



Ver.mob
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Brief guide

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Introduction

PianoLabM – is a mobile version of the program PianoLab to tune and analyze piano for the Android platform.

Main features

- spectral analysis and display audio signal in real time measurement of sound frequency with accuracy up to tenths of a Hertz,
- automatic calculation of plan the optimal tool settings for the zone temperament, given the disharmony of the strings
- automatic selection in the spectrum of the sound of the pressed note of its harmonics frequency (the number of analyzed harmonics – 5),
- saves a snapshot of the signal spectrum for visual comparison of spectrums of two notes (for tuning of unisons),
- stores information about the scale of the instrument to a file, loading information from a previously saved file,
- other: scaling in amplitude and frequency and.

It should be emphasized the presence in the program module for finding an optimal solutions for areas of temperament. The fact that the issue range on the display and recommendations for the frequencies of the idealized (without disharmony strings) – the task is not difficult. And it allows to make almost all of the hardware and software tuner type guitar. But to find the optimum for an array of frequency zones in accordance with certain restrictions and criteria - – this task is more difficult and allow to do this only quite expensive tuners.

Hardware and software requirements

- Operating system – Android 4 or higher, processor – 2 core and a better frequency 1.5 GHz. and above.

The installation of the program

PianoLabM installer can be downloaded from the website <http://PianoLab.ru/> in the download section.

Description of the main Windows of the program

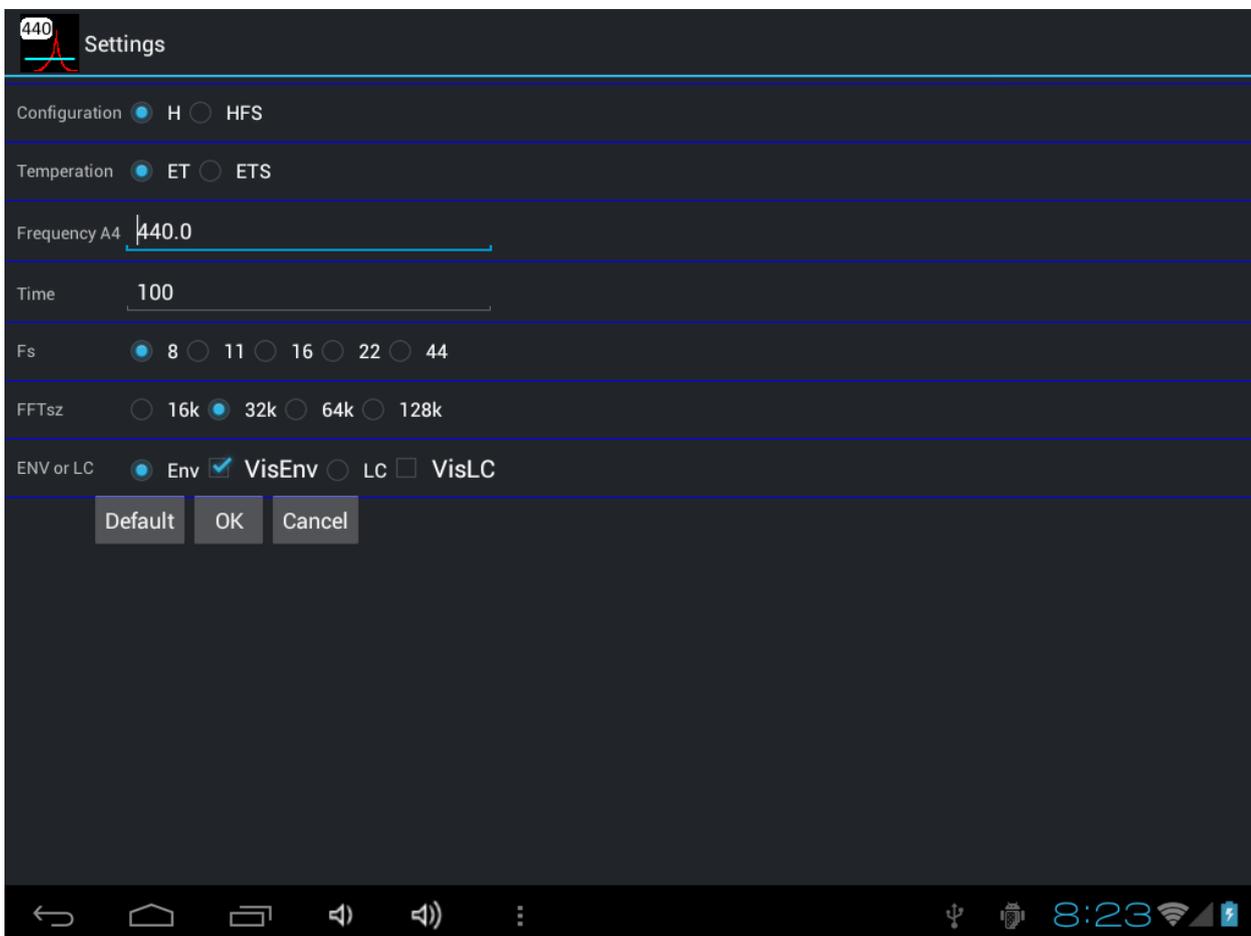
In program it is possible to use two kinds of representation of the information on the screen (configurations):

- **H**(only harmonics)
- **HFS**(harmonics, frequencies and a spectrum)

Configuration **H** is more convenient for devices with small screen - 4-6 inches, and more informative configuration **HFS** - for devices with the big screen - 7-10 inches.

After program installation, configuration **H** is by default exposed.

The configuration choice can be made after start of the program of the menu by button **M**. Select the option **Settings** and then, change the configuration type(**HFS**) – **H** or **HFS**.



After change of a configuration the program should be restarted!

The description of configuration H



Configuration H.

From top to down on a vertical:

The top row of buttons

- Button **A** - On/Off AutoDefinition of note.
- Button **W** - On/Off the permission of record of the note.
- Button  - On/Off / snapshot of current note.
- Button **M** – call the popup menu.
- The Information field - for displaying of messages of the program. By pressing displayed out:
 - B1 - Base1(the left bound of temperament zone)
 - B2 - Base2(the right bound of temperament zone).
 - A4 - Frequency of the base note.
 - T - Time interval in mc through which the screen is updated .
 - Fs - Frequency of digitalization.
 - FFTsz - Size of the block of the analysis of Fourier transformation.
 - Sres – Value of the spectral resolution in Hz.

Horizontal graphic bar

Displays the adjustment value of the envelope in dB. You can change by sliding your finger in the bar to the left/right or vice versa.

A numerical row

- The estimated (desired) frequency of the 1st harmonic of the note.
- Real frequency of 1st harmonic of the note.
- Averaged (on five harmonics) a deviation of real frequency from calculated in cents.

Remark. The first number is highlighted always, the second and the third - only when in a signal spectrum all five harmonics of the given note are defined.

Scale of a deviation of real frequency from calculated in cents

Depending on deviation size, the price of division of a scale can be or 10 cents or 1 cent. In the first case the graphic strip of a deviation has green color, in the second - bright green. If the note is not distinguished in a spectrum or the signal is too weak and lies below bending around the strip is not displayed in general. The deviation scale is analogue of the stroboscope applied in some programs of tuning.

The name of the current note

Illumination of the note name can change, depending on a condition of the analysis of the note in a spectrum:

- Illumination is absent - the current note is not distinguished in a spectrum.
- Illumination of green color - the initial stage of an identification of the note.
- Illumination of bright green color - the note is distinguished.

The bottom row of buttons

- Buttons  ,  octave and note change to the left .
- Buttons  /  – start/stop of input and the analysis of a sound signal .
- Buttons  ,  note and octave change to the right .

The description of the configuration HFS



Configuration HFS

The window is divided vertically into 5 parts:

- two rows of buttons at the top and bottom of the screen
- panel harmonics
- panel frequency markers
- panel spectrum

The top row of buttons

- Button A - turn on/off **Autodetection** notes.
- W button - on/off **recording permission** for note.
- Button VM - turn on/off the **Visualization** of the **optimal markers**.
- Button  - on/off snapshot of the current spectrum.
- Information field – analogue of the inf. field in the configuration H.

Harmonics panel

Analogical window in the configuration **H**.

Spectrum window

Has two scales: Y – axis scale is amplitude in dB. and the X – axis is a linear scale of frequencies in Hz. and spectrum.

The bottom row of buttons

- Button  - zoom the spectrum horizontally, in which all 5 harmonics are placed in the spectrum bar.
- Button  - the enlargement of the scale of the spectrum horizontally.
- Button  - zoom out the spectrum horizontally.
- Button  - reset the scale of the spectrum both horizontally and vertically.
- Buttons  /  – start/stop input and analyze the sound signal.
- Buttons  ,  - moving harmonics with a change of scale.
- Button **M** – call the popup menu (the analogical menu in the configuration **H**).

Used gestures

Change octaves and the notes

Spectrum bar divided into fourths. The top two quarters are used to move through the octaves. The lower the notes. The duration of pressing is approximately 0.5 seconds.

The change in the level of the envelope.

You can change by sliding your finger in the band level of the envelope to the left/right or Vice versa.

Zoom

Only vertically – as standard, two fingers: extension or contraction.

The popup menu

The same for all configurations, is caused by pressing M:

- **RC** - start of the module of calculation of optimum frequencies for a temperament zone.
- **PianoKeys** - is displayed the keyboard of two octaves - small and the first.
- **Settings** - a call of a window of change of options of the program. Here it is possible to adjust some parameters of processing of an entrance signal and spectrum visualization. The parameters exposed by default, are sufficient for adjustment of average accuracy. In this case accuracy of definition of frequencies of notes will be approximately equal 0.2 Hz. (0.8 cents for an average part of a range) or 1 palpation for 5 seconds.
- **Reset** - initialization sound scale from **C0** to **B7** according to a principle equal temperament, i.e. frequencies of the next notes decrease or increase in a root of 12 degrees from 2. As the base note the note **A4** undertakes. If it is chosen temperament on the Stopper for interval factor the root of 19 degrees from 3 undertakes.

- **Beep** - the signal-generator - is synthesized a sinusoidal sound signal with the frequency equal to frequency of the first harmonic of the current note together with 5 harmonics.
- Window of **Rajlsback**.
- Window of **inharmonic**ity.
- Window of **intervals**.
- **Open** a file.
- **Write** file.
- **Registration** - the information on the program status, serial number and the activation button.
- **End of program**.

General comment about sound scale

The program supports advanced piano scale from 0-th to 7th octaves notes from **C0** to **B7**. The numbering of the notes in the scale goes from 0 to 95. Notes in the octave are referred to as follows:

C C# D D# E F F# G G# A A# B,

A special place in the scale occupied by the notes **D3**, **A3**, and **A4** serial numbers in a scale – 38, 45 and 57, as used as zone boundaries temperament depending on the type of temperament (standard **ET** or **ET** for the **Stopper**) . When you run the program the values of the scale are initialized according to the frequency base notes **A4** in accordance with the principle of evenly-tempered scale the frequency ratio of adjacent notes is equal to $2^{1/12}$ ($3^{1/19}$).

Initialization of sound scale happens also, by pressing the button “**Reset**”.

Markers

The marker of a real harmonic – a vertical straight line on the graph with the coordinate of the frequency equal to the frequency of the **real harmonic**. The default is displayed in yellow.

Marker of optimal harmonic – a vertical straight line on the graph with the coordinate on the axis of frequencies equal to the **optimal** frequency harmonics. The default is displayed in green.

For all harmonics of the **current note**, in the spectrum window **displayed markers of optimum harmonics** – vertical line of bright green color. At the initial stage before the start of the module finding the best solution, markers of optimum harmonics exactly coincide with the frequency values of the initialized scale. Then the position of these markers can vary depending on the results of a search for an optimal solution.

Remark. The appearance of markers of real harmonics (yellow vertical) in the process of entering and maintaining the harmonics of the selected note on when the stop occurs only if a note is recognized, in the sense that in the spectrum there are harmonics that fall in the area of theoretical harmonics of the prescribed notes and amplitude of all harmonics are above the cutoff. If the note is recognized, the panel with the note name becomes bright green and only this enables the entry of notes into the computer's memory. The process of removing the harmonics is convenient to control **panel harmonics**.

The beginning of work

Program start.

The use of the program is focused on the landscape position of the device, so before starting the program, the device need to rotate at this position. Turns after starting the program, do not run!

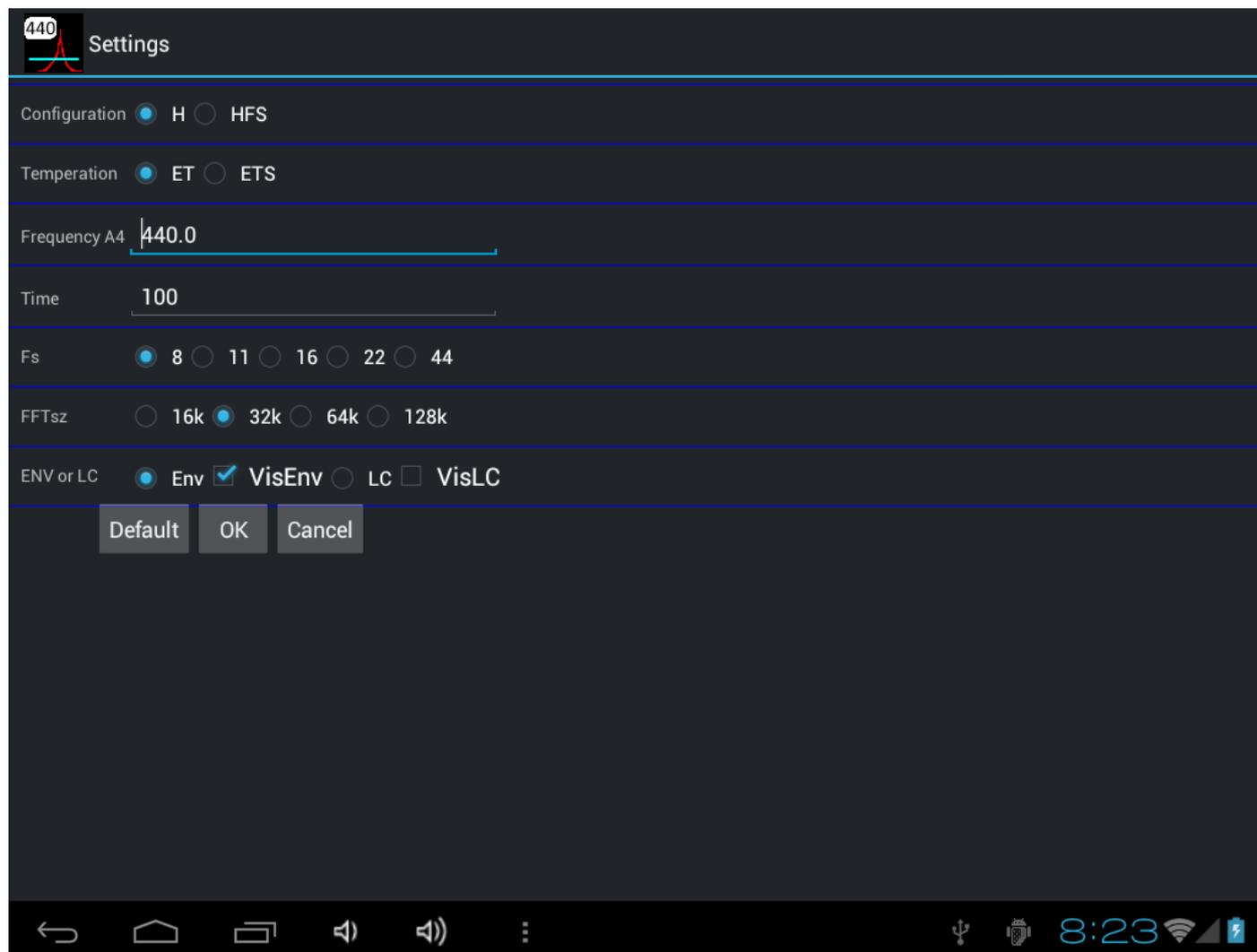
After program start it is necessary to wait about 2 seconds. This is the time required for the build envelope of the background noise. In the info window is given a cycle number and at the end of the formation of the envelope of the message "End ..." stands out.

At this time it is not recommended to make noise!

Change the settings of the program(If necessary)

To do this, click the **M** button, then **Settings** and choose what we need to adjust:

- The choice of configuration;
- Type of temperament;
- Frequency base notes Ля1;
- and other parameters depending on the required accuracy of calculations.



The parameters established by default

Are recommended for the initial stage of use (development) of the program as provide a comprehensible parity between quality of processing of an entrance signal and requirements to capacity of the processor of the computer:

1. Configuration type - **H**

2. Type of temperament – standard equal temperament (**ET**). In the program it is realized two kinds of temperament:

- usual **ET**, with interval factor a root of 12 degrees from 2. For a temperament zone the range from **A3** to **A4** undertakes.
- On the **Stopper (ETs)** with interval factor a root of 19 degrees from 3. For a zone temperament the range from **D3** to **A4** undertakes.

3. Frequency of base note **A4** - is by default equal **440Гц**.

4. Frequency of digitalization. By default - **8000** that corresponds to the maximum frequency of an analyzed signal - **4000** Hz (the Note F#2). If it is necessary to tune higher notes, it is necessary to increase frequency of digitalization. The choice of frequency of digitalization in the program is limited by standard values - 8000, 11025, 16000, 22050 and 44100.

5. Size of the block of the analysis of transformation of Fourier - **32768** (32к). At frequency of digitalization equal **8000** and size of the block of the analysis - **32к** the spectral resolution is equal **0.2** Hz. It approximately corresponds to one palpation for 5 seconds If such accuracy does not suffice, it can be increased, or reducing frequency of digitalization, or increasing size of the block of the analysis.

6. Time. By default - **200мс**. A range of change from **100** to **1000мс**. This parameter defines, how there will be a spectrum updating. If capacity of the computer has not enough for the chosen value of time distortions of a spectrum in the form of rectangles are possible.

Check of input of a sound signal

Press the button  and check the spectrum display of the input signal.

If in the conditions of silence, the information on the screen constantly changes, this means that the amount of the adjustment, the noise envelope is too small and the program finds in the background noise components of the current note (**A4**). In this case you need to increase this setting by changing the value in the graphical strip in the upper part screen. This is done by moving your finger horizontally at the top of the screen along the green strips. Allowable adjustments from **0** to **100**. You need to ensure that in the conditions of silence, the information on the screen did not change.

Remark. If the value of the in-band envelope level **too high** any signal, including a useful will be discarded.

Press key **A4**. The screen should look something like figure and needs to respond to the microphone.



Here:

- The calculated frequency for the key pressed(A4) is 440 Hz.
- Real, identified in a signal, frequency of ~441 Hz.
- The Deviation in cents - +3.8c.

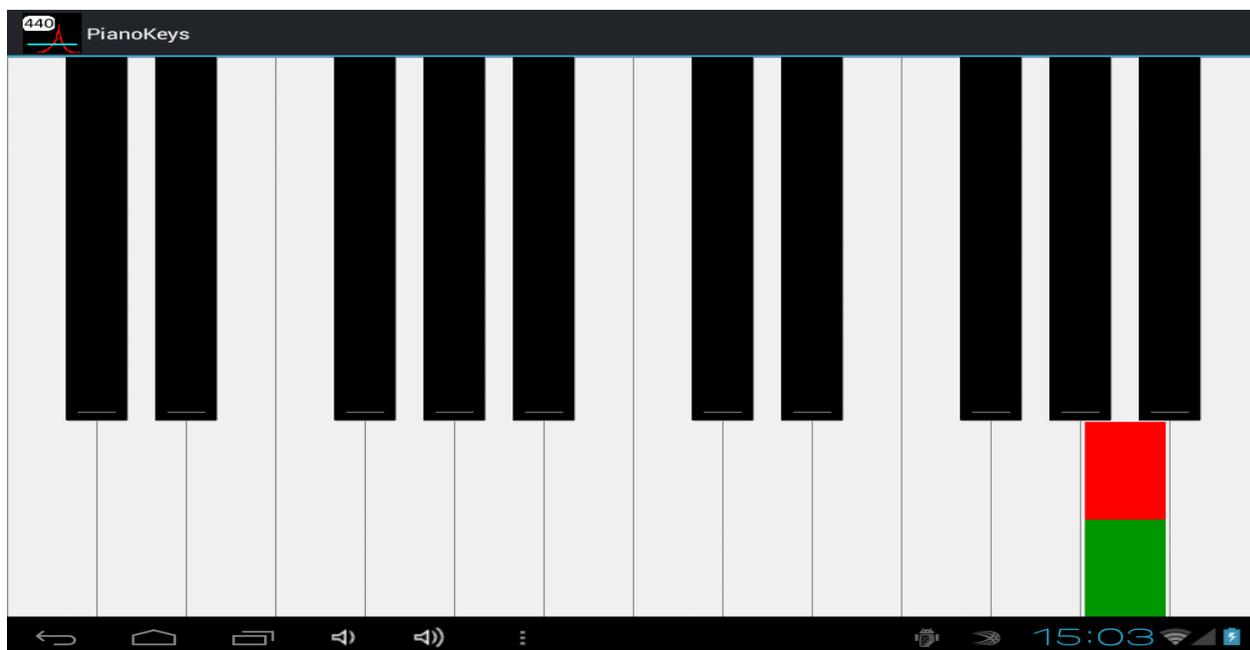
If deviation size as in our case, does not exceed 5 cents color of a graphic deviation and the note name - bright green and the price of division of a scale 1 cent. If the size of a deviation is more than 5 cents color of a graphic deviation and the note name - green and the price of division of a scale is equal to 10 cents.

How to enter notes when setting up

1. Press the button  (**start**).
2. Select the desired note by pressing the appropriate gestures(buttons).
3. Press a corresponding key on a piano.
The spectrum will look like the preceding figure.

In the spectrum of the sound key pressed are automatically **harmonics** and if the note was able to recognize (i.e., these harmonics correspond to the selected note), then highlight with **markers of real harmonics** (yellow vertical).

4. When the input signal it is **important** that all harmonics had higher amplitude envelope(a line cut-off noise level) – the blue curve(line) in the spectrum window. In the zoom bar press the button  to highlight all the harmonics, and the position of the cut-off is regulated by the gesture - movement left-right in-band envelope level.
5. Token real and optimal harmonics can make the decision – to tighten or loosen the string. Since the update of the spectrum occurs often enough, the change in string tension promptly at spectrum. As soon as brought the actual marker on the optimal, you go to another note.
6. Another important point is the preservation of harmonic pressed note in the scale. Press button  (ex ). By pressing this button, the shutdown process audio input, stop displaying the spectrum, and fixation of the harmonics of the selected note, subject to the **inclusion of the flag W**. If retaining the notes was okay, it issued a short beep. Check out what the notes were saved in the “**Keyboard**”.

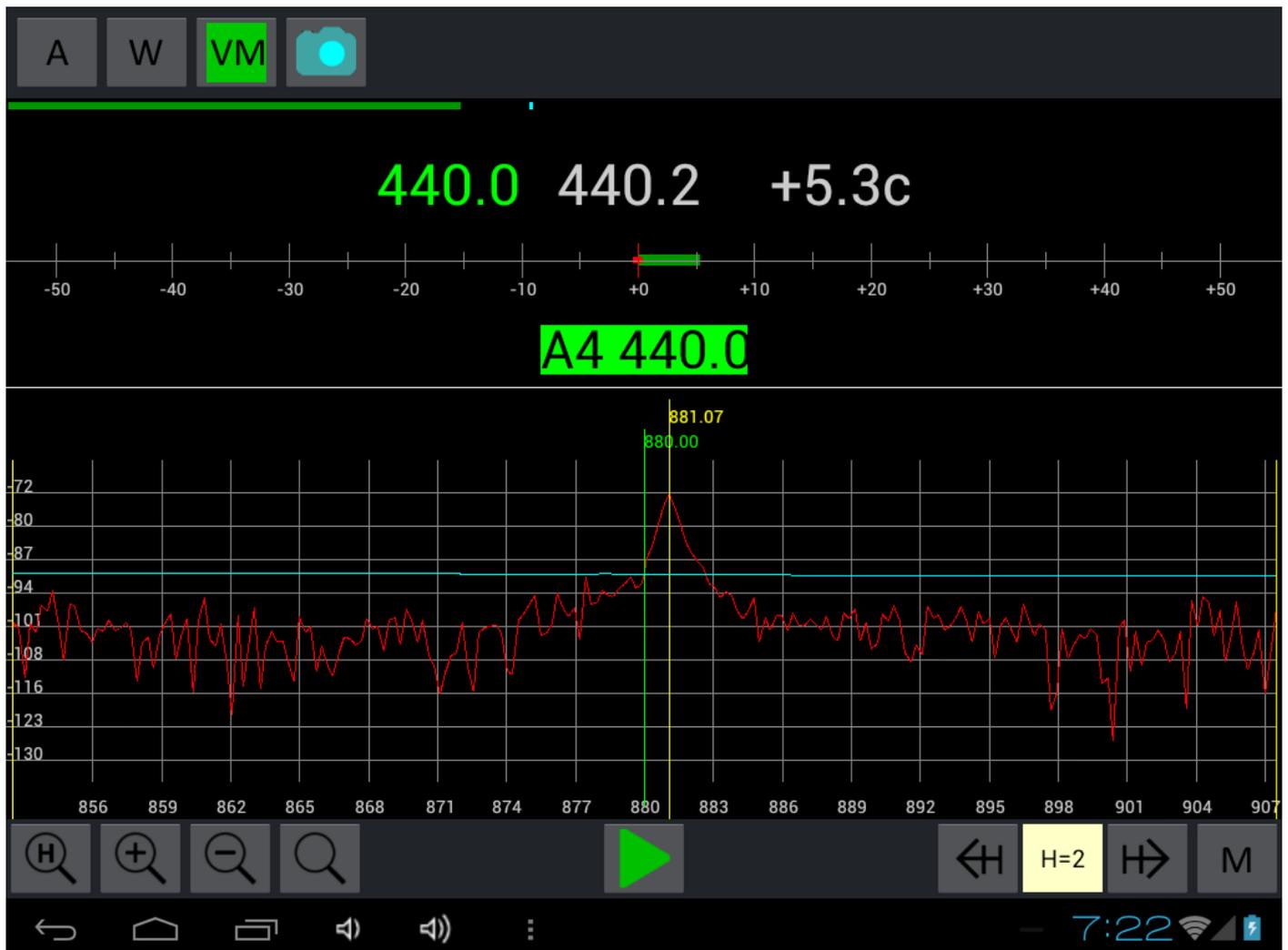


The current note is highlighted in red, and the recorded notes of green rectangles.

Pre-tuning of the sound scale (if necessary)

The initialized frequency of the sound scale does not take into account the specific features of the piano (inharmonicities, etc.) but this idealized system can be used as a first approximation.

If the temperament is raised in several approaches, gradually coming to the desired height, then this is accomplished in the program by changing the frequency base notes **A4** and pressing the “**Reset**” button, which leads to initialization of the scale at a set frequency. And simply lift temperament in accordance with the initialized values of not achieving a particular accuracy.



Example. The figure above shows part of the spectrum of note **A4** for the 2nd harmonic. The real marker harmonic – a vertical straight yellow color. Harmonic frequency– **881.07** Hz and we need to lower it to the optimum marker with a frequency of **880** Hz - vertical green line.

So, to complete pre-tuning, you need to set the required frequency base note, make a “**Reset**” and start the entry process, i.e. click the button , press a key on piano and adjust the yellow marker first (or second) real harmonics of the selected note to the green marker first (or second) optimal harmonic.

Without stopping the input process to move to another note and repeat the adjustment markers. And so – for all notes.

If you want fine tuning, then the first configured area temperament, then at the configured zone set the bass and treble.

Tuning zone temperament with use of an automatic finding of the plan of tuning

Procedure of tuning with use of an automatic finding of the plan of tuning consists in the following:

1. Choose type temperament: usual **ET** or **ET by Stopper**.
2. It is checked in options frequency of the base note **A4**, usually this frequency is equal **440** Hz.
3. Then it is necessary to enter all notes of a zone temperament, by default, it is a range from **A3** to **A4** inclusive for usual **ET** (for **ETs** on Stopper **D3 – A4**). Flag **W** should be **On**.
4. After that, we start process of search of the decision - option **RC** in the menu.
5. If the solution exists, calculated values for temperament zone notes will correspond to the found plan of tuning.
6. Now it is necessary to change only, each note tension of a zone trying to reduce a deviation of real frequency from the calculated.

Remark. The solution is sought so that the beats in quarts, fifths, thirds and sixths fall in a certain interval, and the difference between 2nd harmonic of **A3** and 1st harmonic of **A4** would be minimum (for **ETs** on the **Stopper** the difference between 3rd harmonic of **D3** and 1st harmonic of **A4** is minimized). If the solution exists, in the field of Messages the line that the decision is found with instructions of frequency of the bottom note of a zone темперации stands out.

The solution may not exist for all restrictions or, in the case where one or several notes are significantly different in frequency from the values initialized scale.

The comparison of spectra. Configuring unison. Configure the rest of the scale

Tuning bass and treble are make by octaves from already tuned zone temperament.

You can use the Snapshot of spectrum of the corresponding note.

Button **Snapshot** of the spectrum  is used for fixation on the screen of the current spectrum. This recorded spectrum can be used for comparison with subsequent spectra.



Pressing the button **Snapshot** again resets the spectrum **Snapshot**.

The figure shows the parts of two spectra: the spectrum of blue color is **Snapshot** of **A4** and spectrum of red color – current spectrum of **A3**.

The comparison of spectra can be used, for example, to configure the unisons.

So to configure the rest of the sound scale need to go through one by one all the notes of a temperament zone. Do for each note the **Snapshot** and it custom in unison with the proper note from the next octave. This, of course, does not cancel control quart, quint, thirds and sixths and especially audio control. The fact that the disharmony of the strings can manifest itself in different ways and to equalize all the matching harmonic interval is not always possible. In such cases it is necessary to compromise and choose to hearing more harmonious option.

The results can be saved in the file.

Remark. When tuning up should take into account the effect of temperature – so if You, for example, tuning up a zone of temperament at the same temperature, saved the results to a file, and the rest of the scale set at another temperature and the use of a stored table of frequencies of a zone of temperament, for obvious reasons, the tuning will be incorrect. In this case you need to rebuild or frequency zones temperament and recalculate the optimal plan or tune in unison, which is more preferable.