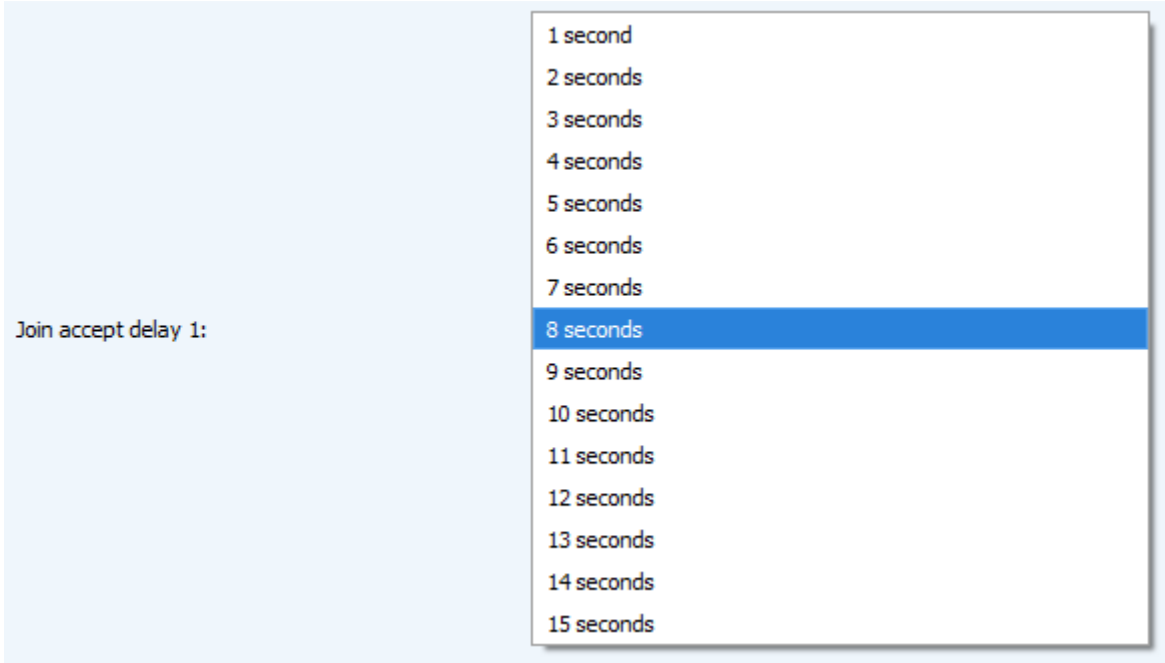

Figure 19 — Choice of the time for opening the first receiving window for join accept receiving

3.5.2.7 «Uplink number of transmission» (not displayed in the "Simple" mode) – sets the number of uplink during the one communication session (fig. 20). 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"

function is enabled, the device will send packets until it receives a confirmation or until it sends as many packets as specified in this option.
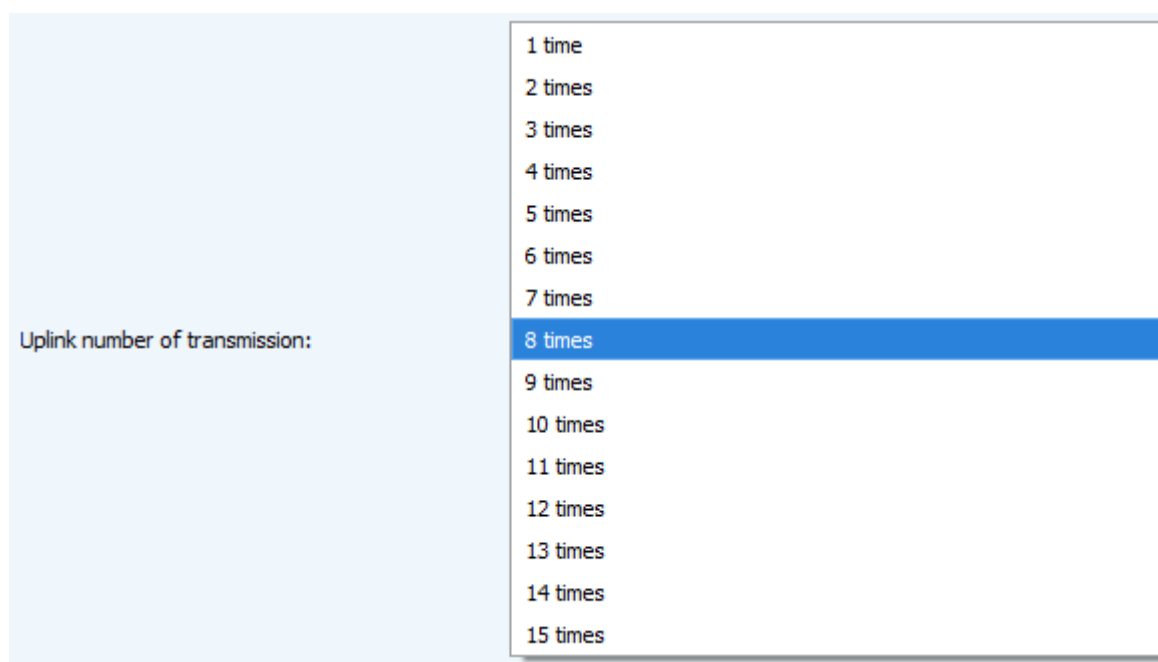

Figure 20 — Choice of the uplink number

3.5.2.8 «TX power» (not displayed in the "Simple" mode) – the device RF transmitter power has adjusted to this value when sending packets to the LoRaWAN network (fig. 21). This option can be change by the network server.
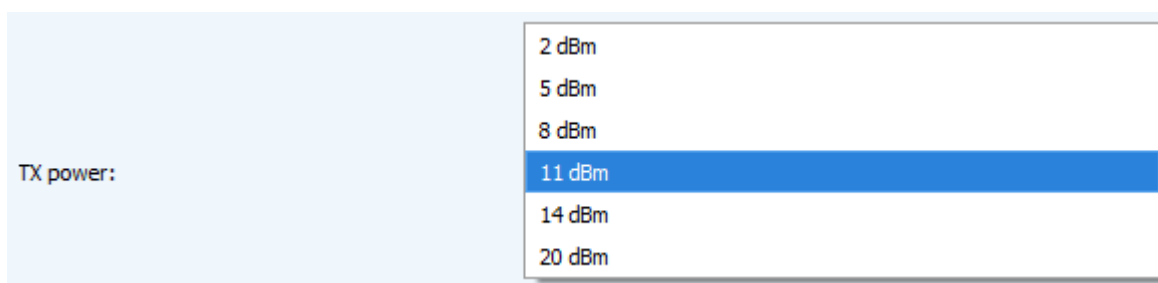

Figure 21 — Choice of the TX power

3.5.2.9 «TX datarate» (not displayed in the "Simple" mode) – the device transmission datarate at which it will transfer packets to the LoRaWAN network (fig. 22). This speed can be changed by the network server if the ADR algorithm has enabled.
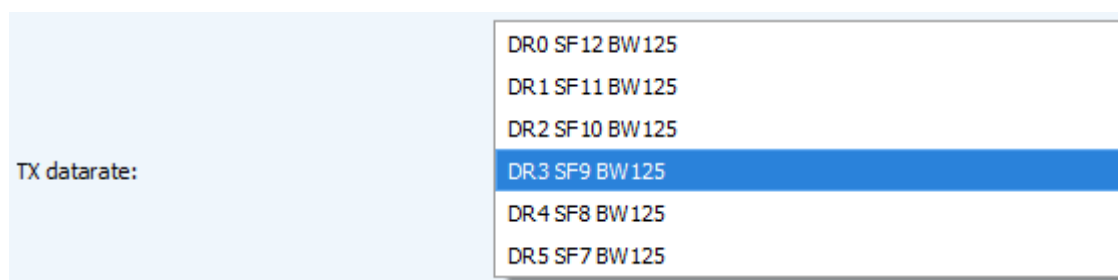

Figure 22 — Choice of the TX datarate

3.6 "BETAR VEGA SVE" TAB

3.6.1 BASIC DESCRIPTION

"Betar Vega SVE" tab contains the special settings and parameters of the connected device (fig. 23).

Figure 23 — "Betar Vega SVE" tab

3.6.2 FIELDS DESCRIPTION

3.6.2.1 «Current state» – displays the current parameters of the device (temperature, battery charge, meter diameter, current readings).

3.6.2.2 «Data transmission settings» – a group of parameters that allows you to configure the collection and transmission periods, and the time zone for the internal clock of the modem will be set which.

Transmission (communication) period may be equal to 1, 6, 12 and 24 hours.
Data collection period may be equal to 1, 6, 12 and 24 hours.

3.6.2.3 «Commands» – displays control commands, which are represented as a buttons.

"Enable calibration mode" button switch meter to the calibration mode, when optical port pulse frequency is proportionally to volume water consumption. One pulse weight is equal to 0.0001 cubic meters. Calibration mode automatically off after one cubic water flowing through the pipe since the mode activation.

3.7 DEVICE SETTINGS BY DEFAULT

In the table 4 the device settings by default are shown.

Table 4

Parameter	Value
Communication period	12 hours
Data collection period	12 hours
Time zone	UTC +03:00
Calibration mode	Active
Frequency plan	RU868
Activation method	OTAA
"Confirmed Uplinks" function	ON
Adaptive Data Rate (ADR)	ON
Transmitter power	14 dBm
Uplink number	3

4 LORAWAN COMMUNICATION PROTOCOL

4.1 TRANSMITTING MESSAGES

ATTENTION! In fields consisting of several bytes, the little endian byte order is used.

4.1.1 CURRENT READINGS

Message with current readings has generated with pre-specified collection period and transmits on LoRaWAN port 2 in according with the schedule. Message structure shown in table 5.

Table 5

Size in bytes	Field description
1 byte	Packet type, this packet = 1
1 byte	Battery charge, %
1 byte	Temperature, °C
1 byte	External magnetic field 1 – fixed 0 – not fixed
1 byte	LED indicator lock flag 1 – LED indicator locked 0 – LED indicator unlocked
4 bytes	Time of the readings at that packet (unixtime UTC)
1 byte	Leak flag (continuous consumption < 0.3 cubic meter per hour) 1 – leak 0 – normal
1 byte	Breakthrough flag (continuous consumption > 0.3 cubic meter per hour) 1 – breakthrough 0 – normal
4 bytes	Current readings (in cubic meters multiplied by 10 000)
1 byte	Setting – Confirmed uplinks 1 – ON 0 – OFF
1 byte	Setting – communication period 1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours
1 byte	Setting – data collection period 1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours
2 bytes	Timezone in minutes (for example, for Moscow timezone +3 that value will be equal to 180). May be negative.

The modem has internal clock and calendar; time and date is factory set or may be correct while exploitation. 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 sending;

- 6 hours period: 00:00, 06:00, 12:00, 18:00 readings are sending;

- 12 hours period: 00:00, 12:00 readings are sending;

- 24 hours period: the readings of 00:00 of the current day are sending.

When taking readings, the time zone specified in the settings taken into account.

4.1.2 TIME CORRECTION REQUEST

Time correction request send once a day on LoRaWAN port 4. Message structure shown in table 6.

Table 6

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

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

4.2 RECEIVING MESSAGES

4.2.1 SETTINGS

Sending on LoRaWAN port 2. Message structure shown in table 7.

Table 7

Size in bytes	Field description
1 byte	Packet type, this packet = 1
1 byte	Setting – confirmed uplinks 1 – ON 0 – OFF
1 byte	Setting – communication period 1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours
1 byte	Setting – data collection period 1 – 1 hour 2 – 6 hours 3 – 12 hours 4 – 24 hours
2 bytes	Timezone in minutes (for example, for Moscow timezone +3 that value will be equal to 180). May be negative.

4.2.2 UNLOCK LED INDICATOR COMMAND

Sending on LoRaWAN port 2. Message structure shown in table 8.

Table 8

Size in bytes	Field description
1 byte	Packet type, this packet = 2

4.2.3. TIME CORRECTION

Sending on LoRaWAN port 4. Message structure shown in table 9.

Table 9

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