NETWORK TESTER
VEGA TS-12

User Manual

User Manual contains information how to work with
LoRaWAN™ network autonomic tester Vega TS-12, and
also contains warranty terms and conditions and rules
for operating, storage and transportation

Document information	
Title	Network tester Vega TS-12
Document type	Manual – translation from Russian
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This document applies to the following products:

Product name	Type number
End devices	Vega TS-12

Revision history

Revision	Date	Name	Comments
01	06.11.2018	KEV	Document creation date
02	08.10.2019	KEV	Specified port, on which the device transmits data

CONTENT

1 DESCRIPTION AND OPERATION

Network tester Vega TS-12 designed for testing LoRaWAN networks during its deploying and setting up

Tester sends a special signal to the LoRaWAN™ network ('Uplink' packet), in response to which the tester received a confirmation ('Downlink' packet).

Tester represents various information about network:

- «Uplink» frequency – frequency on which the request sent to the network (MHz);
- «Downlink» frequency - frequency on which the confirmation sent from the network (MHz);
- **SF** (spread factor) - coefficient determining the data rate of «Uplink» and «Downlink» signals;
- Tester's transmitter power (dBm);
- Requests number;
- **RSSI** (Received signal strength indicator) – «Downlink» signal power (dBm);

- Receiving window number at which confirmation was received (1 or 2);
- UDM - Uplink demodulation margin (hereinafter **UM**);
- DDM - Downlink demodulation margin (hereinafter **DM**);
- **PER** (packet error rate) – relation of the received packets number to the total number of sending packets expressed as a percentage;
- Number of visible gateways.

In addition, tester may represent information from navigation satellites:

- number of visible GPS and GLONASS satellites;
- **LAT / LON** – latitude / longitude – coordinates of tester;
- **UTC** – current satellites time;
- **ALT** – altitude;
- **SATU** – number of satellites from which navigation information received;
- **HDOP** - horizontal dilution of precision;
- quality of navigation signal.

Tester powered from [rechargeable battery](#) 550 mAh by which tester may work up to 16 hours with disable GNSS transmitter and up to 7 hours with GNSS transmitter turned on.

Tester configured via self-interface '[Settings](#)'.

2 SPECIFICATION

| Main	
Operating temperatures	-40...+85 °C
Display	OLED, 1,3"
USB-port	micro-USB, 5 V, 500 mA
LoRaWAN	
LoRaWAN class	A
Supported LoRaWAN channels number	No less than 16
LoRaWAN antenna type	internal
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	Up to 100 mW (configurable)
GNSS	
Sensitivity of GNSS transmitter, not less than	-160 dBm
GNSS antenna type	internal
Power	
Rechargeable battery	550 mAh
Case	
Ingress protection rating	IP64
Housing dimensions	90 x 52 x 31 mm

3 FAST NETWORK TESTING

Press 'OK' button

Waiting for device loading
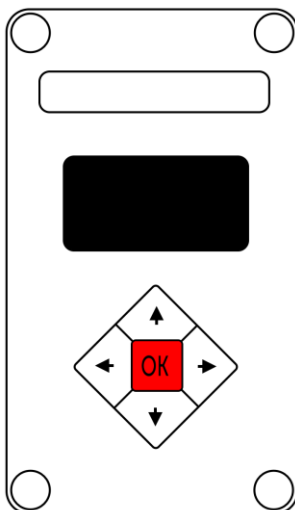
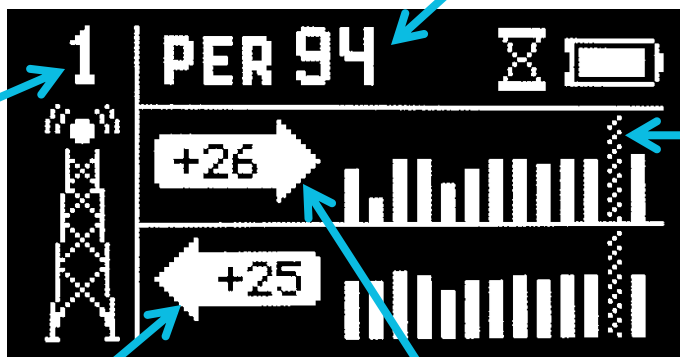Press 'Left' button for display switching

Press 'Up' button:

The first pressing – connection to the network, the second – network test
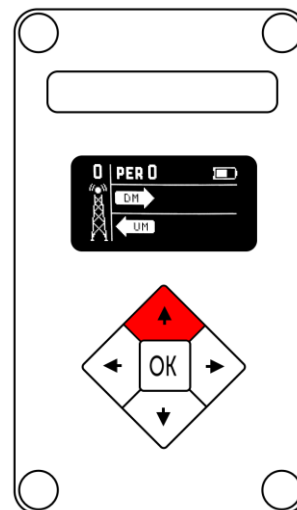
Successful transmissions in percent

Gateways number

No signal / no data

Uplink demodulation margin in dBm

Downlink demodulation margin in dBm

PER 80-100   10+
PER 41-79   5-10
PER 0-40   0-5

4 DEVICE OPERATING

USER INTERFACE

Tester equipped with control buttons, sound speaker and OLED display. Every pressing on the button accompaniment with sound signal if device sound is not off.

To common main menu it need to press 'OK' button while device is on. Menu appears independent on what was on the display before button pressing.
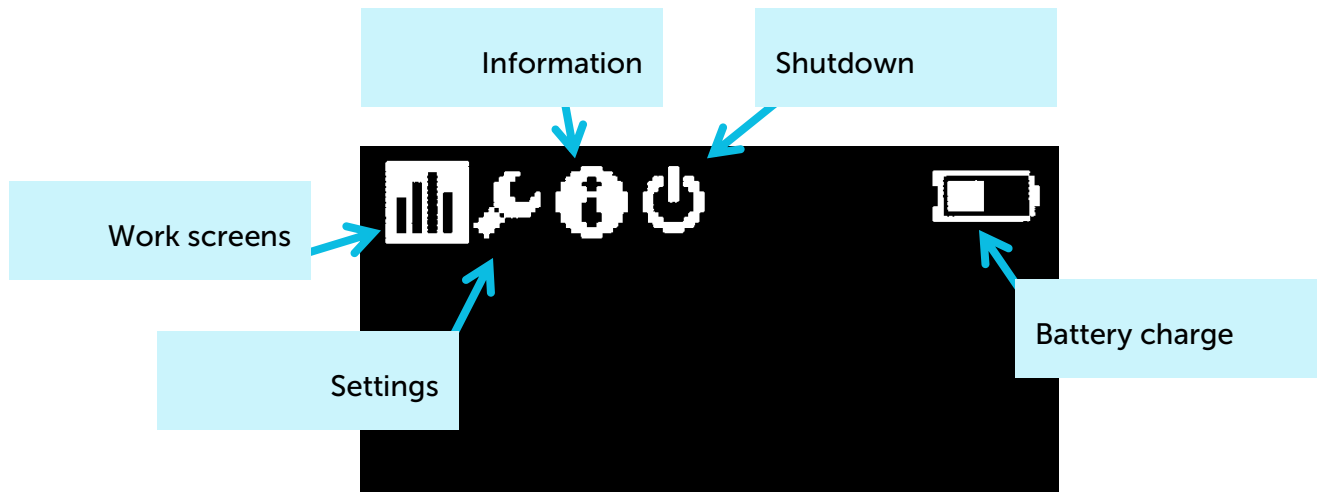
'Right' and 'Left' buttons is using for navigating through the menu. Press 'OK' button for select a menu item. Main menu contains the follow items:

Work screens – screens with the full information about the network.

Settings – tester settings screen.

Information – displays the keys and identifiers of the tester.

Shutdown – choose that item to switch device to low power consumption mode.

Battery charge – battery charge indicator.

WORK SCREEN 1 –UPLINK AND DOWNLINK DEMODULATION MARGIN

Work screen 2 appears just after device switch on. Switching between screens carried out by pressing 'Left' and 'Right' buttons. During the testing process, you can freely navigate between them to get more completely information about the network.

For the work screen 1 appearing, you can press 'Left' button after device switch on. Herewith the data is not available on it. Work screen 1 allows you to get the follow information:

- Number of visible gateways;
- PER coefficient – percent of successful transmissions;
- Margin demodulation diagrams and numerical values of UM and DM of the last session.

Percent of successful transmissions

Battery charge

Number of gateways

DM – Downlink Margin demodulation

'Gateway' icon

UM – Uplink Margin demodulation
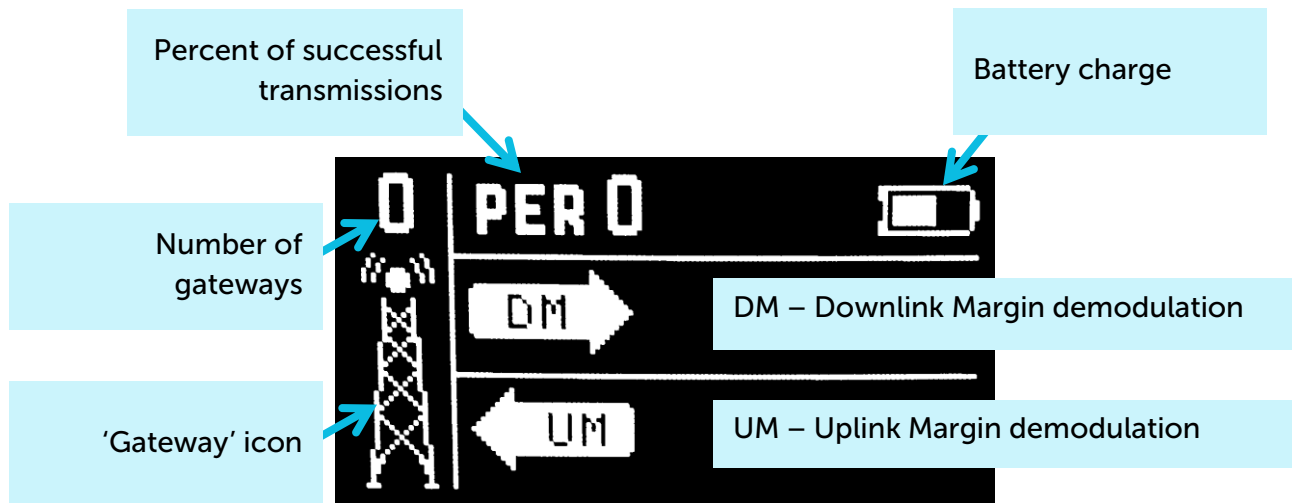
Margin demodulation is the positive integer value displayed in dBm and indicating how much received signal above the demodulation threshold. '0' value means that the packet was received on the bottom of demodulation (0 dBm), whereas, for example, '20' value means that the packet was received on 20 dBm above the demodulation threshold.

|	
from 0 to 5	Communication on the brink of failure, unstable connection to the network
from 5 to 10	Border zone, stable communication is not guaranteed
above 10	Good signal strength, confident communication

'Gateway' icon - displays the activity of the communication process as an animation. Animation continues until the confirmation is accepted or the receiving window timeout expires.

Number of gateways - the number of gateways received the last packet from the network tester successfully.

Percent of successful transmissions – PER (Packet error rate) coefficient is calculated as the ratio of the number of confirmations received by the tester from the network to the total number of requests, expressed as a percentage. It can vary from 0 (no one confirmation has come, or PER is less than 1% and rounding up to integer) to 100% (the number of confirmations is equal to the number of requests).

Battery charge – displays the current battery charge status. When the battery is critically discharged, the icon becomes empty, flashes, and the tester emits a periodic beep. The approximate remaining time of operation is not more than 5 minutes, it is necessary to charge the battery.

The first time the 'Up' button is pressed, the tester sends a request to the network to join the network (hereinafter '**join-request**'), which is displayed on the UM (Uplink demodulation margin) diagram as a shaded bar. If the tester is successfully connected to the network, a filled bar appears in the DM diagram (Downlink demodulation margin).
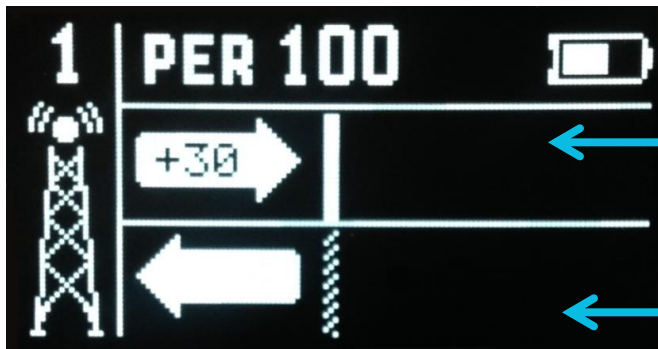
Connection to the network is successful – filled bar

Join-request, is displayed as a shaded bar

A shaded bar appears on the DM diagram if a failed attempt is made also. In total, the network tester takes three attempts to join the network.
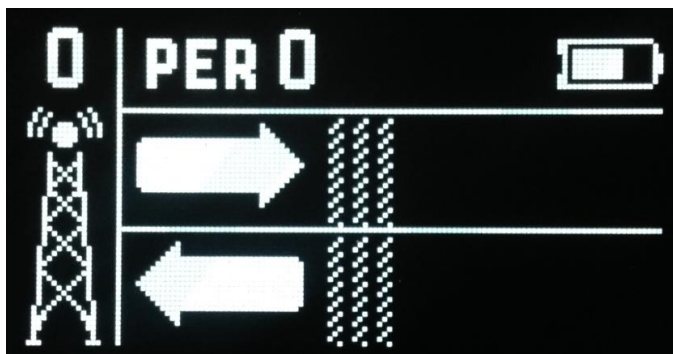
Three failed attempts to join the network

After successful joining the network, you can start testing the network. There are two ways: **manual** and **automatic**. In the first case, the network tester sends an Uplink request to the network each time the 'Up' button is pressed. In the automatic mode, the tester will send requests itself with the period specified in settings, and also by pressing the 'Up' button.

'P' icon – automatic mode indicator is located near the 'Gateway' icon. If it is, automatic test mode is on, if not - off.

'GPS' icon

DM diagram

UM diagram

'P' icon
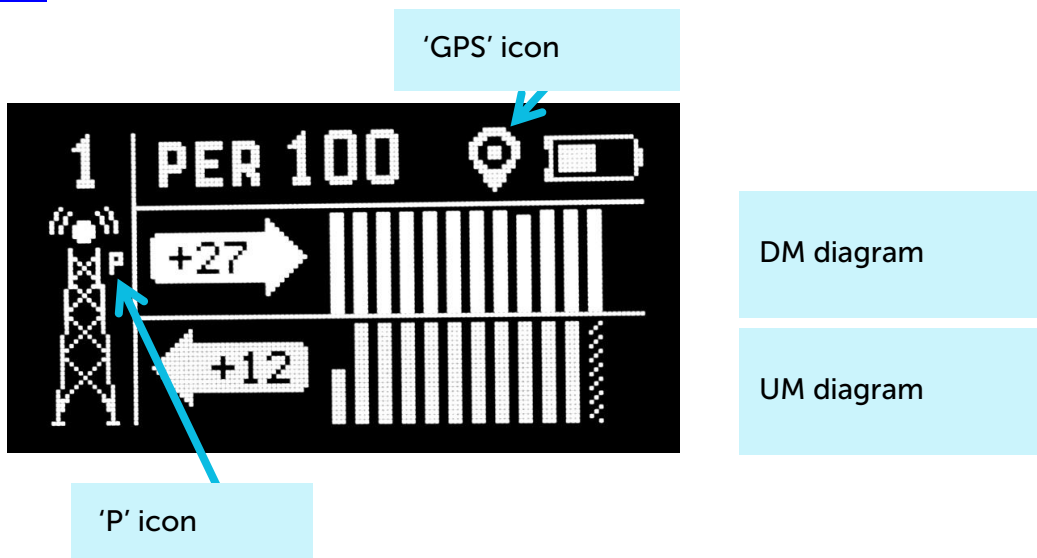
Diagrams DM and UM - the arrow indicates the direction of the radio signal propagation, and the diagram shows the history of its change. The level of each bar on diagram shows the demodulation margin of a particular packet. The latest (recent) radio communication is displayed on the bar located next to the arrow. On the arrow is displayed the numerical value of the demodulation margin in dBm of the latest radio communication. During the execution of new communications, the diagram shifts to the right.

'GPS' icon - satellite positioning function indicator located in upper right screen side. If it is satellite positioning function is on, if there is no – off.

If the radio communication has not passed or the data has not been received, for example, an error occurred during reception or the confirmation window timeout expires, the shaded bar is displayed (that bar type has no level and occupies the entire amplitude of the diagram).

WORK SCREEN 2 – FULL INFORMATION ABOUT THE NETWORK

Work screen 2 allows you to get the following information:

- PER coefficient – percent of successful transmissions;
- Number of visible gateways;
- Tester's join status;
- Number of packets transmitted by the tester - **COUNT**;
- **UM** (demodulation margin), **P** (power), **SF** (spread factor) and **FQ** (frequency) of the latest transmitted packet;
- Receiving window number of the latest received confirmation - **slot**;
- Number of packets received by the gateway - **COUNT**;
- **DM** (demodulation margin), **RSSI** (signal level), **SF** (spread factor) and **FQ** (frequency) of the latest received packet.
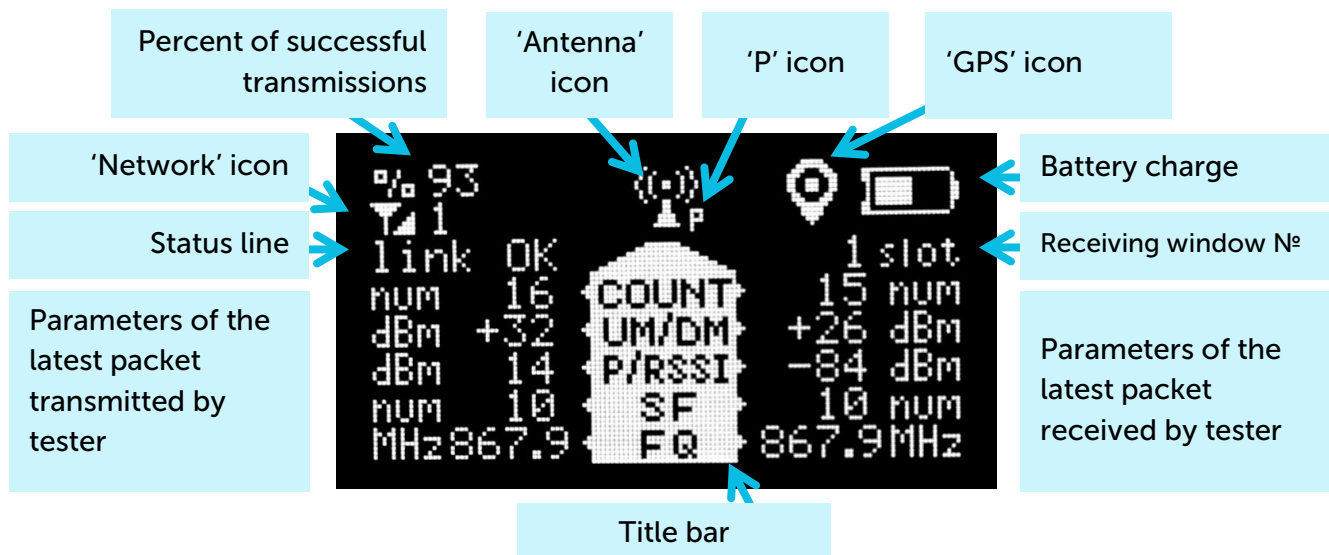
Unlike other screens, the work screen 2 displays information only about the last communication session. The accumulated data here is the PER coefficient and the total number of received / transmitted packets.

Percent of successful transmissions – PER (Packet error rate) coefficient is calculated as the ratio of the number of confirmations received by the tester from the network to the total number of requests, expressed as a percentage. It can vary from 0 (no one confirmation has come, or PER is less than 1% and rounding up to integer) to 100% (the number of confirmations is equal to the number of requests).

'Network' icon - has two states: joined / disconnected. Next to the icon, the network capacity is displayed as a number of gateways that successfully received the latest packet from the network tester.

Status line – the current transmission status is displayed in text form:

- join TX – a request to join the network is performed;
- join RX – reception of confirmation to a network connection request;
- joined – the connection to the network was successful (the 'Network' icon changes its status);
- link TX – 'Uplink' request is performed;
- link RX – reception of confirmation 'Downlink';
- link OK – communication session was successful;
- time-out – 'Downlink' packet receiving window timeout expires;
- error – communication session error.

Parameters of the latest packet transmitted by tester – to the left of the title bar there is information display from top to bottom in order:

- COUNT – total number of 'Uplink' packets transmitted by the tester;
- UM – demodulation margin of the latest transmitted 'Uplink' packet;
- P – power of network tester transmitter;
- SF – Spread factor – the latest 'Uplink' packet transmitting rate indicator;
- FQ – frequency on which the latest 'Uplink' packet transmits.

Title bar – is located in the center of work screen. It is the list of displayed parameters. To the left of the title bar there is transmitting information displayed, to the right of the title bar there is reception information.

Parameters of the latest packet received by tester – to the right of the title bar there is information display from top to bottom in order:

- COUNT – total number of 'Downlink' packets received by the tester;
- DM – demodulation margin of the latest transmitted 'Downlink' packet;
- RSSI – the latest 'Downlink' packet power expressed as dBm;
- SF - Spread factor – the latest 'Downlink' packet transmitting rate indicator;
- FQ - frequency on which the latest 'Downlink' packet transmits.

'Antenna' icon – is located above the title bar and displays the moments of sending and receiving packets as an animation.

'P' icon – automatic mode indicator is located near the 'Antenna' icon. If it is, automatic test mode is on, if not - off.

'GPS' icon - satellite positioning function indicator located in upper right screen side. If it is satellite positioning function is on, if there is no – off.

Battery charge – displays the current battery charge status. When the battery is critically discharged, the icon becomes empty, flashes, and the tester emits a periodic beep. The approximate remaining time of operation is not more than 5 minutes, it is necessary to charge the battery.

Receiving window № - in the first or second window the latest 'Downlink' packet was received.

WORK SCREEN 3 – DOWNLINK SIGNAL RSSI AND UPLINK DEMODULATION MARGIN DIAGRAMS

Work screen 3 allows you to get the follow information:

- **RSSI** (Received signal strength indicator) – 'Downlink' signal power expressed as dBm;
- **UM** - demodulation margin of the latest transmitted 'Uplink' packet expressed as dBm;
- The presence of lost packets.

'Antenna' icon

'P' icon

RSSI as dBm

UM as dBm

RSSI diagram (Downlink signal power)

UM diagram (Uplink demodulation margin)
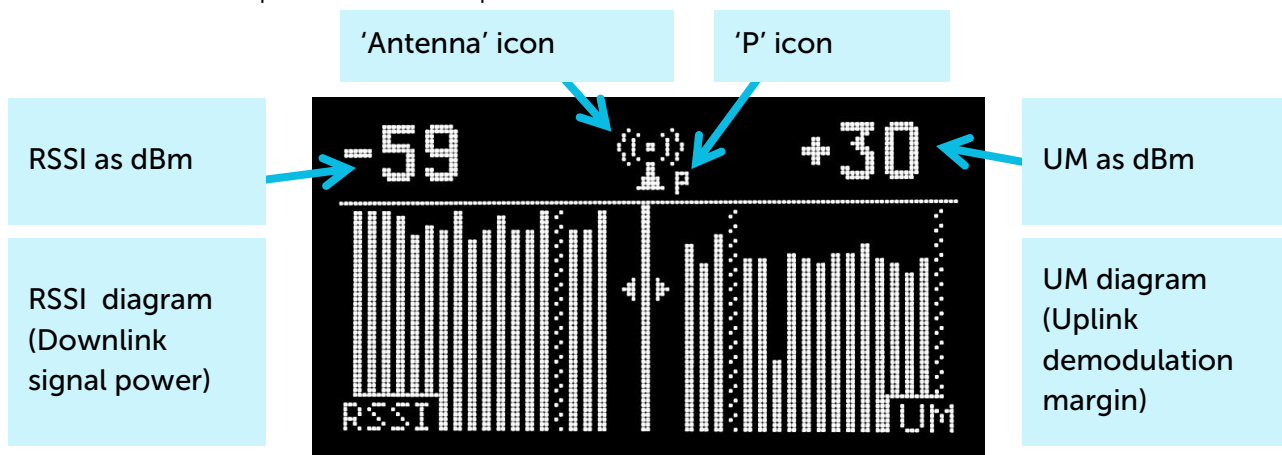
Please note that screen 3 does not show the battery charge level, and there is no satellite positioning function indicator. It is not confluence to the function work.

The left side of the screen displays an RSSI diagram, and in the upper left corner the RSSI value for the last received packet in dBm is shown. When a new packet is received, the diagram shifts to the left, and the bar corresponding to the last received value appears on the right side.

The right part of the screen displays the 'Uplink' packet demodulation diagram, and in the upper right corner the UM value for the last transmitted packet is displayed. When a new packet is

send, the diagram shifts to the right, and the bar corresponding to the last received value appears on the left.

If the communication session was successful and the data was received, then the bar on the diagram is filled with white color, if the session has not passed or the data is not received, then the bar is shaded.

'Antenna' icon - displays moments of transmission and reception of packets as an animation.

'P' icon – automatic mode indicator is located near the 'Antenna' icon. If it is, automatic test mode is on, if not - off.

WORK SCREEN 4 – SATELLITE POSITIONING

Work screen 4 allows you to get the follow information:

- Number of visible satellites **GPS** and **GLN** (GLONASS) all and separately;
- Relative satellite signal level;
- Tester coordinates **LAT** (latitude), **LON** (longitude), expressed in degrees and **ALT** (altitude), expressed in meters;
- **UTC** – world time in format hh:mm:ss;
- **SATU** – satellites number, used to determine current coordinates;
- **HDOP** – horizontal dilution of precision.
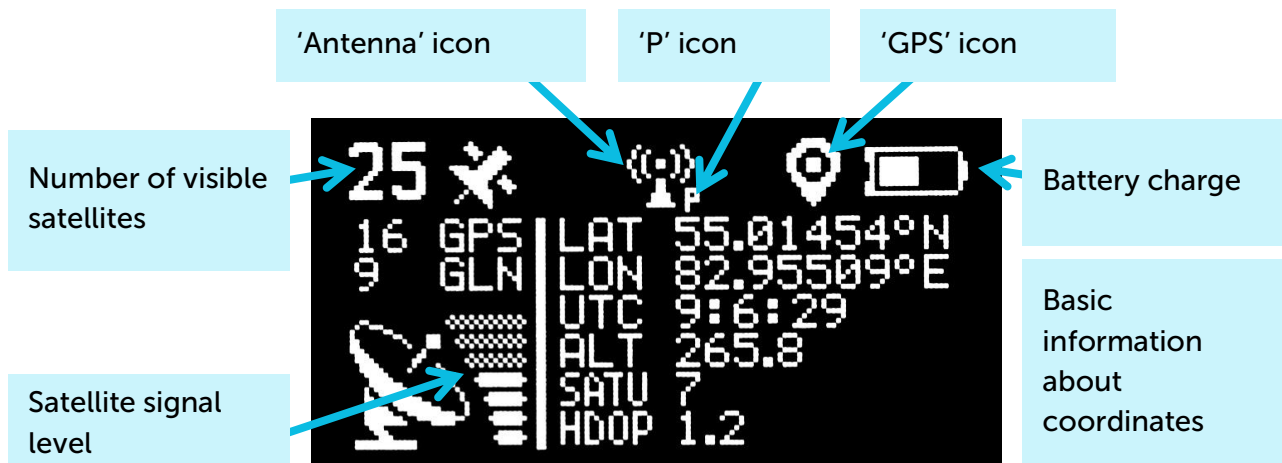
'GPS' icon - can take the form ⊙ or ⊠, or absent.

If satellite positioning function switch off there is no any information on work screen 4 in case of coordinates not determinate after tester last loading or there is a last navigation information in stable form. 'GPS' icon absent in that case and it means that displayed information not valid.

'GPS' icon absent, - all information not valid
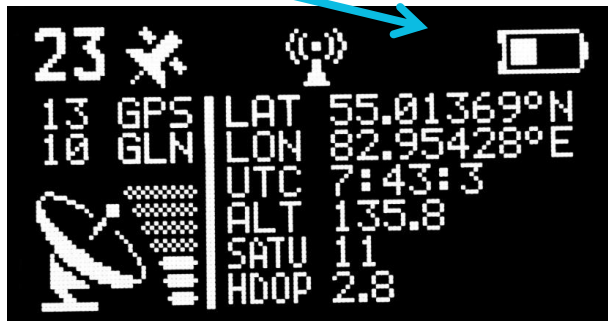
When satellite positioning function is on there are two possible states of 'GPS' icon:

Searching for satellites and determining coordinates; information about the number of satellites is relevant

Coordinates defined; all information is current and update once a second.

The left side of the screen displays the number of visible satellites and signal level; that information is valid always during the satellite positioning function is on.

The right side of the screen displays navigation data, coordinates, time, altitude, number of used satellites and HDOP. That information is valid while there is a 📍 icon only, and in that case the data update once a second.

Battery charge – displays the current battery charge status. When the battery is critically discharged, the icon becomes empty, flashes, and the tester emits a periodic beep. The approximate remaining time of operation is not more than 5 minutes, it is necessary to charge the battery.

'Antenna' icon – is located above the title bar and displays the moments of sending and receiving packets as an animation.

'P' icon – automatic mode indicator is located near the 'Antenna' icon. If it is, automatic test mode is on, if not - off.

SETTINGS

To go to the settings menu, you need to call up the main menu by clicking on the 'OK' button. Press the 'Left' / 'Right' button to move the cursor to select the 'Settings' icon and press the 'OK' button again. A screen with a list of settings or PIN-code enter screen appears if a PIN access to settings is enabled.

All settings saved when the power turned off

**Move through the settings menu - the 'Up' / 'Down' buttons, change the settings - the 'Right' / 'Left' buttons**

Frequency plan – choice of the frequency standard. EUR – European frequency plan. RUS – Russian frequency plan. USER – custom frequency plan.

Adjust USER plan – while pressing the 'Right'/'Left' button an additional screen appears on which you can set a custom frequency plan.

That screen is seems like below:
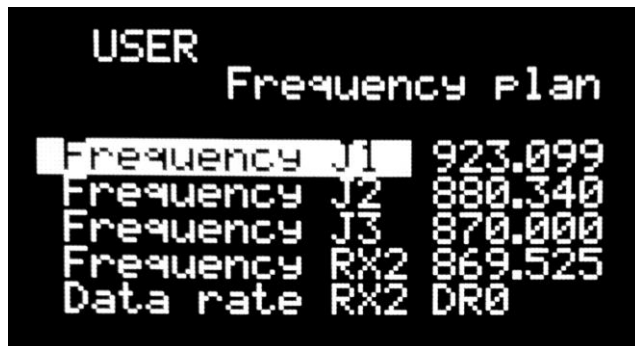
Move through the parameters list – the 'Up' / 'Down' buttons, parameter choice – the 'Right' / 'Left' buttons, edit choosing value – the 'Up' / 'Down' buttons
Move on level above – the 'OK' button

The custom frequency plan is limited in the range of 860-960 MHz. The data rate (DR) of the second receiving window (RX2) can take values from 0 to 5, where 0 corresponds to spread factor 12 (SF12).

ADR – allows to on/off an automatic data rate set of the 'Uplink' packet and the first receiving window also. ADR parameter have not influence on the data rate of the second receiving window.

Data rate – sets data rate of the 'Uplink' packet and the first receiving window while ADR parameter is switched off and can vary from 0 to 5. When ADR parameter is switch on the first attempt to join the network will initiates with this data rate value.

Device sound – switch on/off the network tester sound. ON – all sound signals is on. OFF – all sound signals is off.

Logotype – logotype displaying while device is switching on. ON – logotype and firmware version are displayed, OFF – no logotype and firmware version are displayed, there is work screen 1 appears at once.

Auto-off minute – set timeout of automatic network tester switch off. Timeout sets in minutes from 1 to 60. The timeout restart each time for the specified period by pressing any button

on the device. If no device button is pressed, then after timeout expired the network tester goes to sleep mode, to save the battery power.

The auto-off function is deactivated during the device operates in the automatic test mode.

Request period – set automatic test mode period. The period may be equal to any value from 30 seconds to 24 hours accurate to a second. There is the follow display format – hours:minutes:seconds. One pressing on the 'Right' button will increase the counter by one second. If you press the 'Right' button and hold it, the counter will start increase by 1 minute. If you hold the button for more than 5 seconds, the minutes counter will accelerate to 5 minutes at a time and so on. After the value 24:00:00, the value 00:00:30 appears again. The 'Left' button decreases the counter value in the same way.

Confirm uplink – allows to on/off a function of confirmation uplink.

Menu language – switching between menu languages: RU – Russian, EN – English language.

GPS – allows managing satellites positioning function. If the function is ON then the device activates GNSS transmitter and listen the satellites updating coordinates once a second independently of buttons pressing or other work with the device. When communication session with the server occurs, the device sends the current coordinates with other data in standard packet. If the function is OFF then the GNSS transmitter inactive, coordinates does not determinate and standard packet not contain information about the coordinates.

Use PIN – allows to on/off PIN-code request for access to the settings menu. If the parameter is ON then the PIN-code setting below parameter will be required for access to the settings.

PIN – set the PIN-code for access to settings menu.

PIN-CODE ACCESS TO SETTINGS

In case of need you may to limit access to settings menu by the forth sign code. This parameter is set in settings and when the parameter is ON the enter PIN field appears with every attempt of settings menu call.

«Up», «Down» buttons allow you change digit values, and «Right», «Left» buttons allow you jump between them. When you enter the code, you should press «OK» button.

If you mistake, the «WRONG» message will appears and the tester will emit a characteristic beep (if sound is ON). When «OK» pressed again, the tester displays the main menu.

The number of attempts is not limited.

If you enter the right code, the «OK» message will appears and the tester will displays the settings menu.

If you enter the right code and come out from settings menu to the main menu, the tester will not require enter PIN-code again with attempt the settings menu re-call. You will should to enter PIN-code again when you come from the main menu on any other display and the next attempt to access the settings menu.

AUTOMATIC TEST MODE

In the automatic mode, the tester will send requests itself with the period specified in settings, and also by pressing the 'Up' button. Automatic requests period will not be shifted when the request initiates by the 'Up' button pressing. The period may be equal to any value from 30 seconds to 24 hours accurate to a second.

The automatic mode can only be switched on or off on work screens 1 and 2. On the work screen 3, the automatic mode works, but it is impossible to control it and the 'Hourglass' icon is not displayed.

To switch device to automatic mode, press the 'Up' button and hold for 1 second until the characteristic sound signal and / or the "Hourglass" icon appear. You can disable automatic mode in the same way.

The first request will be made after the period specified in the settings since the mode was activated.

The function is not non-volatile; the function will be disabled the next time when the network tester is turned on. The auto-off function is disabled during the device operates in the automatic test mode.

INFORMATION

To go to the section with information, you need to call up the main menu by pressing on the 'OK' button. Press the 'Left'/ 'Right' buttons to move the cursor to select the 'Information' icon and press the 'OK' button again. A screen with a list of network tester IDs for registering it on the network will appear. The 'Left' / 'Right' buttons allow you to scroll through the pages of the 'Information' section, which include:

- DevEui, DevAddr,
- AppEui, AppKey,
- NwkSKey, AppSKey,
- And the device name, manufacture and firmware version are displayed on the last page.

SHUTDOWN

To switch the network tester into low power mode, without waiting for auto-off, you must select the 'Shutdown' icon in the settings menu and press 'OK' button or press and hold the 'Down' button during a second. Thus, you can turn off the tester at any time, even when the automatic test mode is on.

BATTERY CHARGING

The device is equipped with a battery. When device is connected to a micro USB, the battery charging starts automatically, regardless of whether the device is turned on or off. In addition, if the device is turned on, the charging process is displayed on the screen as an animation

of the battery icon, the capacity of which increases with time. The device can be used during charging.

FIRMWARE UPDATE

Updating the firmware of the network tester is carried out through the micro USB port using the configurator - "Vega LoRaWAN configurator". The configurator can be downloaded from http://iotvega.com/ in the Soft section. The firmware file can be downloaded from the product page - Network Tester.

1. Download and unzip the configurator to a folder.

2. Run the «Vega LoRaWAN configurator» application. Configurator window opens then choose 'Information' tab.
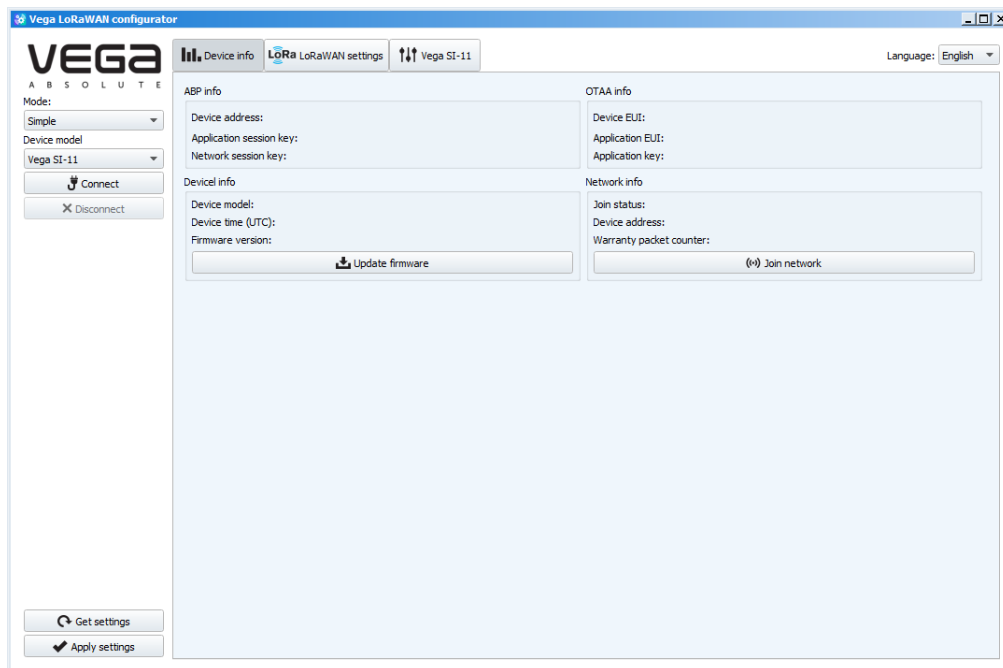
3. Press 'Update firmware' button. The dialog window will appears. Choose 'Yes' and specify the path to the firmware file with the extension *.vbf
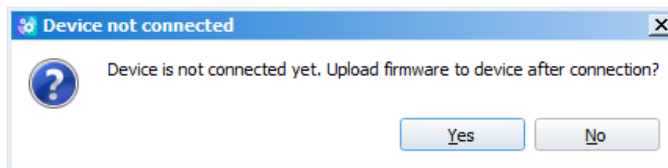
4. Connect the network tester to a personal computer via a USB port and turn on the network tester. After the tester is turned on, the bootloader runs (the firmware update program) which activity is displayed with the inscription 'BOOT'.
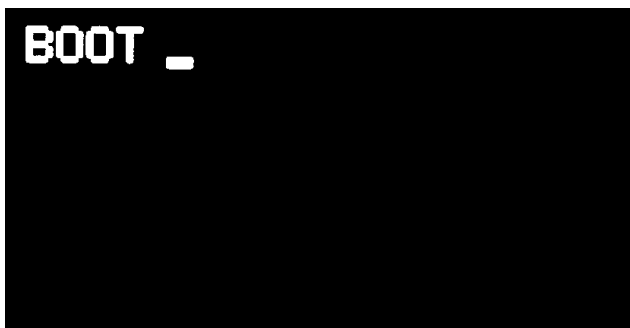
5. While the loader is active (while the tester's screen displays the 'BOOT'), you should to click the 'Connect' button in the "Vega LoRaWAN configurator" application. The firmware file will download. The boot process is displayed both in the configurator and on the network tester screen. At the end of the boot process, the network tester will immediately start running under the updated program.

5 COMMUNICATION PROTOCOL

Network testers support communication protocol AdeunisRF LoRaWAN Demonstrator.

Standard packet made by the principle: there is a presence bit there is a data, there is no presence bit - there is no data. Packet sent on the LoRaWAN port 4.

Data	Byte	Bits	Description	Possible values
Presence bits	1	7	Information about temperature: 0 – no, 1 – yes	0 or 1
		6	Not used, always 0	0 or 1
		5	Packet transmitting reason: 0 – in automatic mode, 1 – by the button pressing	0 or 1
		4	Navigation data: 0 – no, 1 – yes	0 or 1
		3	Uplink packets number: 0 – no, 1 – yes	0 or 1
		2	Downlink packets number: 0 – no, 1 – yes	0 or 1
		1	Battery charge information: 0 – no, 1 – yes	0 or 1
		0	Information about RSSI and SNR: 0 – no, 1 – yes	0 or 1
Temperature	2	7...0	Temperature value in degrees in two's complement	-128...+127
Latitude	3	7...4	BCD coding of the tens of degrees	
		3...0	BCD coding of the units of degrees	
	4	7...4	BCD coding of the tens of minutes	
		3...0	BCD coding of the units of minutes	
	5	7...4	BCD coding of the tenths of minutes	
		3...0	BCD coding of the hundredths of minutes	
	6	7...4	BCD coding of the thousandths of minutes	
		3...1	Not used	
		0	Hemisphere code: 0 – North, 1 – South	0 or 1
Longitude	7	7...4	BCD coding of the hundreds of degrees	
		3...0	BCD coding of the tens of degrees	
	8	7...4	BCD coding of the units of degrees	
		3...0	BCD coding of the tens of minutes	
	9	7...4	BCD coding of the units of minutes	

		3...0	BCD coding of the tenths of minutes	
	10	7...4	BCD coding of the hundredths of minutes	
		3...1	Not used	
		0	Hemisphere code: 0 – East, 1 – West	0 or 1
Uplink counter	11	7...0	Uplink packets number	0...255
Downlink counter	12	7...0	Downlink packets number	0...255
Battery charge	13	7...0	MSB battery voltage in mV	
	14	7...0	LSB battery voltage in mV	
RSSI	15	7...0	RSSI absolute value in dBm (for example, 82 value means -82 dBm)	0...255
SNR	16	7...0	SNR signed value in dBm in two's complement	-128...+127

6 STORAGE AND TRANSPORTATION REQUIREMENTS

The network tester Vega TS-12 shall be stored in the original packaging in heated room at temperatures +5°C to +40°C and relative humidity less than 85%.

The tester shall be transported in covered freight compartments of all types at any distance at temperatures -40°C to +85°C.

7 CONTENT OF THE PACKAGE

Network tester delivered complete with:

Network tester Vega TS-12 – 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 supply elements;

- 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.