



NETWORK TESTER VEGA TS-11

User Manual

User Manual contains information how to work with LoRaWAN™ network autonomic tester Vega TS-11, and also contains warranty terms and conditions and rules for operating, storage and transportation

www.vega-absolute.ru

Document information	
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This document applies to the following products:

Product name	Type number
End devices	Vega TS-11

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Revision	Date	Name	Comments
01	28.09.2017	KEV	Document creation date
02	27.12.2017	KEV	New paragraphs at 'Settings' menu
03	24.10.2018	KEV	Number of channels is added to specification
04	13.08.2019	KEV	Added communication protocol

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1 DESCRIPTION AND OPERATION

Network tester Vega TS-11 is designed for testing LoRaWAN networks while they are 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.

Tester powered from [rechargeable battery](#) 550 mAh by which tester may work up to 16 hours.

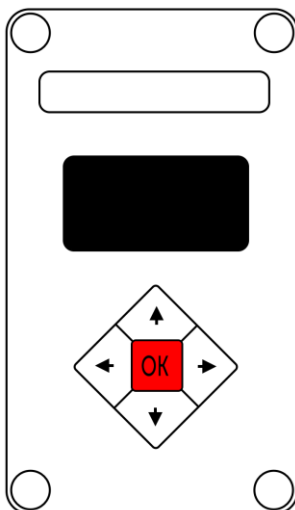
Tester configured via self-interface '[Settings](#)'.

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
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)
Power	
Rechargeable battery	550 mAh
Case	
Ingress protection rating	IP64
Housing dimensions	90 x 52 x 31 mm

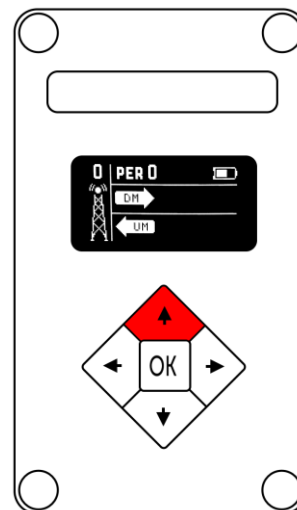
3 FAST NETWORK TESTING

Press 'OK'
button



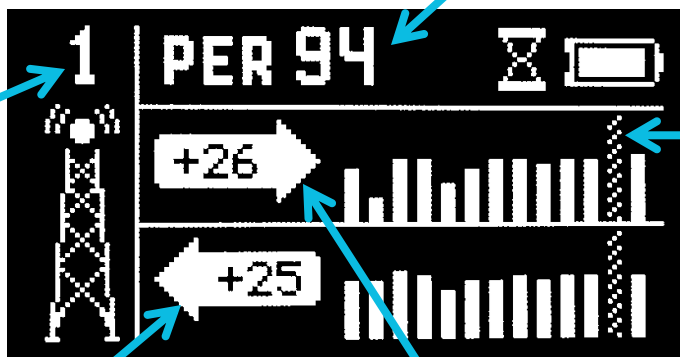
Press 'Up'
button:

The first
pressing –
connection to
the network, the
second –



Successful
transmissions in
percent

Gateways
number



No signal / no
data

Uplink demodulation
margin in dBm

Downlink demodulation
margin in dBm

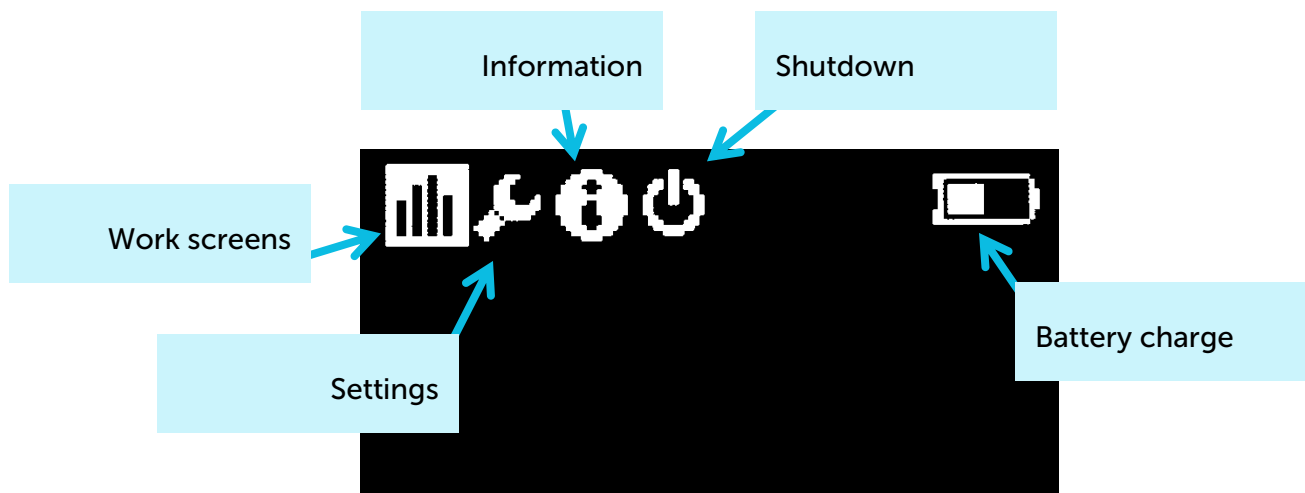
PER 80-100	10+
PER 41-79	5-10
PER 0-40	0-5

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.

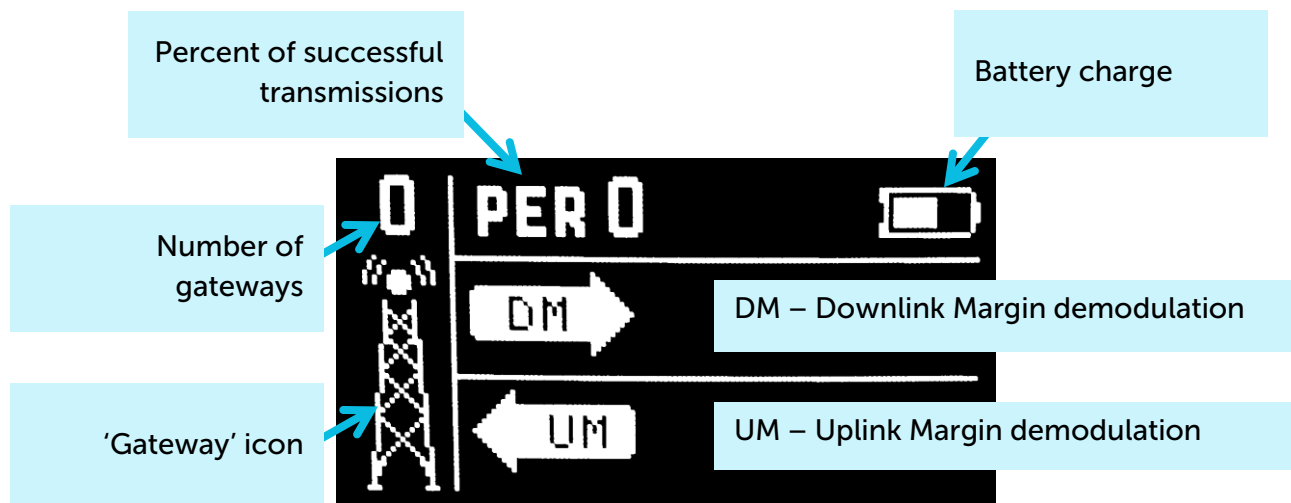
[Shutdown](#) – choose that item to switch device to low power consumption mode.

[Battery charge](#) – battery charge indicator.

WORK SCREEN 1 – UPLINK AND DOWNLINK DEMODULATION MARGIN

First work screen appears just 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.



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

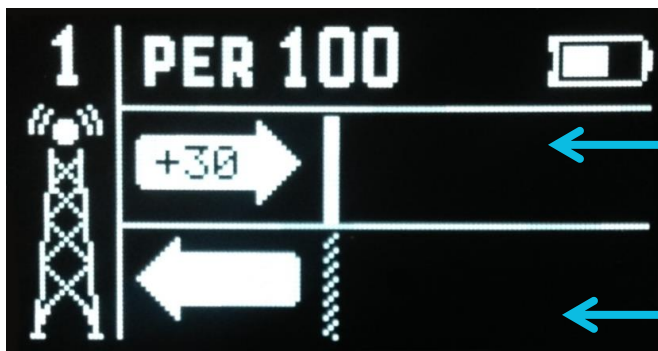
'Gateway' icon - displays the activity of the communication process as an animation. Animation continues until the confirmation is accepted or the receiving window timeout expires.

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](#).

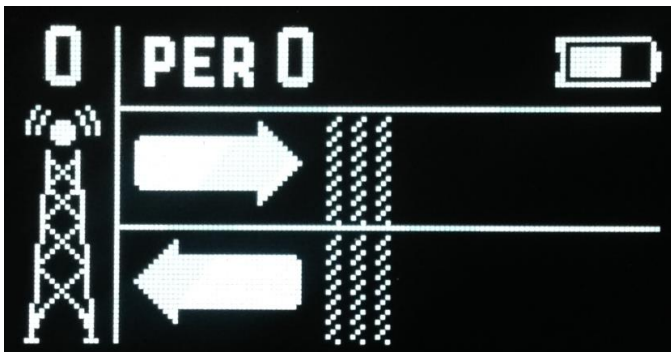
The first time the 'Up' button is pressed, the tester sends a request to the network to join the network (hereinafter 'join-request'), which is displayed on the UM (Uplink demodulation margin) diagram as a shaded bar. If the tester is successfully connected to the network, a filled bar appears in the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

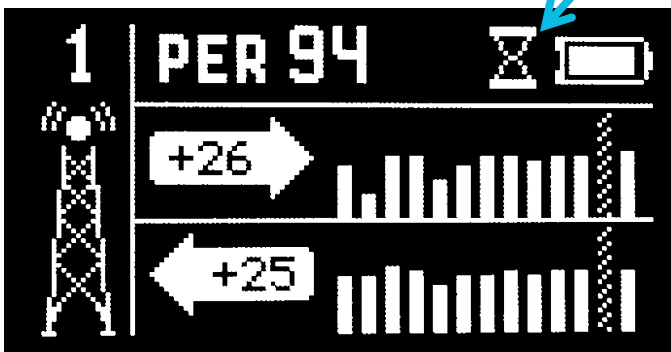


Three failed attempts
to join the network

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.

'Hourglass' icon – automatic mode indicator is located in the upper right corner of the screen. If it is, [automatic test mode](#) is on, if not - off.

'Hourglass' icon



DM diagram

UM diagram

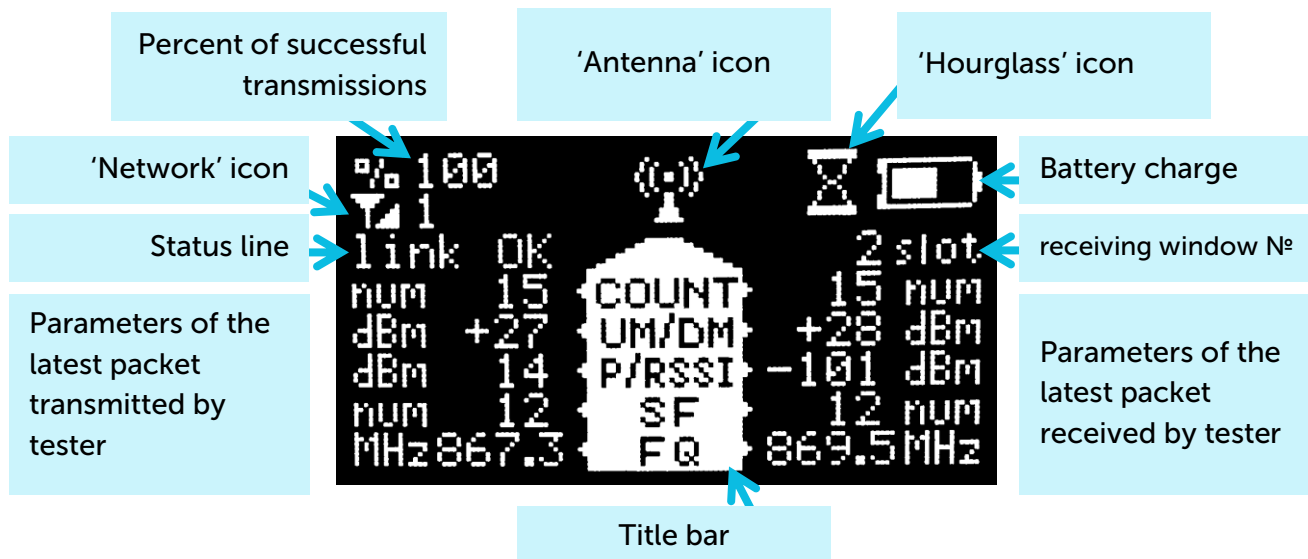
Diagrams DM and UM - the arrow indicates the direction of the radio signal propagation, and the diagram shows the history of its change. The level of each bar on diagram shows the demodulation margin of a particular packet. The latest (recent) radio communication is displayed on the bar located next 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.

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

Switching between screens is carried out by pressing 'Left' and 'Right' buttons. During the testing process, you can freely navigate between them to get more complete information about the network. Work screen 2 allows you to get the follow 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.

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

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 is displayed, to the right of the title bar there is reception information.

Parameters of the latest packet transmitted by tester – to the left of the title bar there is information is displayed 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.

Parameters of the latest packet received by tester – to the right of the title bar there is information is displayed 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.

'Hourglass' icon – automatic test mode indicator is located in the upper right corner of the screen. If it is, [automatic test mode](#) is on, if not - off.

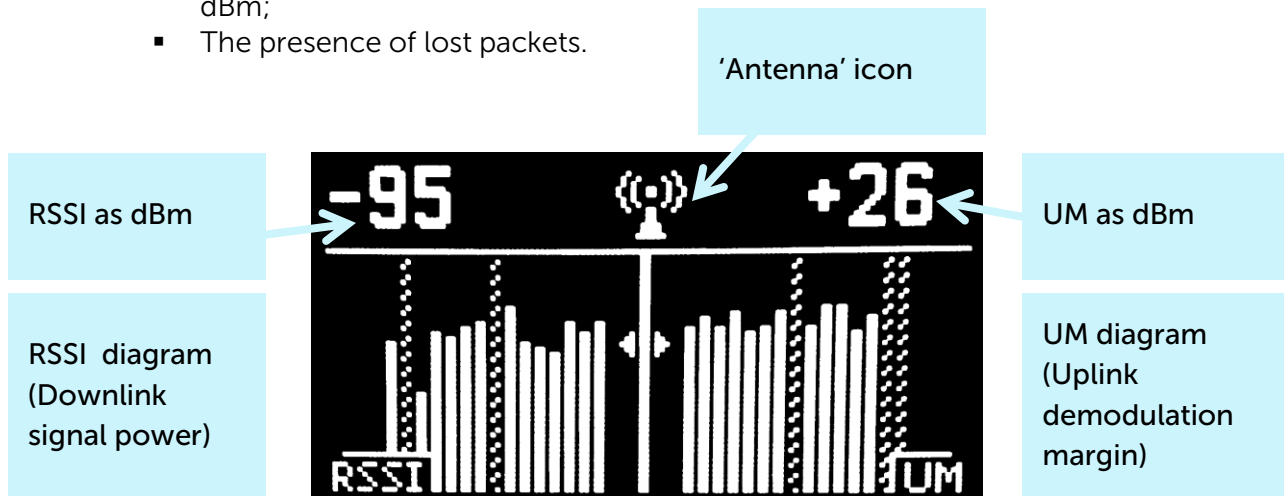
Battery charge – displays the current battery charge status. When the battery is critically discharged, the icon becomes empty, flashes, and the tester emits a periodic beep. The approximate remaining time of operation is not more than 5 minutes, it is necessary to [charge the battery](#).

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.



Please note that screen 3 does not show the battery charge level, and there is no way to enable / disable the [automatic](#) network testing mode.

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.

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 appears.

All settings are saved when the power is turned off

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

```

Frequency plan    EUR
Adjust USER plan ->
ADR              ON
Data rate        DR1
Device sound     ON
Logotype        ON
Auto-off minute  10
Request period   00:03:30
  
```

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

```

USER
Frequency plan
Frequency J1  923.099
Frequency J2  880.340
Frequency J3  870.000
Frequency RX2 869.525
Data rate RX2 DR0
  
```

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 is restarted 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.

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.

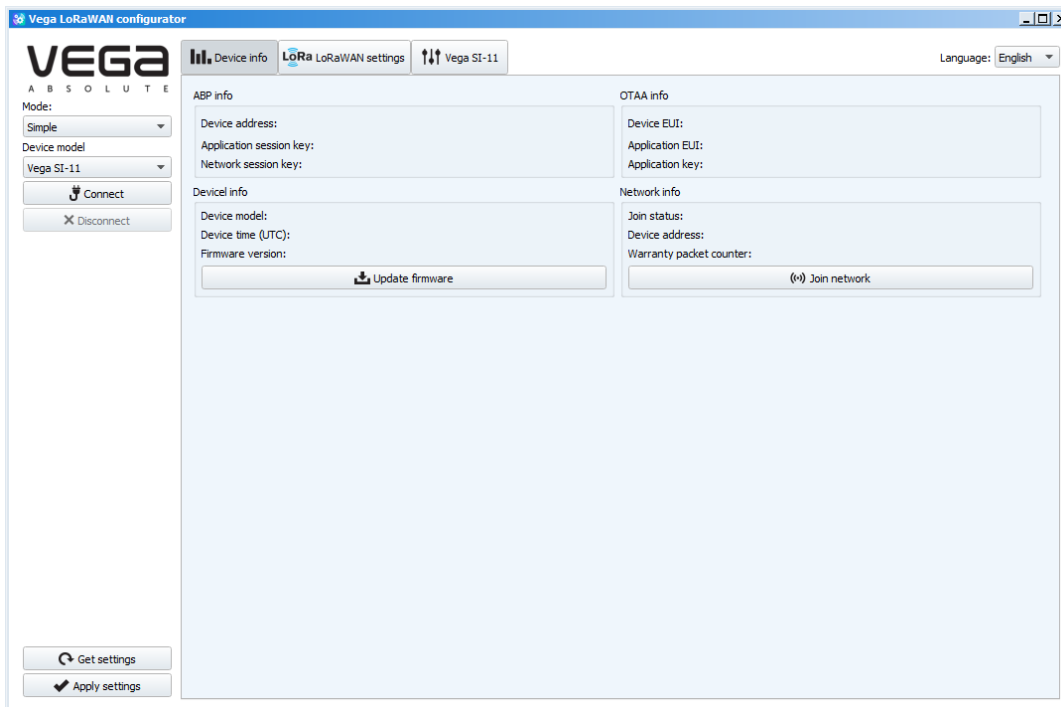
BATTERY CHARGING

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.

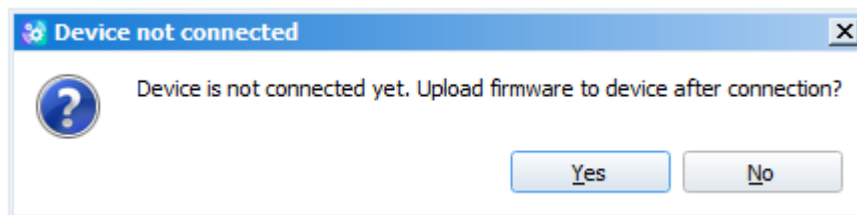
FIRMWARE UPDATE

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.

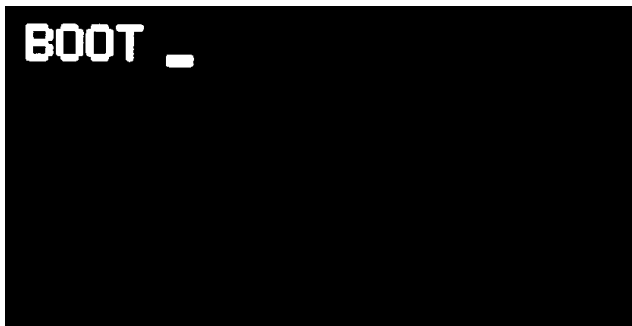
1. Download and unzip the configurator to a folder.
2. Run the «Vega LoRaWAN configurator» application. Configurator window opens then choose 'Information' tab.



3. Press 'Update firmware' button. The dialog window will appear. 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 'BOOT' is displayed on the tester's screen) it is necessary to click the 'Connect' button in the "Vega LoRaWAN configurator" application. The firmware file will be downloaded. 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 –s no data.

Packet sent by device 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
Uplink counter	2	7...0	Uplink packets number	0...255
Downlink counter	3	7...0	Downlink packets number	0...255
Battery charge	4	7...0	MSB battery voltage in mV	
	5	7...0	LSB battery voltage in mV	
RSSI	6	7...0	RSSI absolute value in dBm (for example, 82 value means -82 dBm)	0...255
SNR	7	7...0	SNR signed value in dBm in two's complement	-128...+127

5 STORAGE AND TRANSPORTATION REQUIREMENTS

The network tester Vega TS-11 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.

6 CONTENT OF THE PACKAGE

Network tester is delivered complete with:

Network tester Vega TS-11 – 1 pc.

Screw – 4 pcs.

Factory certificate – 1 pc.

7 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.



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