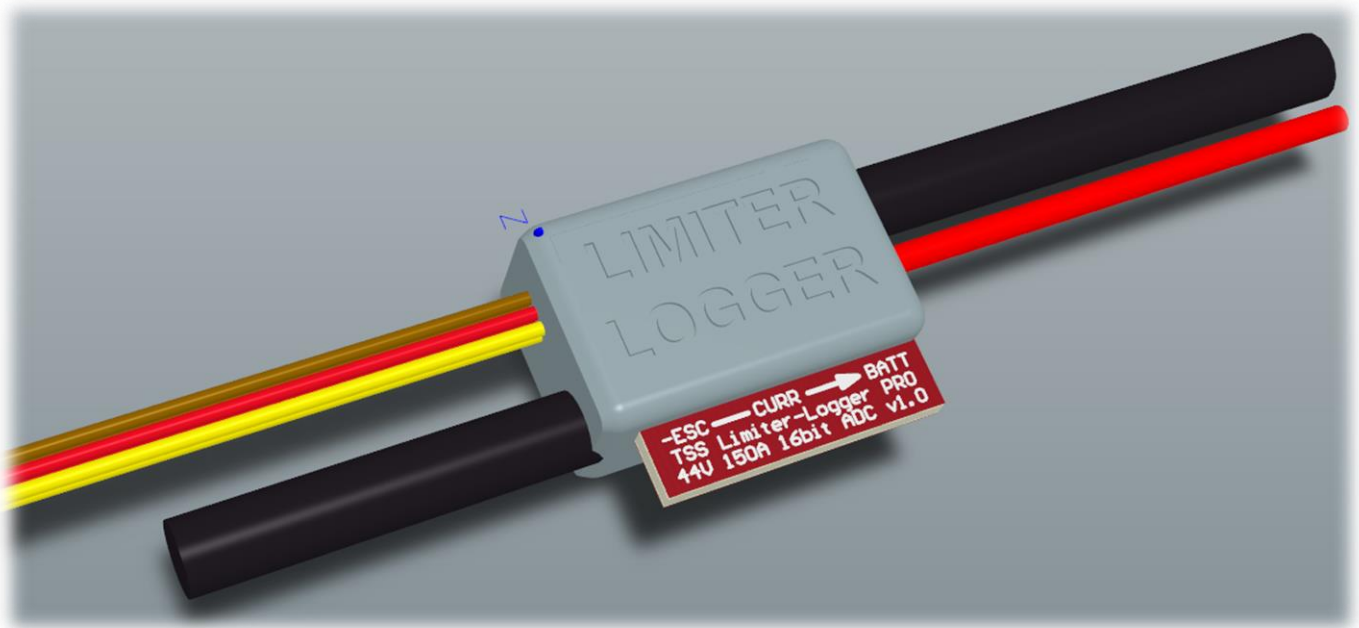


# Energy limiter for radio controlled models

## TSS Limiter (v.1.0 – v.3.5)

### User manual

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## Caution!

- **The red LED is constantly on!** This problem is typical for limiters versions 1.0.x and 1.1.x.

To restore the operation of the limiter, use the detailed instructions:

<https://disk.yandex.ru/i/aDo465sFD-gT3A>



- **It is forbidden to use the power switch of the electric motor speed controller in the negative wire, this will lead to failure of the limiter!** Use only the recommended connection diagram.
- **It is forbidden to use the limiter with ESC that have galvanic insulation!** In case of urgent need, it is strongly recommended to connect the power and signal grounds of the ESC with a wire with a minimum length, and external BEC, located as close as possible to the ESC (Appendix 1). These actions are performed at your own risk!
- **Limitation BEC voltage for version 3.0.1.** This version has a smaller margin for permissible voltage levels, do not use a BEC voltage greater than 5V, this may damage the limiter!

## Technical specification

Parameter	Versions 1.x, 2.x	Versions 3.x
MCU version	32bit mcu	
Type of communication interface	BLE 5.0 (Bluetooth Low Energy)	
Communication Interface range	100m (In direct visibility)	
Adc type	delta-sigma 16bit	delta-sigma 24bit
Sampling frequency	300 Hz	10 kHz
Measured voltage	0 – 43V (10S)	0 – 52V (12S)
Voltage measurement accuracy	$\pm 0.1\% + \pm 5mV$	$\pm 0.05\% + \pm 5mV$
Measured current (up to 20 sec)	1 – 150A	
Measured current (DC)	1 – 100A	
Current measurement accuracy	$\pm 0.5\% + \pm 50mA$	$\pm 0.25\% + \pm 40mA$
Measured energy	0 – 300kWh	
Energy measurement accuracy	$\pm 1.0\%$	$\pm 0.5\%$
Limiter shunt resistance	0.25mOhm	
Receiver signal (PPM 3.3-10V)	0.7 – 2.3ms	0.4 – 2.3ms (supported T-FHSS SR)
BEC voltage	4 – 8.4V * (recommended 5 – 8.4V*)	
Current consumption (from BEC)	6mA	14mA
Working temperature range	0 – 50°C	
IP rating	IP67	
Dimensions of the device (w/o wires)	22.5 x 19.5 x 10.5mm	21 x 18 x 10mm (Lite) 22.5 x 19 x 10mm (Pro)
Weight (Including all wires and plugs)	18g	13g (Lite mini), 19g (Lite), 16g (Pro mini), 22g (Pro)
Wire to receiver length	240 $\pm$ 20mm	
Wire to ESC length	40 $\pm$ 10mm	

Type of signal wires	22AWG (JR) or 26AWG (JR)	
Type of the power wire	AWG10 (AWG13 – for mini version)	
Logger (only Pro version)	51 min for 10Hz	106 min for 10Hz
Logger write frequency	1 – 10Hz	1 – 100Hz
RPM and speed measure	Only v.2.0	Only v.2.5 Pro
Active energy control (AEC)	–	Yes (firmware > 23.2)
Status	Discontinued	Active

\* Version 3.0.1 has a maximum voltage limit of 5V. This voltage must not be exceeded!

## Useful links

- Telegram channel: <https://t.me/TSSLimiterNews> (All news about firmware updates, new versions of programs are posted in this channel);
- Network drive with new versions of firmware and programs: <https://disk.yandex.ru/d/s9IeueLSqpWJFA>



- <https://tsslimiter.com> Main site.

## Introduction

The energy limiter for radio-controlled models (hereinafter the limiter) is intended for calculation and limitation of the energy consumed by the model.

The device is equipped with the Bluetooth Low Energy (BLE) interface for communication with mobile devices or computers which allows to perform its settings and receive the current readings without need of having direct access to and its removing from the model.

The device can be used both for running the competitions to limit the energy consumed by the model from the accumulator and for training intentions to set the model and take the actual readings on current, voltage, energy and consumable battery capacity.

The device fully meets the Naviga requirements which allow using it in all kinds of registered or non-registered competitions according to Naviga rules. In event of rule changes, the new array of device settings will be available in new firmware upgrades of the device. The firmware upgrade is performed through the user`s phone or PC, you need not send the device anywhere. The firmware upgrade procedure is described below.

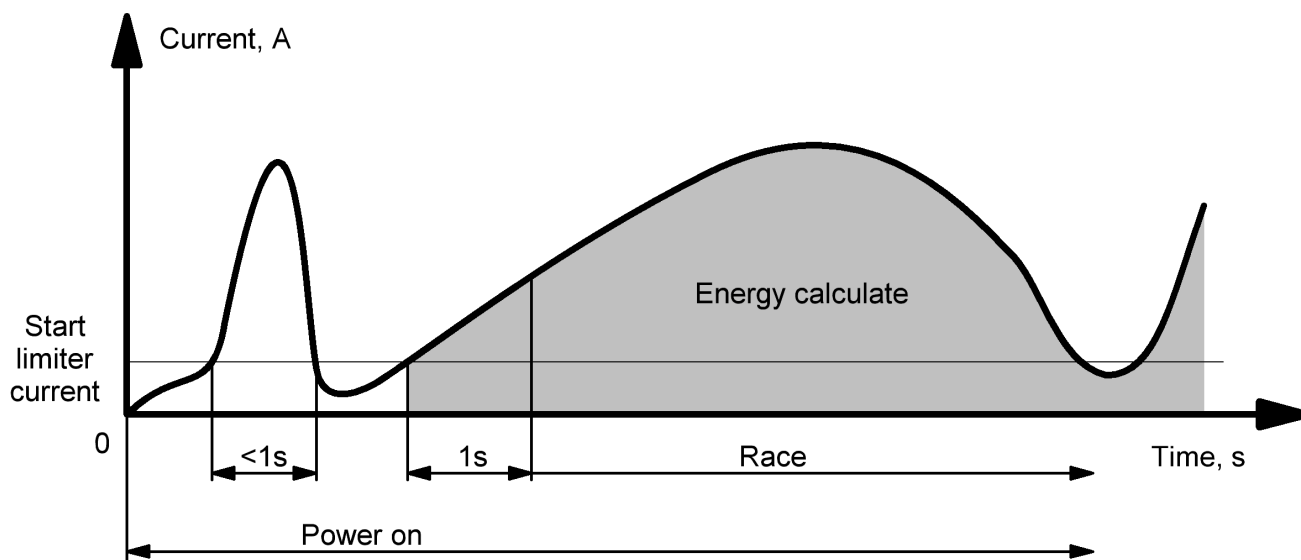
Each device instance has its own unique 32-bit number used for identification.

The limiter has the system for voltage control before racing and after racing which allowing the judge to check the voltage level without need of having the model opened.



## Description of device operation

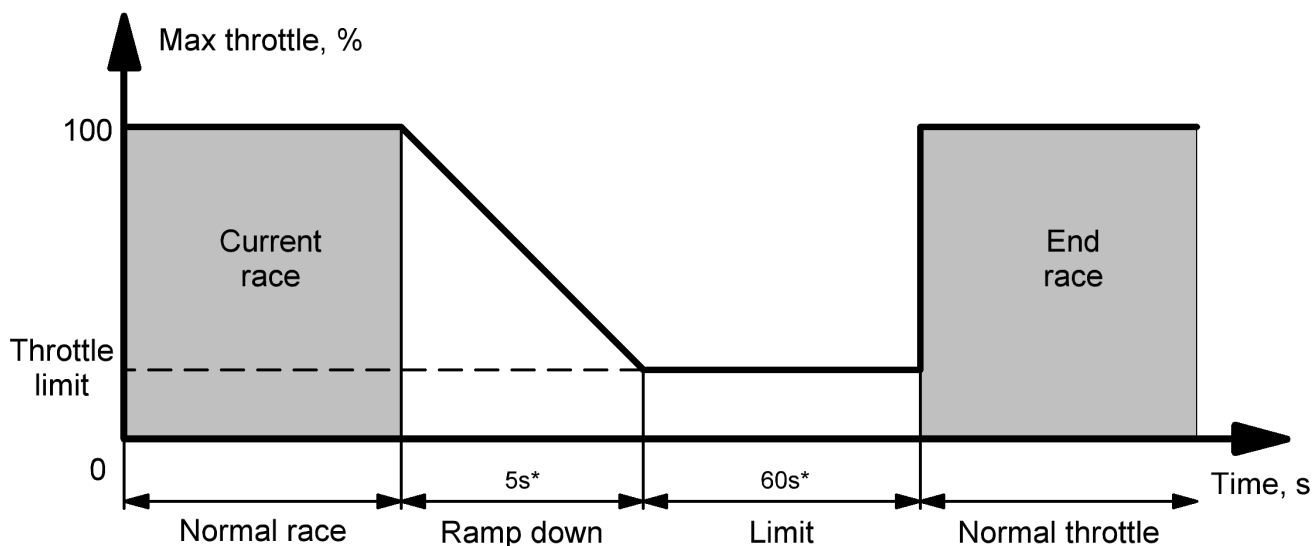
The startup algorithm for energy calculation is presented in Figure 1:



**Figure 1. The startup of energy calculation**

The user can check the engine start any number of times provided that check time will be less than 1 second or if the current will be less than the starting current for energy calculation.

The device operation principle in the mode of energy limiter is presented in Figure 2. Until the moment when the current energy value exceeds the maximum, the competition runs in a common way, as if without the limiter. After exceeding the energy maximum, the soft limitation of the top speed takes place by changing the control signal from the receiver to the ESC.



**Figure 2. Transfer to the energy limitation mode**

After the limit time is expired, the limiter will switch to the mode without restrictions, in this mode, the model can reach the starting bridge to complete the race.

**If the ESC power is turned off (using emergency switch) during a race or during a rampdown, the limiter, when turned on again, will continue to calculate the energy or rampdown if the energy has already exceeded its peak.**

Reset of the limiter to the initial state from the state of the running race is possible only after fully disable battery from limiter, or manually using button.

## Indication

The device has a green LED indication.

With the indication you can understand what mode the device is in and what settings are used.

Indication is carried out periodically according to the following algorithm:

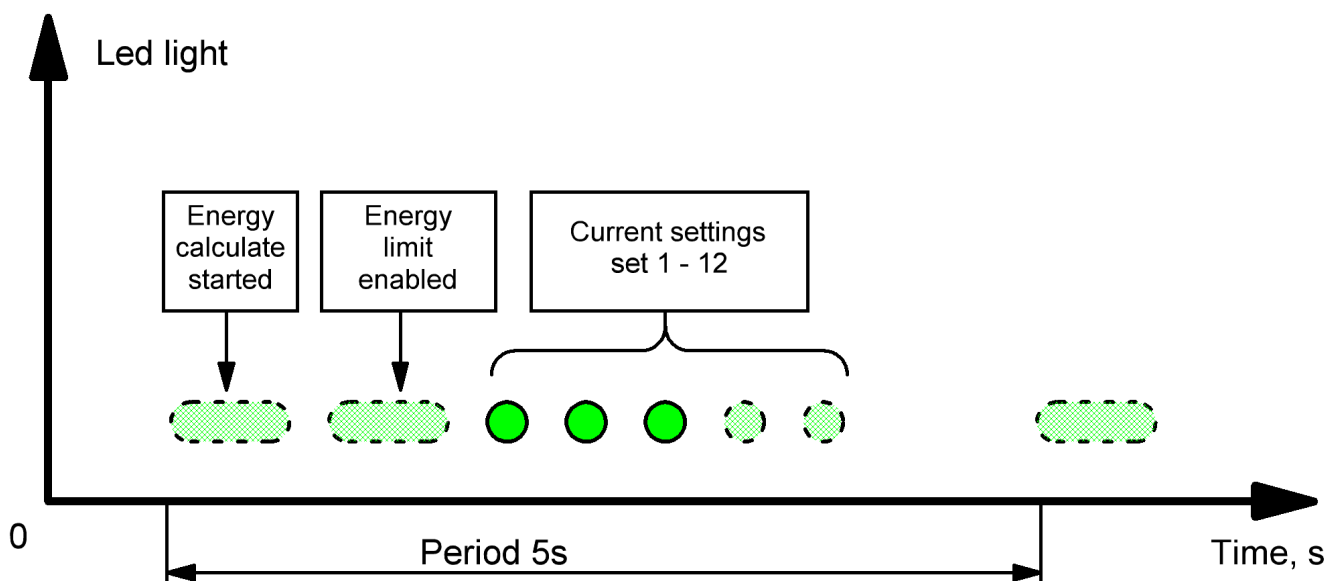


Figure 3. Device LED indication.

Duration of long flashes is 0.75 s, duration of short flashes is 0.25 s. Long flashes always mean that the device is in energy counting mode (race mode).

**Before starting, you need to make sure that the energy counter is reset and the device is in standby mode, in this case there will be only short flashes showing the current set of settings.**

**If a set of settings with a number greater than 12 is used, it will be displayed in one flash, lasting 3 seconds!**

All other information including the actual values of currents, voltages, energy, capacity, temperature, etc., are displayed via a mobile phone and Windows program.

### Preset settings

The device has 6 sets of preset settings. These settings cannot be changed and 1 – 5 sets fully comply with the Naviga rules.

Settings set number	Purpose	Energy limitation
0	Training mode, telemetry only	$\infty$
1	Mini Eco, Mono, Hydro	21Wh
2	Eco Expert, Mono I, Hydro I	60Wh
3	Mono II, Hydro II	120Wh
4	FSR-E	180Wh
5	Mini FSR-E	42Wh (2Wh in FW before 23.2)

For all sets of preset settings, the following settings of limitation are used:

Settings	Value	Note
Start current	3A	
Throttle limitation (% from full)	0%	That is a complete shutdown
Time of rampdown	5s	
Time of throttle limitation	60s	

## Full list of the device settings

### Some settings are only available in the Windows program!

The device contains general settings used for the device as a whole and sets of settings for racing.

### General settings

Settings	Value	Note
User name	3 - 31 characters	Example: Sergey Turnaev
User password	3 - 31 characters	
Registration number	8 – 9 symbols	Example: RUS-0153
Current set of settings	1 – 14	
Realtime data update freq.	1, 2, 5, 10Hz	
Logger frequency (v. < 3.5)	1, 2, 5, 10Hz	
Logger frequency (v. >= 3.5)	1, 2, 5, 10, 25, 50, 100Hz	
Motor poles (v 2.0 and 3.5)	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	

### Sets of the settings for race

In total, the device has 14 sets of settings, 8 (6 - 14) of which are user-defined and are subject to change.

Settings	Value	Note
Setting name	1 - 31 characters	
Energy limit threshold	1 – 300000Wh	
Current at the counting energy start	2 – 10A	
Throttle limitation	0 – 99%	In limiting mode
Time of rampdown	1 – 999s	
Time of throttle limitation	1 – 999s	Before restarting the limiter

### Connection diagram

Connection diagrams are shown in Figure 4 and Figure 5. Device measures the current in the negative (black) power wire. It is necessary to connect the power wires in such a way that the direction of electric current flow corresponds to the direction of the arrow on the limiter body so that the end of the arrow points to the wire connected to the battery. In new versions of limiters on the body there is the designation ESC - ESC side and BAT - battery side.

**Note! The limiter should be connected first of all to the negative power wire of the ESC; after power is applied, it is forbidden to disconnect this wire, this may damage the limiter!**

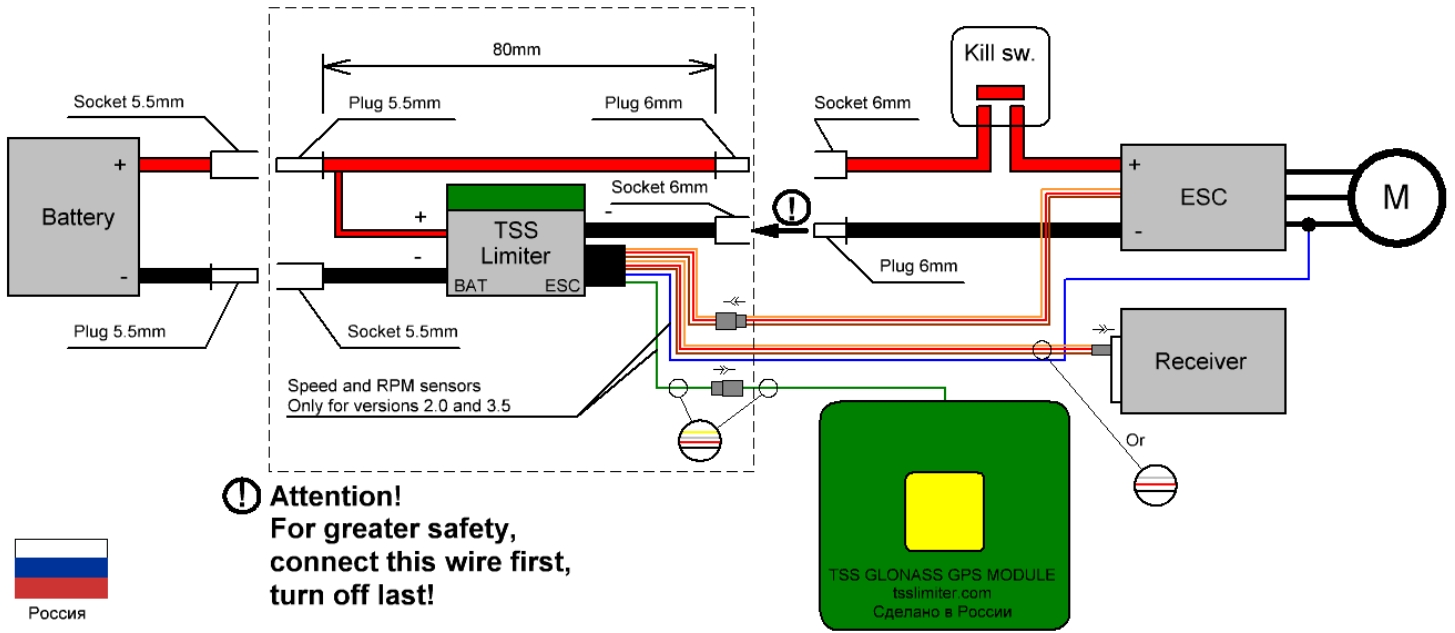


Figure 4 Standard connection diagram of the limiter

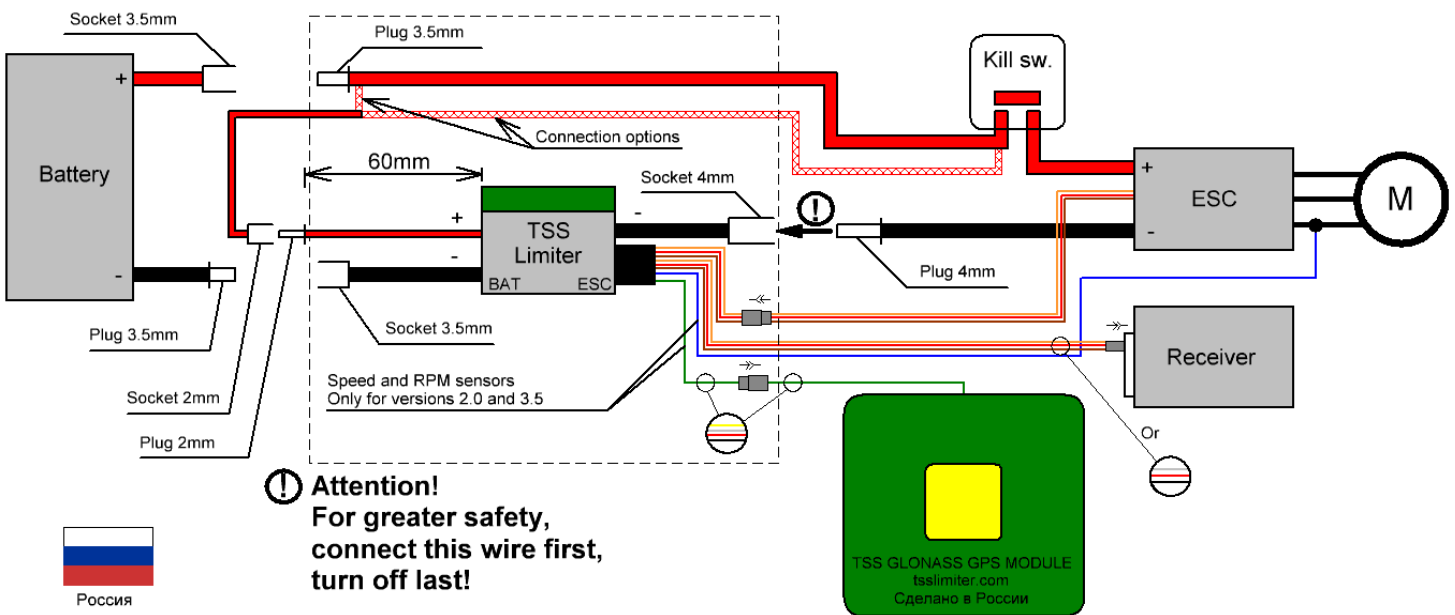


Figure 5 Connection diagram of the limiter for mini classes

## Limiter location in the model

To ensure maximum limiter telemetry range, do not place the red power wire near the limiter antenna; it is optimal to place it next to the limiter power wires. When installed in a model, the limiter should be oriented with the antenna up, as high as possible. Installing the limiter sideways or with the antenna down can significantly reduce the telemetry range.

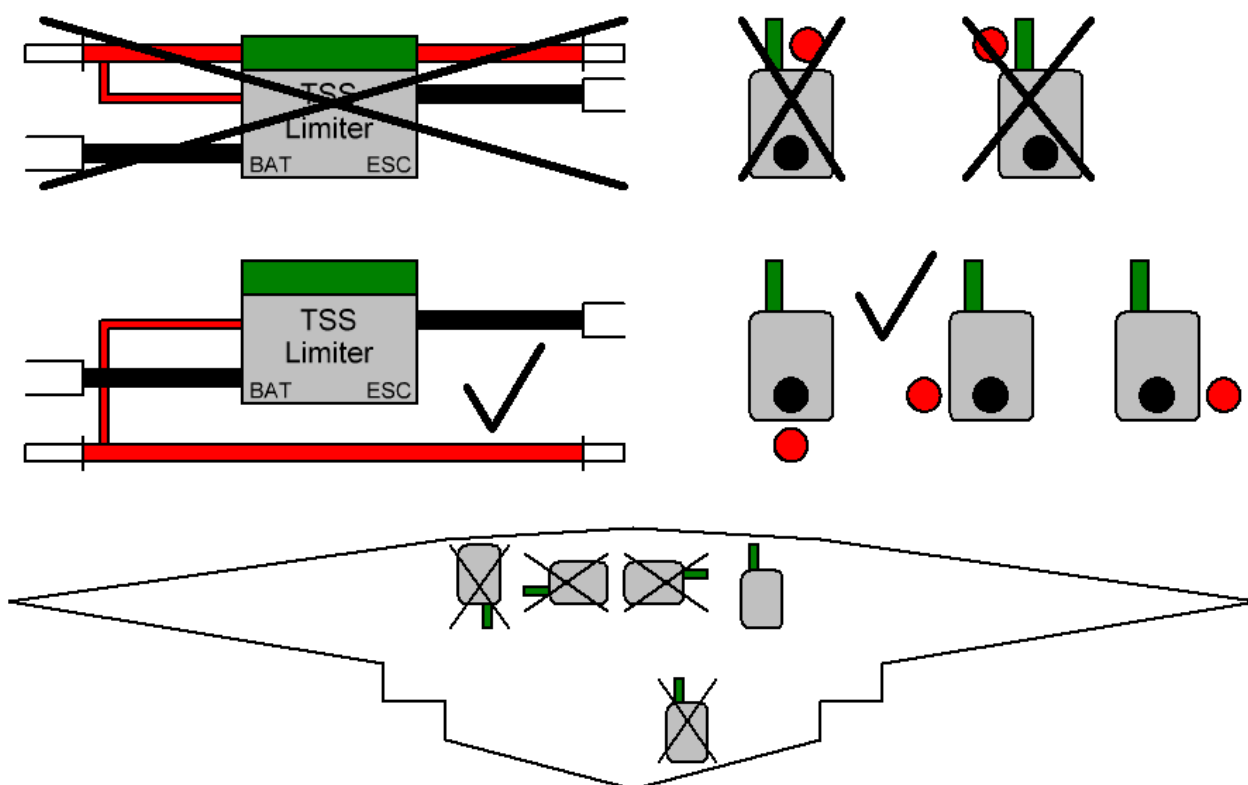
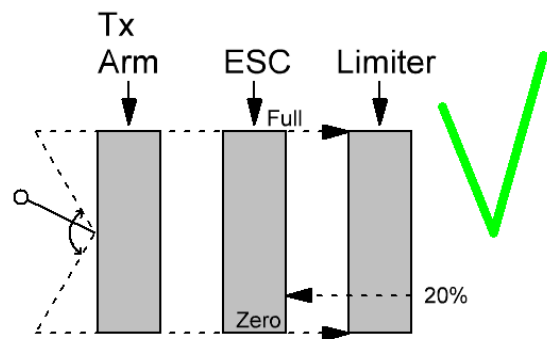
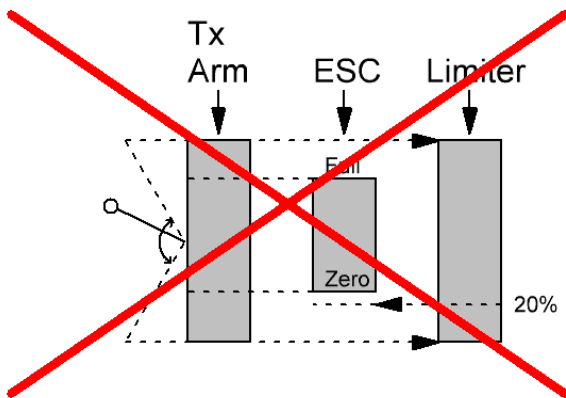


Figure 6. Limiter location in the model



## Setting of throttle grip

Using a limiter, pay special attention to the correspondence of the throttle grip position on the transmitter with positions of zero and full throttle in the ESC. The limiter counts the limit (0% by default) from the zero position of the throttle grip on transmitter, therefore, if the controller uses a narrower operating range, this will lead to a complete stop instead of the limiting!



## Setting by button

Device can be particular set up by the button connected through power wire (red) and signal wire (yellow) going into the receiver. Normal state of button is open.

If necessary, connect a button, disconnect the limiter from the receiver connecting it then to the button, perform the required actions and reconnect the limiter to the receiver.

Functions of setting by button is given in the table:

Function	Parameter	Note
Reset of energy calculation	Hold down for 5 - 13 seconds and release.	There should be three long green flashes. Indication can be updated with delay in one period
Switching the set of settings up *	Push once	Only if the energy calculation is not started. Cyclically switching between 0–5 sets
Switching the set of settings down *	Hold down for 1 second	Only if the energy calculation is not started. Cyclically switching between 0–5 sets
Password reset	Hold down for $30 \pm 10$ seconds	Only if the energy calculation is not started.
Manual start of bootloader	1.Hold down before limiter switching on; 2.Enable limiter BEC power; 3. release button as soon as the red(or green for	In normal device operation it is not used. Required if there are problems with updating the firmware in a regular manner.

	v.3.5) LED goes out	
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Since the period of indication is 8 seconds, it is recommended to switch the sets of settings no faster than one increment over the period of indication, otherwise, it may not be clear which set has been turned on, since the display will be delayed.

\* In firmware starting from version 23.3, to switch a set of settings, you first need to manually reset the energy calculation using the button (press for 5-13 seconds and release), this action unlocks the ability to switch settings. After this, you need to make one single clicks, this will completely unlock the switching of settings using the button. Thus, starting from the second press, switching settings will be available.

## Limiter settings

Currently, the configuration application for the Android operating system (version 6 and above) is being debugged. It will be available for download via Google Play in the near future.

At the moment, it is recommended to view the current values and logs using the following third-party programs, the same programs have versions under iOS:

[nRF Toolbox for BLE](#)

[nRF Connect for Mobile](#)

[nRF Logger](#)

[nRF Toolbox for BLE \(iOS\)](#)

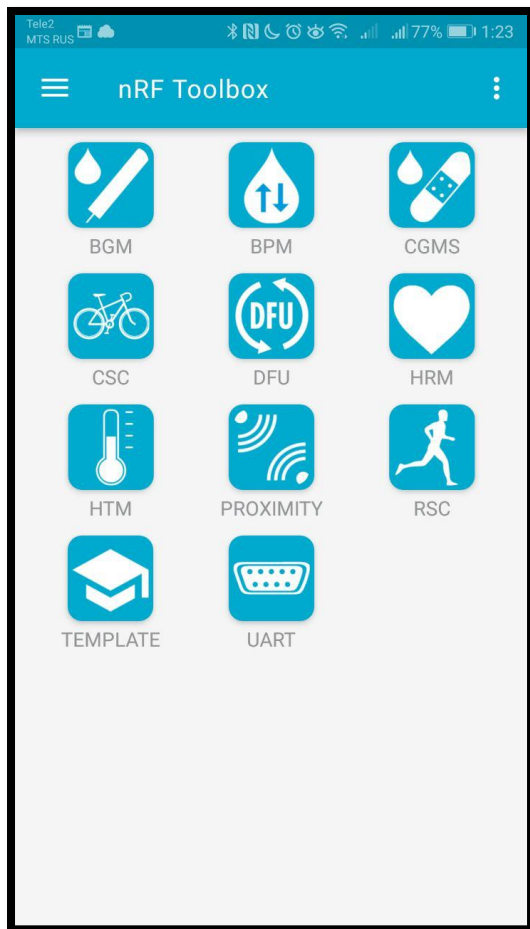
If hyperlinks are not available, use the QR codes below:



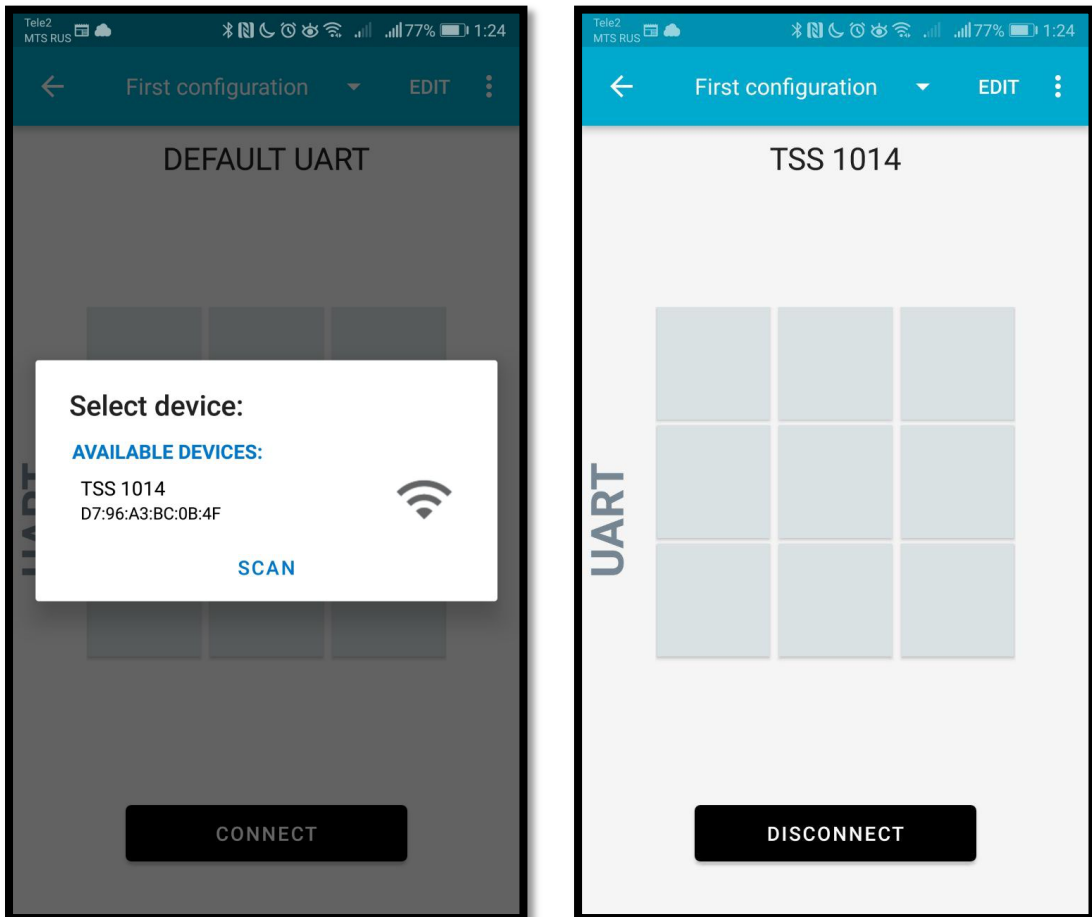


## Sequencing

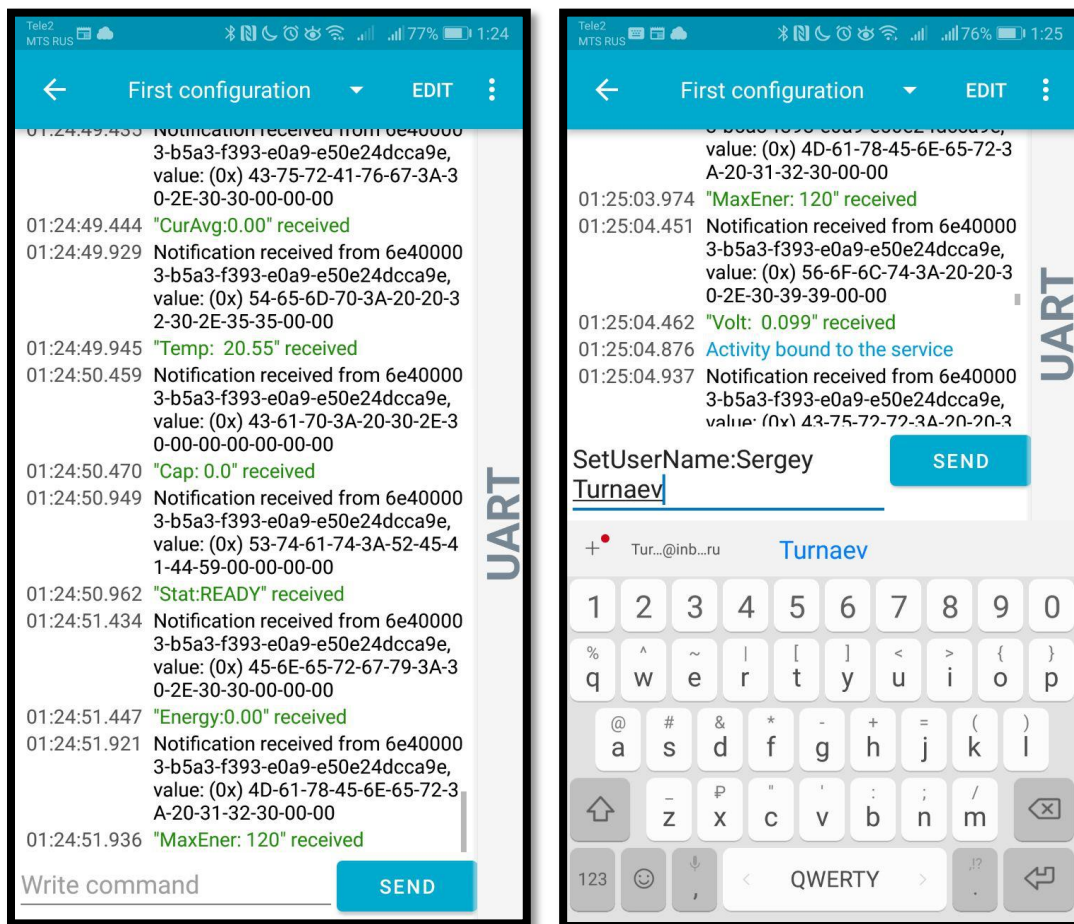
- Install the **nRF Toolbox for BLE** program and run it:



- Open the **UART** menu, push the **Connect** button and select the limiter, it always has the name TSS xxxx, where xxxx is its unique number. In the future, this name can be changed to a registration number, for example RUS-5555:



- Swipe the screen from left to right to open the test console, or rotate the phone horizontally. The console displays the current settings in sequence, including: voltage, current, average current over 10 seconds, consumed capacity, consumed energy, maximum available energy, temperature, current status.



The **Status** parameter can have the following values:

- READY - Ready for work
- RACE - Energy count started
- OVERVOLT - Overvoltage detected at turning on
- UNDERVOLT - Too low voltage detected after race
- LIMITED - Limit mode on, energy over
- ERROR - Error



## List of supported console commands

Commands can be entered at the bottom of the console as text. Commands may be with parameters and without them; if there is a parameter, then after the command a colon is set, and the parameter is entered. If the parameter is a number, then input of spaces or other non-digit characters is not allowed. **Bold** marked the most important commands.

Command	Parameter	Note
GetUserName	-	Show user name
GetUserRegNum	-	Show registration number
SetJudgePassword:	4 - 31 characters	Set the judge password
CheckJudgePassword:	4 - 31 characters	Check the judge password
ClrJudgePassword		Reset the judge password
Password:	4 - 31 characters	If the password has been set, this command unlocks the settings record.
SetUserName:	3 - 31 characters	SetUserName:Sergey Turnaev
SetUserPassword:	4 - 31 characters	SetUserPassword:12345ABC If parameter empty, then no password
SetUserRegNum:	7 - 9 parameters	SetUserRegNum:RUS-5555
<b>SetSettSet:</b>	0 – 14	SetSettSet:8 Set current used settings set
GetSettSet:	0 – 14	GetSettSet:4 Request selected settings set
GetSettSet		GetSettSet - without parameter, returns current settings
SetAdvTime:	1 – 99999	Device detection duration, minutes

<b>Stop</b>		Stop sending data
<b>Start</b>		Enable sending data
<b>Data</b>		One-time current data request
SetSettName:	4 – 31 characters	Settings set name
SetEnergyRef:	1 – 300000	Energy limitation
SetStartCurrent:	2 – 10	Current at the counting energy start
SetThrottleLim:	1 – 99	throttle limitation
SetRampDownTime:	1 – 999	Complete rampdown time
SetLimitTime:	1 – 999	Time of throttle limitation
Help		Displays list of commands
GetFwInfo		Display the firmware version

In case the user password is set, the current settings can be changed only after entering the password with the “Password:” command. With each subsequent connection, the password must be repeated. If the limiter is blocked by the judge (the judge password is set), then the settings can only be changed by resetting the judge password, if this is done, it will be detected at a technical check after the race.

## Firmware update

The device supports updating the firmware by phone.

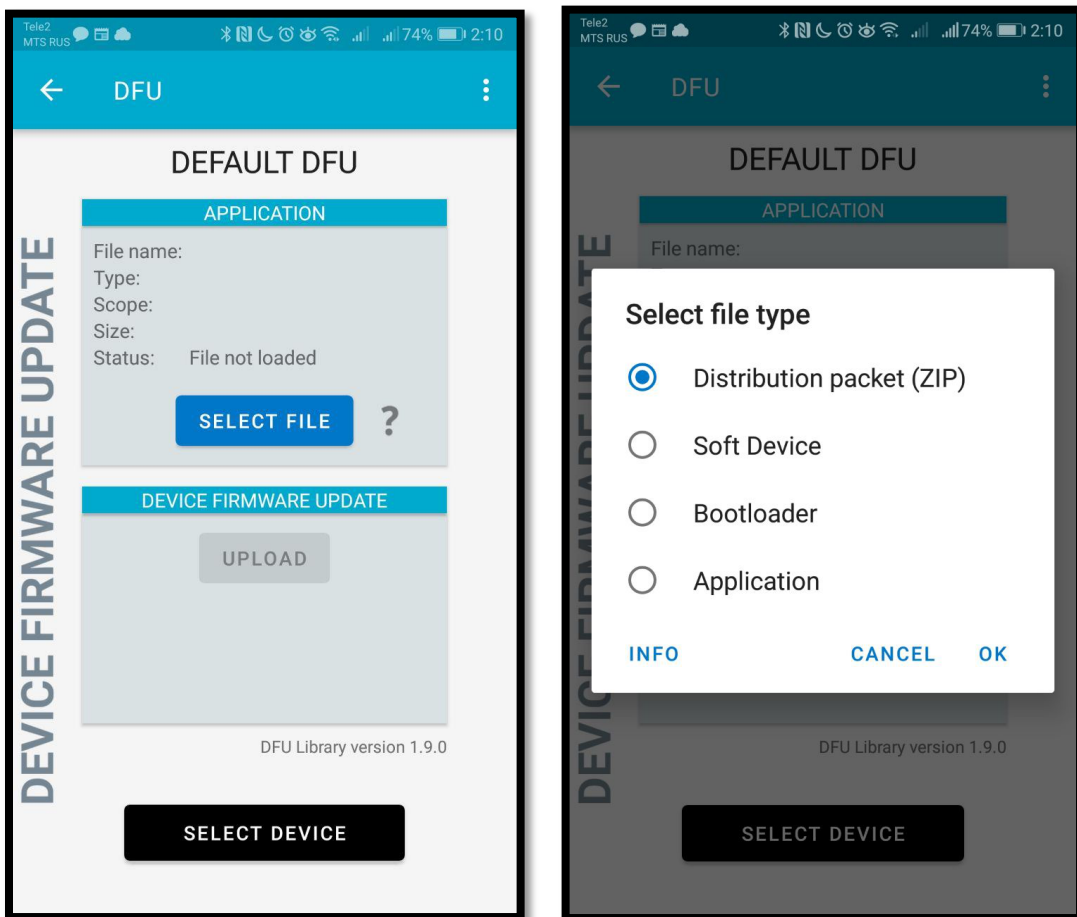
Download the firmware update file. To do this, go to the firmware sector of the website <http://tsslimiter.com>. Save the file to any accessible folder on your phone.

In the future, the new firmware version will be inside the latest version of the configuration program, and downloading files from the Internet will not be required.

Before starting the update process, make sure that the device is not in energy counting mode, otherwise the update is not possible.

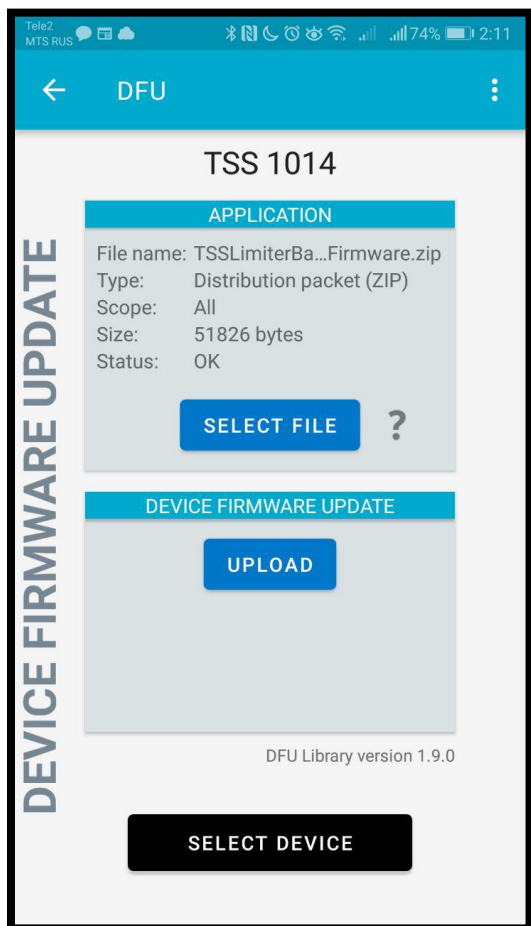
If you have set a password to record the settings, connect to the device as described in the section "Setting up by phone", and enter the password in the console, then tap the **Disconnect** button (If only the console is visible, you need to run your finger across the screen from right to left). Exit the UART menu with the "Back" button. After entering the password, you have five minutes to start the firmware update. If there is no password, you can go directly to the next item.

In the **nRF Toolbox for BLE** main menu, open the **DFU** section:



Tapping the **Select file** button and selecting the **ZIP** type, tap **OK** then. A standard file selection dialog will open, run the firmware file saved from the Internet in the previous step.

Select the device to update, the same way as it is selected in the UART section.



If everything is selected correctly, the **Upload** button will become active, tap it.

Firmware update takes about 30 seconds. Wait until the update process is complete.

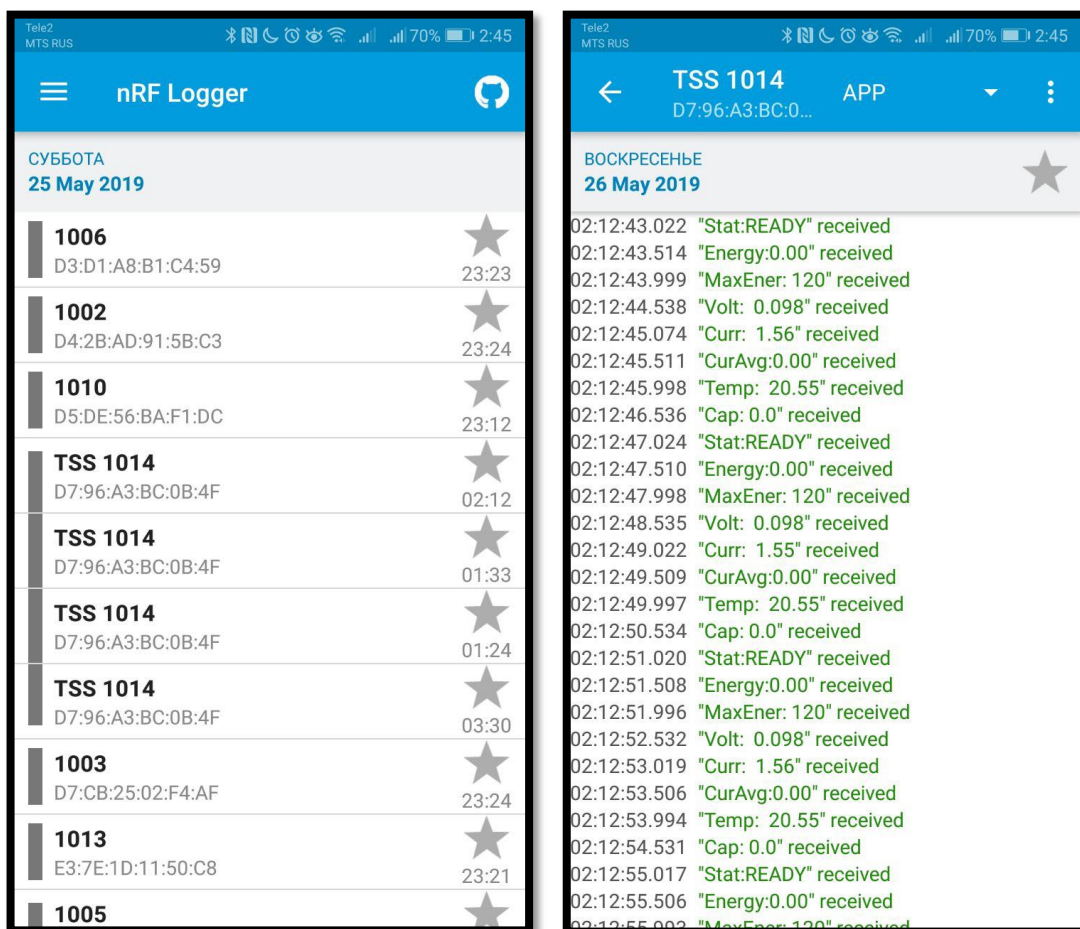
If for some reason you cannot connect to the device, then try updating the firmware via the bootloader (the bootloader is not the upgradeable part of the firmware flashed by the manufacturer), to do this, start the bootloader as follows:

- Power off the device.
- Use the optional configuration button or a simple piece of thin wire to close the wires of red and yellow colors in the connector going to the receiver. In case of a button, it must be hold down.
- Turn on the power. You will see that the LED is on constantly, as soon as it goes out after a few seconds, immediately release the button.

- Device will go into bootloader mode and will appear in the device selection menu on the phone as: **TSSLimiterBLE\_DFU**.
- Repeat all upgrade steps via the **DFU** menu from the beginning. You do not need to enter the **UART** menu to type a password.

## View logs

If you need to look at the log, run the [nRF Logger](#) application, it stores all information about the connections to the TSSLimiter limiters. After selecting the communication session of your interest, we recommend choosing the **APP** setting at the top, instead of the default **Debug** setting.



## **Warranty and servicing**

Manufacturer guarantees that the device has been tested at production site, calibrated and is fully operational. In case of a factory defect detection, the device can be made warranty repair within 12 months from the date of sale, this period as agreed may be extended to the time of delivery by mail.

The warranty does not cover damage of the device caused by connection errors, exceeding the maximum permissible values of currents and voltages, and the associated overheating.

For warranty service please contact us by e-mail.

## **Manufacturer**

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