

Audio Processor for processing microphone signals
User's Manual



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Appointment. General characteristics.

The audio processor (AP) is designed for digital processing of the microphone input signal and output of the processed signal.

AP contains the following key components:

- high-performance processor STM32F746;
- high quality audio codec CS4272, incorporating ADC and DAC with high dynamic range;
- 3,2" 320*240 TFT display.

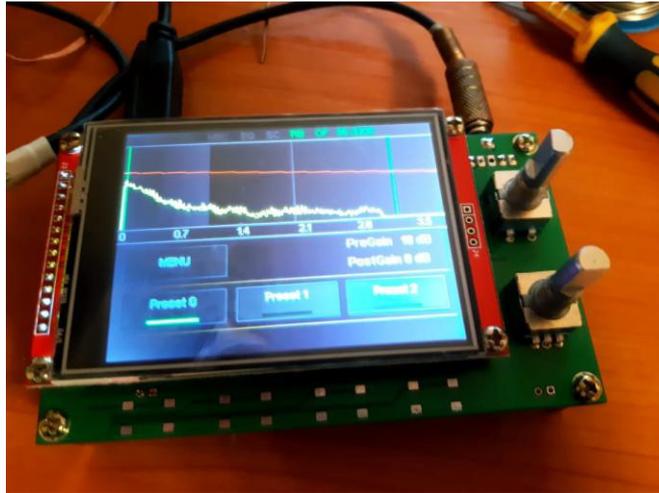


Figure 1 Photo of AP without case

The block diagram of signal processing is shown in the figure. 2.

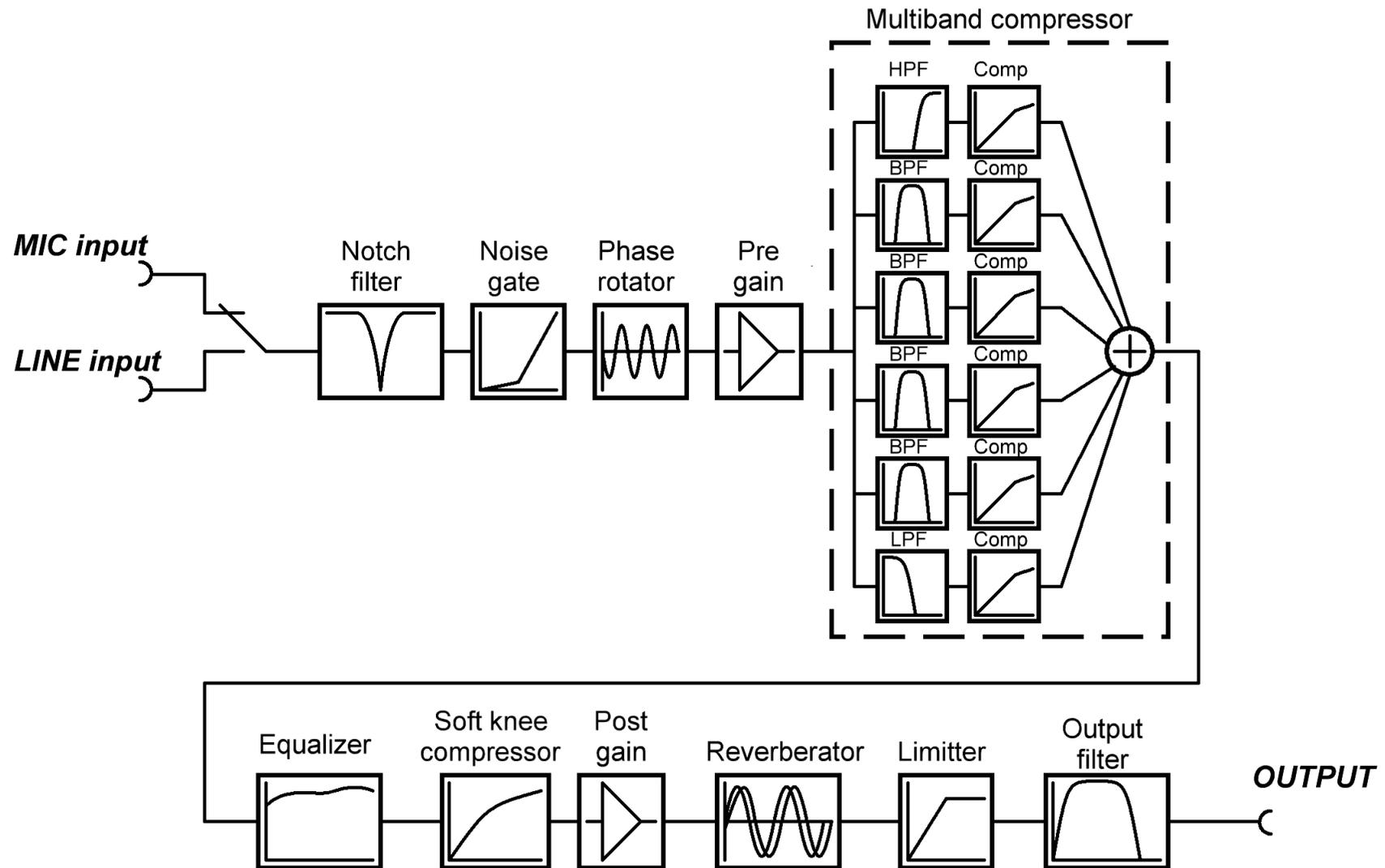


Figure 2 Block diagram of signal processing

AP contains the following nodes with setting ranges:

1) Notch filter:

- frequency adjustment range - 5 ... 1000Hz with a step of 5Hz
- filter width - 5 ... 300Hz, step 5Hz

2) Noise gate:

- **время атаки** - 0.1 ... 20ms in 0.1ms steps
- recovery time - 1 ... 300ms in 1ms steps
- threshold - 0 ... -100dB with 1dB steps
- ratio - 0...1 with a step of 0.1

3) Phase rotator:

- frequency - 50 ... 1000Hz
- number of stages - 1 ... 30

4) 6 ways Multiband compressor:

- **время атаки** - 0.1 ... 20ms in 0.1ms steps
- recovery time - 1 ... 300ms in 1ms steps
- threshold - 0 ... -100dB with 1dB steps
- ratio - 0...1 with a 0.1 step

5) Pre and Post gain - -40dB...+40dB with 1dB steps

6) 6 channels Equalizer - with gain control -15...+15dB with 1dB steps

7) Soft knee compressor:

- **время атаки** - 0.1 ... 20ms in 0.1ms steps
- recovery time - 1 ... 300ms in 1ms steps
- threshold - 0 ... -100dB with 1dB steps
- ratio - 1... 20 in 0.1 steps
- "knee" curvature - 0 ... 1 with a 0.1 step

8) Reverberator:

- delay - 1 ... 100ms in 1ms steps
- echo gain - 0 ... 1 with a 0,1 steps

9) Output filter - adjustable in the range 0 ... 10000 kHz with a 5 Hz step;

10) Limiter:

- **время атаки** - 0.1 ... 20ms in 0.1ms steps
- recovery time - 1 ... 300ms in 1ms steps
- threshold - 0 ... -10dB with a 1dB step

It is possible to select the rectangularity of the filters - both as a general filter and as part of a compressor. 4 values of squareness.

AP connection

AP contains the following connectors:

- 3.5 mm jack for connecting audio inputs and outputs;
- USB type B for USB connection to PC.
- DC 2.5mm (2.1mm) for power supply connection.

ATTENTION! The AP has no galvanic isolation in all connected circuits! If necessary, the galvanic isolation must be implemented by the user!

AP power supply

The AP is powered from a DC source with a rated voltage of 5V, the maximum allowable voltage is no more than 5.5V. The maximum consumption is no more than 300mA. Power supply is possible through both a separate connector and USB.

Attention! When power is supplied through a DC connector, polarity reversal of the power connection will lead to malfunction of the AP!

AP control parts:

AP main controls:

- two encoders with built-in buttons - marked on the printed circuit board as EN1 and EN2;
- four tactile buttons, marked on the printed circuit board as S1-S4;
- touchscreen.

Updating and initial download of software (software)

AP supports the following firmware functions:

- initial software loading (primary processor firmware), at the very first start-up;
- software update as part of the assembled device, without the need for disassembly the case.

In both cases, you only need a USB connection to the PC, the PC itself and the drivers and software installed on it. No additional programmers are required.

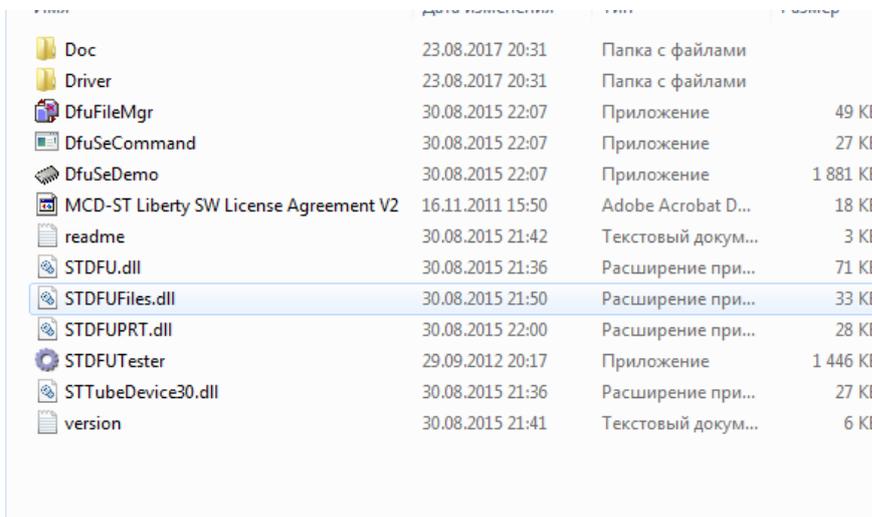
- Before flashing, you need to prepare the software for loading.

Preparing software download.

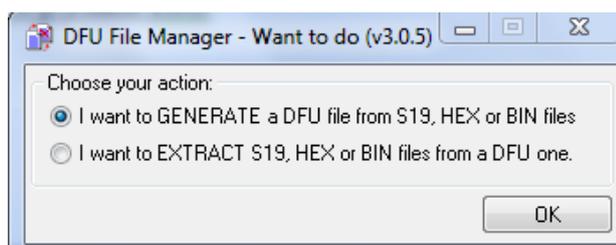
Before downloading, you need to install the DfuSe program. You can download it on the ST website at the link <https://www.st.com/en/development-tools/stsw-stm32080.html#getsoftware-scroll> or http://rx9cim.ucoz.ru/load/programma_proshivki_stm32_v_dfu_rezhime/1-1-0-39.

In the archive, the last link contains the archive, it must be unpacked. The Bin folder contains utilities that are required:

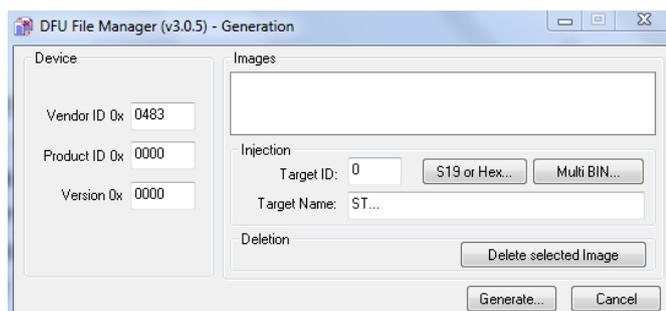
- Dfu file manager;
- DfuSeDemo.



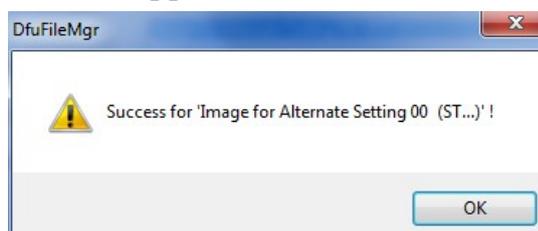
Run DfuFileMgr. In the window that opens, select the settings in accordance with the picture:



Click OK. A window will open:



Click on the "S19 or Hex" button, find and select the AudioProcessor.hex firmware file. Click the "Generate ..." button. The program will suggest a location to save the file with the .dfu extension. Specify the desired file name and specify the path for saving. A message like this will appear:



Click OK. Next, we move on to the boot procedure.

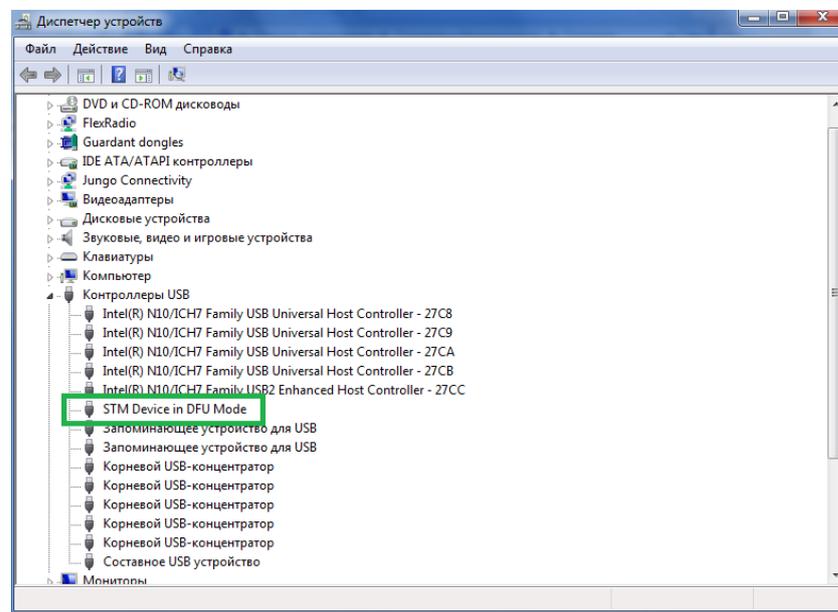
Boot procedure

For the initial firmware of the AP, you must perform the steps in the following sequence:

- A) before powering on, short-circuit the terminals of the Boot0 connector located on the printed circuit board;
- B) connect AP via USB to PC;
- C) open the pins of the BOOT connector.

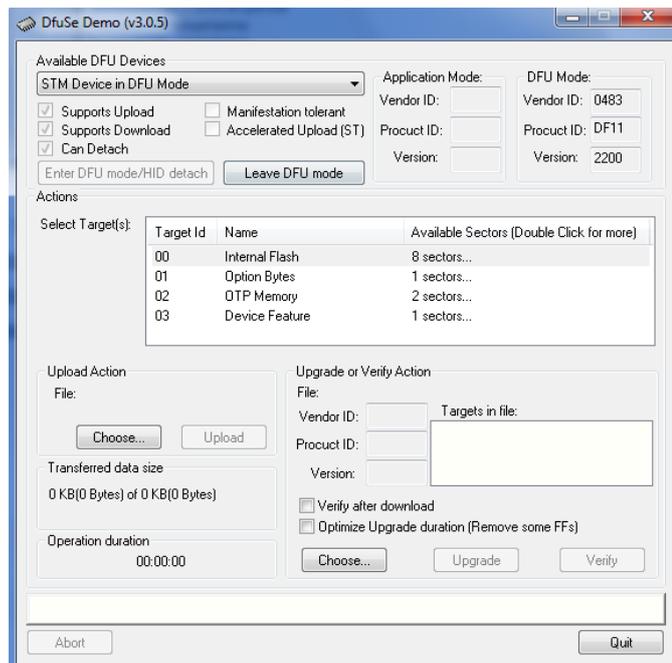
To update the firmware as a part of the finished device, you need to connect the AP via USB to the PC, wait until the AP turns on and simultaneously press the encoder buttons EN1 and EN2 and hold until the display disappears.

A device of the type should appear in the list of PC USB COBNTROLLERS devices:

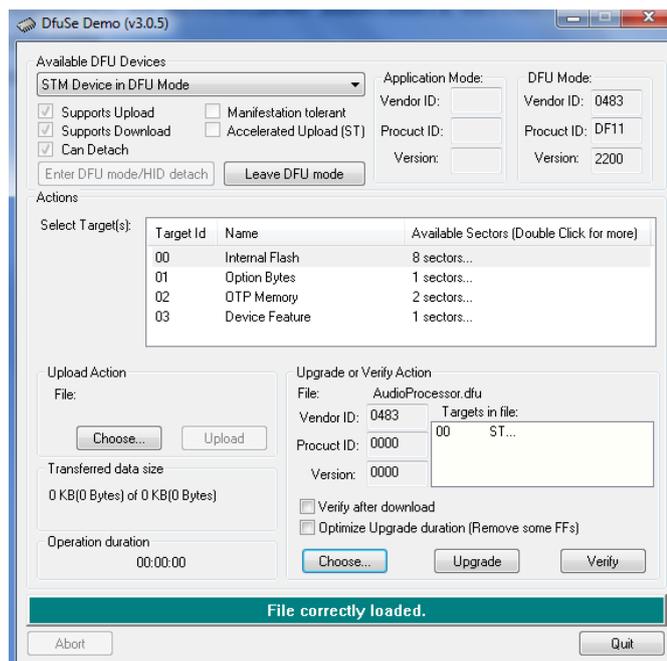


If this device is marked as undefined (with a yellow triangle), then you need to automatically search for drivers on your computer.

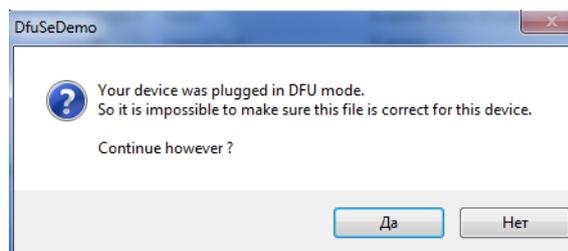
Next, you need to run the DfuSe Demo program. The following window will open:



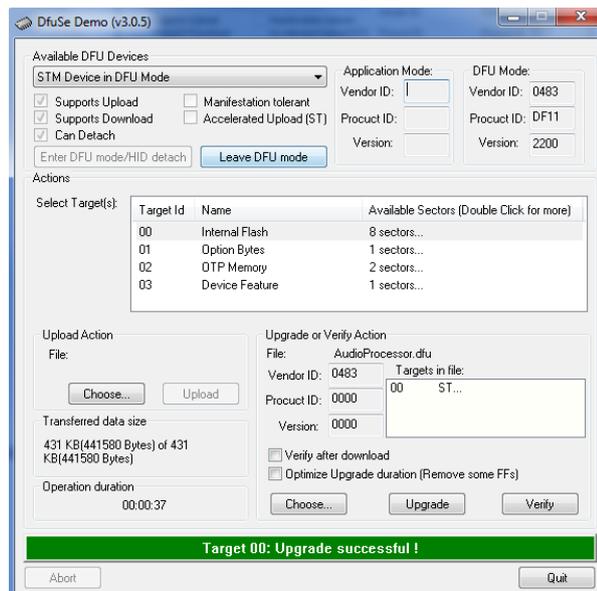
Press the “Choose...” button and select the previously prepared file with the .dfu extension. The window is converted to the form:



Press the "Upgrade" button. A window will pop up:



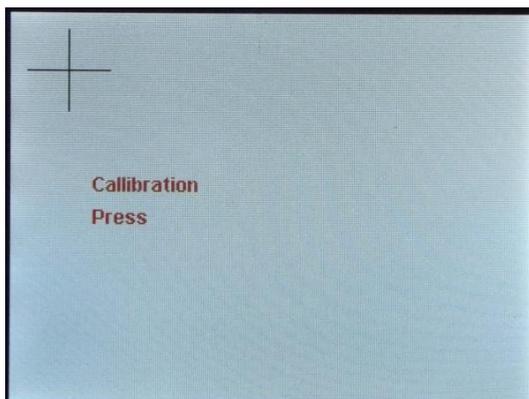
Click "Yes". The software update process will begin. We are waiting for the window to switch to the following form:



HPress “Quit”. Everything! Software loaded! Next, you need to re-enable the AP.

First time power on. Reset

The very first time you turn it on, a screen like the following will appear:



It is necessary to click on the crosshair in the indicated places - this is necessary to calibrate the touchscreen.

When finished, the AP will go to the next menu.

To reset the AP settings, including calibration of the touchscreen, you must press the touchscreen before turning on the AP

turn on the AP, wait a few seconds and remove the press from the touchscreen.

Global settings. Selecting Profiles (Presets)

After turning on the AP, it goes to the global settings window and the selection of presets, which looks like this:



In the upper part of the screen, the states of the processing blocks for this profile are displayed in green and gray. Gray - the block is off. Green - the block is on.

By pressing the buttons “Preset 0”, “Preset 1”, “Preset 2” on the display, the previously saved basic settings.

By turning EN2, the PreGain value can be changed. Turning EN1 can change the PostGain value.

Pressing the "MENU" button will open the following window:



EN1 Reverse and EN2 Reverse are used to invert of the encoder rotation. The user can define himself how it is convenient for him to make decrement and increment.

MBC filter sharpness affects the squareness of the multiband compressor filters. The higher the value, the higher will be the squareness

and the multi-band compressor will produce a "sharper" sound. The OUT filter sharpness parameter affects the squareness of the multiband compressor filters. The higher the value, the higher the squareness and "sharper" sound of the multiband compressor.

Preset settings

In order to go to the preset settings after turning on the AP, while in the global settings menu, press the EN2 knob.

Further, to switch windows with settings for processing units, you must press the button as part of EN2. To move between the touchscreen buttons inside the window - press the corresponding touchscreen button or move to it by pressing the button as part of EN1. The touchscreen buttons are grouped into corresponding blocks.

To turn on / off one or another unit, select the button corresponding to the unit and long press the button as part of EN1. The switched off unit has buttons with a red border.

Phase shifter and output filter settings window



The phase shifter has settings:

- Freq – frequency;
- Stage – number of stages.
- A vertical line with a slider shows the signal's degree of symmetry, and in the process of adjusting the phase shifter, it is necessary to achieve a value of the slider close to 1.

The output filter has the following settings:

- Low Freq – lower slope frequency;
- Top Freq – upper slope frequency.

Notch filter and Noise gate settings window



Notch filter has the following settings:

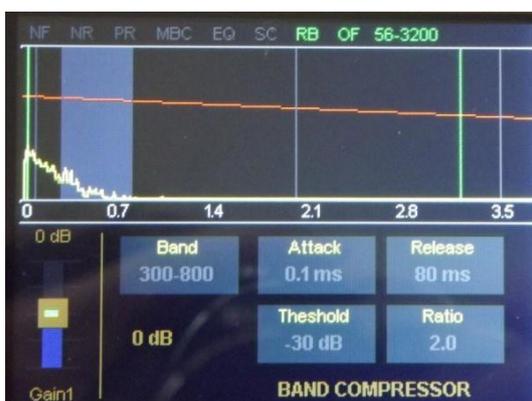
- NF freq – filter setting frequency, in Hz;
- Width – filter width, in Hz.

Noise gate has the following settings:

- Attack – attack time, in ms;
- Threshold – response threshold, in dB;

- Release – recovery time, in ms;
- Ratio – slope coefficient of the amplitude characteristic, the slope is determined from the relation: $1/\text{Ratio}$.

Multiband compressor and PreGain settings window



The window contains the following settings

for PreGain and Band compressor. The Gain1 parameter corresponds to the PreGain value.

Band compressor has the following settings:

- Attack – attack time, in ms;
- Threshold – response threshold, in dB;
- Release – recovery time, in ms;
- Ratio – slope ratio

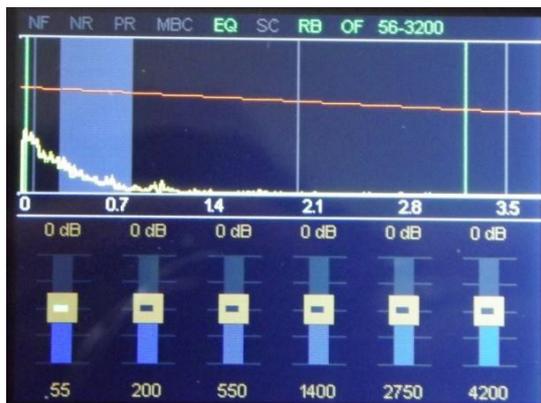
amplitude characteristic, the slope is determined from the ratio $1 / \text{Ratio}$.

- **Ratio** – коэффициент наклона амплитудной характеристики, наклон определяется из соотношения $1/\text{Ratio}$; **This is double**

- **Band** – selection of the frequency range and distribution of bands for the compressor and equalizer. Band switching is done by EN2, band changing is done by EN1.

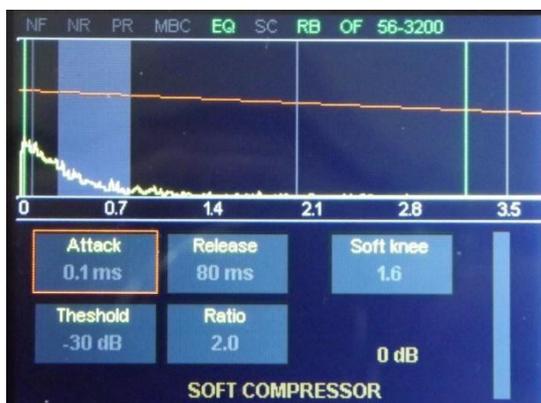
The actual compression value when the signal is applied is displayed under the Band button.

Equalizer settings window



In this window, the gain is set for each of the 6 bands. Frequency values correspond to the middle of the band.

Soft compressor settings window



This window contains the settings for the soft compressor.

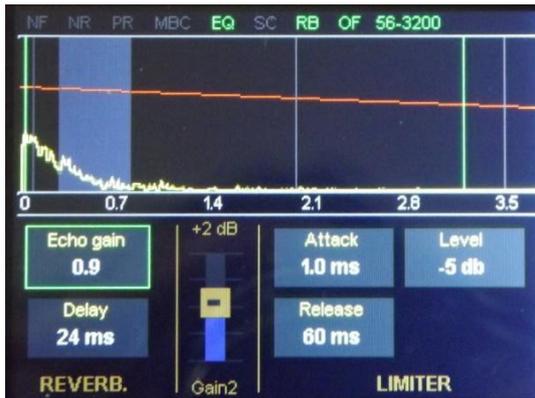
The compressor has the following settings:

- Attack – attack time, in ms;
- Threshold – response threshold, in dB;
- Release – recovery time, in ms;
- Ratio – slope coefficient of the amplitude characteristic, the slope is determined from the ratio $1 / \text{Ratio}$.

- **Ratio** – коэффициент наклона амплитудной характеристики, наклон определяется из соотношения $1/\text{Ratio}$; **???**

- **Soft knee** - "knee smoothness" of the transient amplitude characteristic. The higher the value, the more abrupt the transition. A value of 1 corresponds to a normal compressor. The actual compression value for the current signal is shown under the "Soft Knee" button,

Reverberator, PostGain, Limiter settings window



Reverberator has the following settings:

- Echo gain - signal echo gain;
- Delay – signal delay value.

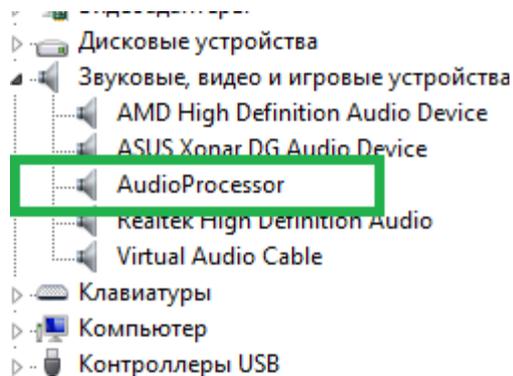
The Gain2 parameter corresponds to the PostGain value.

The limiter has the following settings:

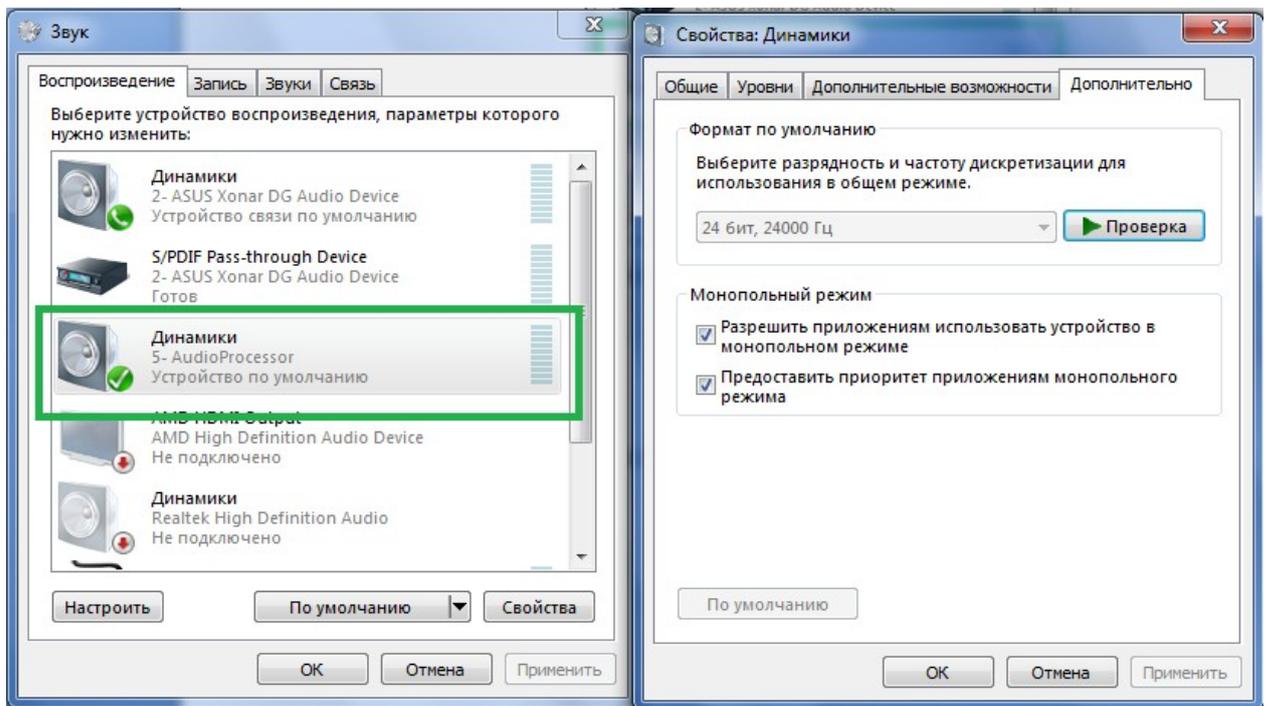
- Attack – attack time, in ms;
- Level – signal limiting threshold relative to the maximum value;
- Release – recovery time, in ms.

Connecting to a PC as an audio device

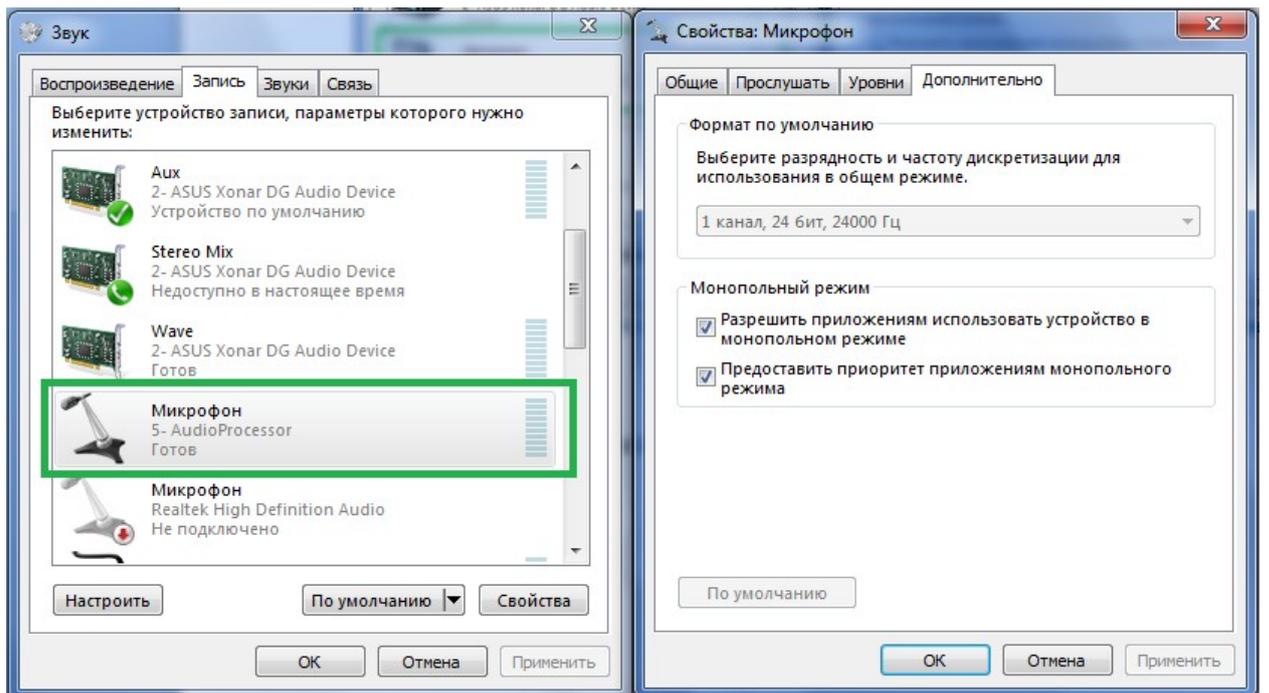
When connected to a PC, a new AudioProcessor audio device should appear:



In the list of playback devices, the AP should be defined as Speakers:



In the list of recording devices, the AP should be defined as Microphone:



If there is playback via USB from a PC to the AP, the AP automatically transmits a signal from the PC to the audio output. This was specially designed to be able to work with digital modes from a PC and with a microphone connected to the AP without unnecessary switches and commutations.

List of abbreviations

AP - audio processor

DAC - digital-to-analog converter

ADC - analog-to-digital converter