TuneLab Piano Tuner

FOR ANDROID

© 2015 Real-Time Specialties
(734) 434-2412
www.tunelab-world.com

30 November 2015
version 2.1

Chapter 1

What is TuneLab Piano Tuner for Android?

TuneLab is software that helps you to tune pianos. This form of the software runs on Android devices with at least an ARMv7-A or later processor. TuneLab is also available for iPhone/iPad/iPod Touch devices and on Windows computers. There are other manuals to describe these other forms of TuneLab, and they can be found on our web site at tunelab-world.com. This manual describes only the Android version of TuneLab.

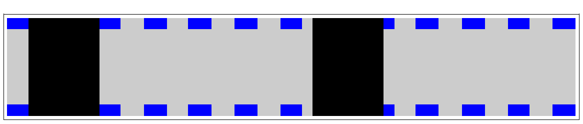
Visual Tuning

TuneLab is a software program that turns an Android device (phone or tablet) into a professional Electronic Tuning Device, which provides a piano tuner with real-time visual guidance in tuning. The sound of a note as it is played is picked up by a microphone and analyzed. The results of the analysis are displayed in visual patterns. TuneLab displays two main visual patterns - the **phase display** and the **spectrum display**. Both of these displays indicate if the pitch of a note should be raised or lowered, but each display has its own unique advantages. Seeing both displays simultaneously gives the piano tuner the best of both worlds.

Note Selection Terminology

In this manual we will be referring to notes on the piano by note name and octave number. For example, A4 is the A above middle C. Each numbered octave runs from C up to the next higher B. So the lowest complete octave on a standard piano is octave 1, and it includes C1...B1. The notes below that are A0, A#0, and B0. The highest note on the piano is C8. Notes that are sharps or flats will always be designated as sharps. So, for example, we write A#0, not B*b*0.

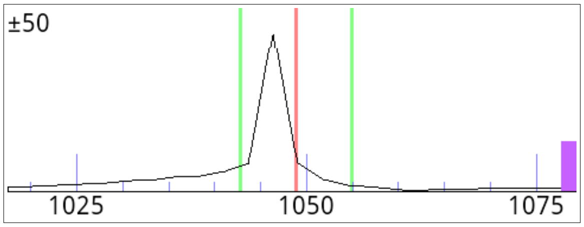
Phase Display



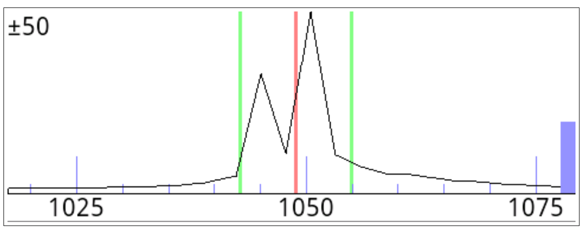
The phase display is the horizontal band shown here. This display is used for fine tuning. The black squares move to the left if the note is flat and to the right if the note is sharp. The closer you get to the correct tuning, the slower the black squares will move. The goal is to make the black squares come as much to a stop as possible. If the piano string has any false beats then the black squares may appear to move in an irregular fashion, sometimes moving back and forth. When there is no note playing, or when the note being played is far from the correct pitch, the black squares will disappear or move randomly.

This display is called the **phase display** because it displays the phase of the sound from the microphone as compared to the phase of an internally generated reference pitch, and is therefore similar to listening to beats. Using the phase display gives the most precise measure of the pitch of a note.

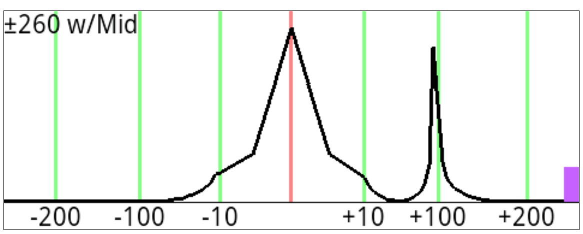
Spectrum Display



The spectrum display is the graph shown here with the zoom set to ±50 cents around the desired pitch. This display can be configured for other zoom levels. This display shows how the sound energy is distributed across the frequency spectrum. If TuneLab is listening to a pure tone, then the spectrum graph will show a single peak, as shown here. This example was made from the note C6, which happened to be about 3.8 cents flat. The red line in the center of the display marks the correct pitch. The green lines nearest the center mark the points that are 10 cents above and below the correct pitch. The objective in tuning with the spectrum display is to tune the note until the peak of the graph is centered on the red line.



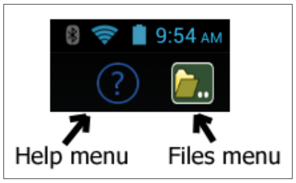
The spectrum display has several advantages over the phase display. One is that it shows where the pitch of the piano is, even when that pitch is far from the correct pitch. The other advantage is that the spectrum display can show several peaks at once. The picture here shows what you would get when playing a poorly tuned unison. Here the piano note C6 is being played with one string tuned nine cents higher than the other two strings. In this display the zoom has been set to its most zoomed-in level, ±50 cents. By looking at individual peaks it is possible to do a rough tuning without mutes! You simply tune one of the strings and watch which peak moves, then move that peak to the central red line.



In addition to zoom levels of "**wide**", **±260 cents**, **±130 cents**, and **±50 cents,** the spectrum display can also be zoomed in on the center ±10 cents in the center of the display, while still showing ±130 cents or ±260 cents overall. When one of these "**dual-zoom**" modes is selected, the numbers at the bottom of the graph show offsets in cents rather than frequencies in Hz. The picture shown here is of one such setting of the spectrum display showing two simultaneous notes - one at C6 and the other at C#6. This picture also illustrates the use of the "**Wide spectrum traces**" option in **Settings**. A faster way to change the zoom setting is to use a two-fingered pinch gesture in the Spectrum Display itself.

One advantage of the phase display is that it generally provides more resolution than the spectrum display, except in the highest octave where the resolutions of the two displays are about the same. For this reason the spectrum display is used for rough tuning and the phase display is used for fine tuning. False beats can confuse the phase display, though. So you may prefer the spectrum display even for fine tuning in the highest octave. In any case, both displays are available; so you can use whichever display seems to be giving the clearest indication.

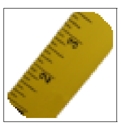
Action Bar (top of Main Tuning screen)



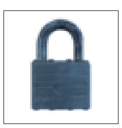
At the top of the Main Tuning screen there is button for Help and a button for the Files menu. Use the File menu to load and store tuning files, to start a new tuning, and to switch to and from Dropbox cloud storage for tuning files. The Help button shows help for items on that screen. Look for a Help button at the top of most other screens in TuneLab too.

Command Buttons (bottom of Main Tuning screen)

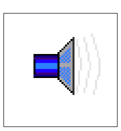
This button switches to the view of the **tuning curve** and the **deviation curve**. The tuning curve shows a graph of the stretch offset for all notes, and the deviation curve analyzes selected intervals for the bass and treble. On this page you can adjust the tuning curve to achieve an appropriate amount of stretch tuning for the particular piano. See "Adjusting the Tuning Curve" in chapter 2 for more information on the tuning curve.



This button starts a measurement of inharmonicity, which is needed when you create a new custom tuning. After pressing this button, play the selected note and hold it for up to six seconds. You should have all but one string muted so that TuneLab hears a single string. You need to measure at least four and preferably five or six notes in order to establish the inharmonicity pattern for the particular piano. After the measurements are made, you can adjust the tuning curve to match them, or just let the tuning curve be adjusted automatically.

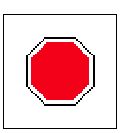


This button turns on **locking mode**. In this mode, TuneLab listens to the sound from the microphone and tries to adjust the offset to match it. You can see the offset changing and you can see the phase display and the spectrum display indicating an in-tune condition. This is used for matching an offset to an existing tuning to measure an existing tuning or to establish a non-standard offset for a tuning. Be sure to turn off locking mode promptly when the sound stops, because otherwise TuneLab will continue to try to lock to noise, resulting in a random offset. The offset produced by locking mode can be reset to zero by tapping on the offset display.



This button switches to sound-generating mode. In this mode TuneLab generates a tone in the speaker or headphones, rather than listening to the microphone. This is not generally used for tuning, but it can be useful for chipping after restringing a piano.

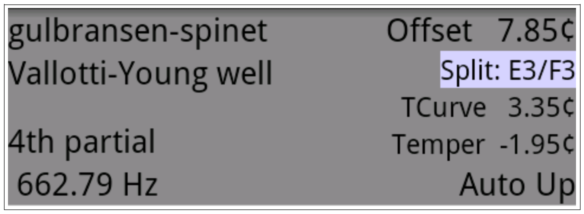
This is the **Settings** button, and it switches to a list of various settings and configuration actions, such as loading and saving tuning files, doing a calibration, configuring the spectrum display, and controlling auto note switching.



This image appears in place of a command button when a mode has been entered that needs to be able to end. This button will stop inharmonicity measurements, locking mode, sound-generation mode, calibration, and over-pull mode.

Current Settings Display

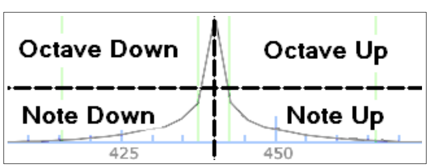
In the middle of the main TuneLab display screen in large letters there is a display of the currently selected note and octave. At the top of the screen is a display of various current settings. Most of these fields usually are blank, but here is an example with most of the fields shown:

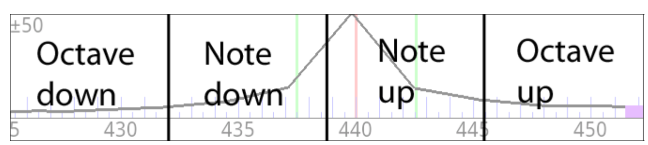


Here is a description of each of these fields, reading down the left column and then the right column:

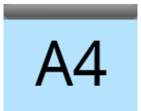
Tuning File Name (*gulbransen-spinet*) - the name of the tuning currently in use
Temperament Name (*Vallotti-Young well*) - the name of the unequal temperament (if one is selected)
Tuning Partial (*4th partial*) - which partial (or fundamental) is used for tuning the current note
Frequency (*662.79 Hz*) - the calculated target frequency, taking into account all offsets
Offset (7.85) - the main offset, if one is used. Otherwise this field is blank.
Split-Scale Break (*E3/F3*) - Indicates the break if Split-Scale tuning is in effect.
Custom Stretch (not shown) - the offset (if any) manually programmed for the current note only
Tuning Curve Stretch (*3.35*) - the stretch offset calculated from the tuning curve
Temperament Offset (*-1.95*) - the offset from the optional unequal temperament in effect
Note Switching (*Auto up*) - tells which form of note switching is in effect

Selecting Notes

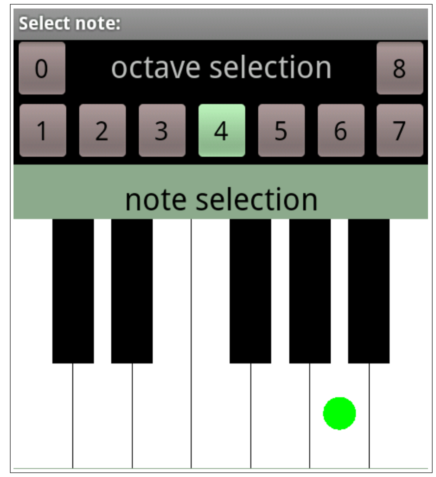




You can change the selected note one note at a time or one octave at a time by tapping on one of the four quadrants of the spectrum display. The two upper quadrants change the octave and the two lower quadrants change the note. The picture on the left shows how the spectrum display is divided into quadrants. The picture on the right shows how the four tapping areas are arranged when the spectrum display has more than a 5:1 aspect ratio (typically in landscape orientation). You can tell which arrangement is in effect because when you tap in the spectrum display the selected quadrant or side-by-side rectangle will briefly turn light green.

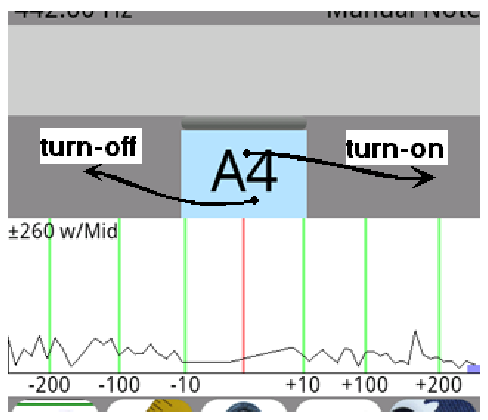


To directly select any note, first tap on the current note display as shown here on the left. That will bring up a note selection page as shown on the right. On this page you first select the octave by tapping on one of the buttons labeled “0” to “8”, and then tapping on the desired note on the piano keyboard. When you tap on a note you will be returned to the main tuning page.



Automatic Note Switching

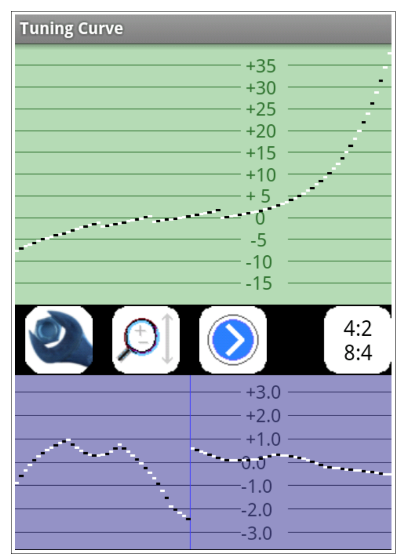
Selecting each note manually takes time and effort that can be avoided. By using automatic note switching, TuneLab will switch to the next note when it hears you play it. You can configure automatic note switching to switch up, down, or in both directions. If you are tuning from low notes to high notes, then it may be an advantage to use “**Auto up**” note switching so that TuneLab will not follow you down the scale as you play notes you have already tuned for test purposes. Automatic note switching may be configured from the **Settings** page.



Automatic note switching can also be turned on or off more quickly by swiping from the current note box to the space to the left (to turn it off) or to the right (to turn it on), as shown here. Start by touching your finger to the current note display (A4 in this case) and then sliding it left or right to quickly turn off or turn on automatic note switching. To cycle through “**Auto-Up**”, “**Auto-Down**”, and “**Auto-Both**”, do the turn-on swiping motion again after it is already on.

Tuning Curve Adjustment

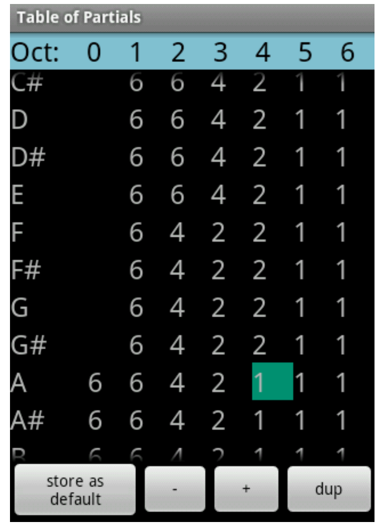
As described in Chapters 2 and 3, the procedure for generating a custom tuning for a particular piano involves measuring inharmonicity for a few notes and then adjusting the tuning curve. The default is for the tuning curve to be adjusted automatically after you measure inharmonicity. But you can also adjust the tuning curve manually or semi-automaticlly. Here is the page where you can examine the adjustment of the tuning curve and change the adjustment if you wish. It is actually composed of two graphs. The upper graph is the tuning curve itself. It gives the stretch offset for each note from A0 to C8 in cents. A typical piano tuning might be at -10 cents for A0 and +30 cents for C8.



The lower graph is called the deviation curve. It shows how the current tuning and the measured inharmonicity affect the two selected intervals shown in the button on the right. The button shown here specifies the 4:2 single octave for the treble and the 8:4 single octave for the bass.

Both the tuning curve and the deviation curve can be zoomed and panned as needed, and the tuning curve can be adjusted in three different ways, as described in Chapter 2.

Partials

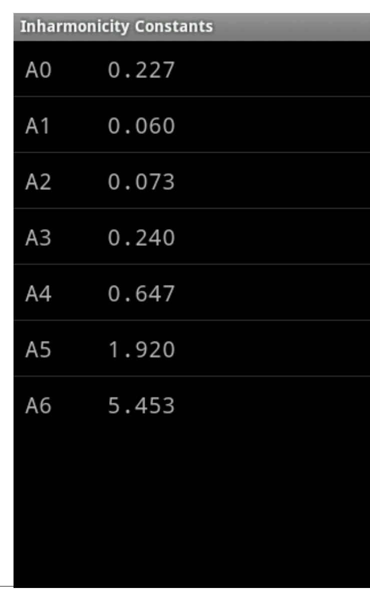


Each note is tuned according to its fundamental pitch or the pitch of one of its partials. The current settings box shows which partial is being used for the current note. The selection of partials comes from a table of partials. This table may be modified from the screen shown here (which is reached from **Settings**). The table shows the partial number for each note from A0 to B6. (C7 through C8 are assumed to be using the fundamental.) You can select any entry in the table by tapping on it. If the desired note is not visible, then you can scroll the table up or down. The selected entry is indicated by the green highlight. Once you have selected the entry you wish to modify, tap on the "**+**" or "**-**" buttons to raise or lower the highlighted partial number. Once a particular partial has been set to the desired value, you may want to use that same partial in some following notes. Tap the "**dup**" button to duplicate the partial value into the next note. In this manner you can quickly set an entire section of notes to the same partial.

The table of partials is stored along with the tuning curve in the tuning file when you save a tuning. So it is possible to customize the table of partials for each piano that you tune. Whenever you begin a new tuning, the table of partials is initialized to the default table of partials. If you want to make a change to the default table of partials that will apply to all new tuning files that you create, then you can tap on the "**store as default**" button to make that table the default.

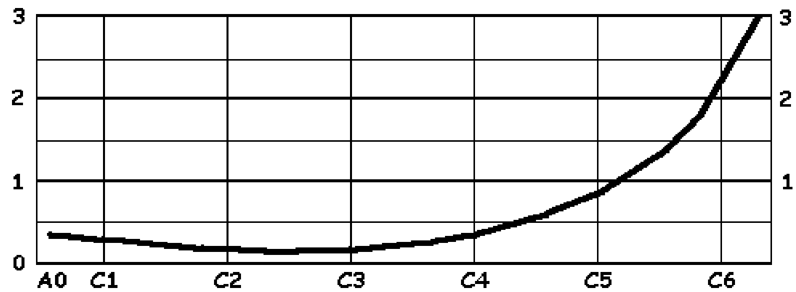
Partials can also be changed for the current note while tuning by dragging your finger horizontally across the spectrum display on the main tuning page. Swipe from the left to the right to go to the next higher partial. Swipe from the right side to the left to go to the next lower partial. These on-the-fly changes are not stored in the table of partials and are canceled when a new note is selected, unless you have enabled **Persistent Partials** under the **Settings**, in which case changes made on-the-fly are immediately incorporated permanently into the current tuning.

Inharmonicity



Inharmonicity is a measure of the relationship between the partials of a given string, and it is the key factor in determining the appropriate stretch for a custom tuning. When TuneLab measures inharmonicity for a string, the pitches of all the partials of that string are analyzed and an inharmonicity constant is generated for that string. The inharmonicity constants are stored in the tuning file when a tuning is saved. You don't need to be concerned with the actual values of the inharmonicity constants that you measure; but if you want to, you can examine them and change or delete them. To change or delete an entry in this list of inharmonicity constants, just tap on the entry in question and follow the prompts.

It is a good idea to become familiar with what typical inharmonicity readings look like so you can recognize an obviously faulty reading.



Typical Inharmonicity Values for a 6' 8" Kawai Grand

In a well-scaled piano you can expect to see the lowest inharmonicity constants somewhere around octave 2. From there the inharmonicity constants increase slightly as you move down to A0 and they increase substantially as you move up to C8. TuneLab uses the specific samples that you collect to interpolate between them to create an inharmonicity model for the entire scale. Using this model, TuneLab makes all the calculations regarding how partials relate to one another.

Over-pull Mode

When raising or lowering the overall pitch of a piano by a significant amount, you will find that the notes that you tune first will not stay where you put them by the time you are done tuning. This is due to the interaction of the string tensions, primarily through the bridge and soundboard and the flexing of the plate. When an entire section of notes is raised in pitch, the result is that the notes that were tuned first will tend to drop in pitch after you tune them. Even the notes that you tuned last will drop somewhat due to the delayed settling of tension in the wire.

Over-pull tuning mode compensates for this change by setting tuning targets that are a calculated amount beyond the desired pitch. In this way the change that occurs will leave the notes right where you want them. In many cases using just one pass with over-pull tuning can take the place of tuning the piano twice. Over-pull mode accomplishes this goal by pre-measuring the pitch of the piano before you start tuning. This process is described in detail in the chapter on over-pull mode.

Calibration

TuneLab should be calibrated on your Android device before you trust its absolute pitch. Without calibration, TuneLab assumes a nominal crystal oscillator frequency in your device's sound system and makes all pitch calculations from that assumption. By doing a calibration, TuneLab learns how to exactly compensate for any deviation from the ideal oscillator frequencies by comparing to a trusted pitch source. You can do a rough calibration using a tuning fork, but a better calibration can be achieved by using a more precise source, such as the NIST standard frequency services described later. The result of a calibration is a knowledge of the actual sample rate of the sound system. Normally, calibration is done only once when TuneLab is first installed on your device. **New for version 2.0: Calibration using the Internet.** See the chapter on calibration later in this manual for details on doing a calibration, including Internet Calibration.

Unequal (Historical) Temperaments

By default, TuneLab assumes an equal-tempered scale. If you would like to tune in some unequal temperament, you can select an historical temperament file to apply to your tuning. An historical temperament is defined by a list of 12 offsets for each of the 12 notes of an octave. When an historical temperament is selected, one of these 12 offsets is used, depending on which note is selected. For any given note, the same offset is used in every octave. The temperament name and the temperament offset for the selected note appear in the Current Settings box shown previously. When you save a tuning the historical temperament values (and temperament name) are saved in the tuning file. See the chapter on historical temperaments for information on making and using temperament files.

Tuning Files

A tuning file is a file made by TuneLab on your device to store a particular tuning. It is stored as part of the TuneLab application. You can organize your tuning files in folders if that makes more sense to you, or you can leave them all in the root folder. Once you have saved a tuning file, that file can be loaded later to re-establish the exact same settings you used the first time. Here is what a tuning file contains:

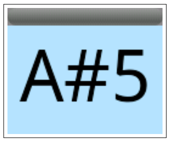
- The inharmonicity constants for the notes that you measured.
- The tuning curve, just the way you adjusted it, or just as it was adjusted automatically.
- The name of the historical temperament (if any) and all 12 offsets from that temperament.
- The partials used for tuning and custom offset (if any) for each of the 88 notes.
- The selection of bass and treble intervals in the tuning curve editor.
- Optional comments and notations that you can associate with this tuning file.

Sound Generation

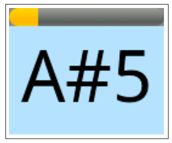
Although the most common use for TuneLab is in listening to notes and providing a visual tuning aid, you can also use TuneLab as a tone generator. When TuneLab is in sound generation mode, the pitch of the sound generated in the speaker or headphones is the same as the pitch that would have indicated correct tuning in the listening mode. The pitch is generated for whichever partial is selected - not necessarily the fundamental. Sound generation is generally used to aid in stringing operations rather than normal tuning.

Tuning Closeness Indicator

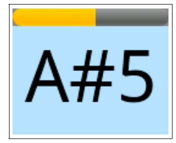
Just above the current note display there is a progress indicator that indicates how close your tuning is to the target pitch. Here are some examples:



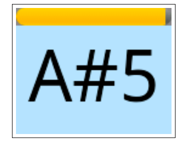
more than
one cent off



slightly less than
one cent off



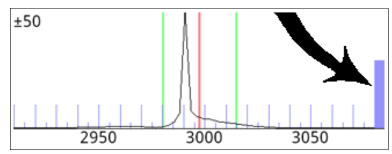
half a cent off



nearly perfect

As these examples show, the progress indicator starts filling in with yellow when the tuning is within one cent of the target pitch; it fills completely when the tuning error goes to zero.

Microphone Level Indicator



To help verify that your microphone is working properly, and to help you control how loud sounds appear to TuneLab, there is a microphone level bar graph indicator at the right edge of the spectrum display as shown here. When the vertical bar reaches the top of the spectrum display, that corresponds to a mic level of 100%. If this indicator does not behave as expected, then you may have a problem with your microphone or with the microphone settings in your device's system.

Chapter
2

Normal Tuning Procedure

This chapter takes you step-by-step through an ordinary piano tuning (not a pitch-raise).
We are assuming that you have not tuned this piano before and saved a tuning file, because if you had, then you could skip the initial setup and just load that tuning file now and being tuning. Similarly, if you would like to try a simple tuning using one of the sample tuning files that came packaged with TuneLab, then you can also skip this initial setup and just load the desired tuning file and start tuning.

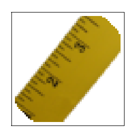
Initial Setup

Begin by selecting **New tuning** from the **Files** menu. This will clear out all the tuning parameters that may have been in effect from the last piano you tuned. This includes inharmonicity measurements, tuning curve adjustments, and any custom offsets. After selecting **New tuning** you should not see any tuning file name in the upper left of the screen.

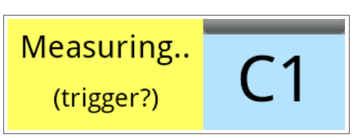
Measuring Inharmonicity

When creating a new tuning, TuneLab needs to sample at least four notes for inharmonicity, and preferably five or six notes. You can measure whichever notes you want. For example let's assume you want to measure C1, C2, C3, C4, C5, and C6. If you have an automatic measuring sequence defined, then these notes may be selected automatically when you start a new tuning. If you would like to define an automatic measuring sequence, go to **Edit Measure Sequence** in the **Settings**.

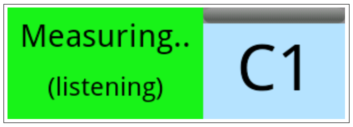
If a particular note is hard to measure accurately because of serious false beats or lack of partials, then just measure some other nearby note instead. When you measure the inharmonicity of a note you should mute all but one string of the note. Measuring the inharmonicity of two or three strings sounding at once is not recommended, even if those strings are tuned together perfectly.



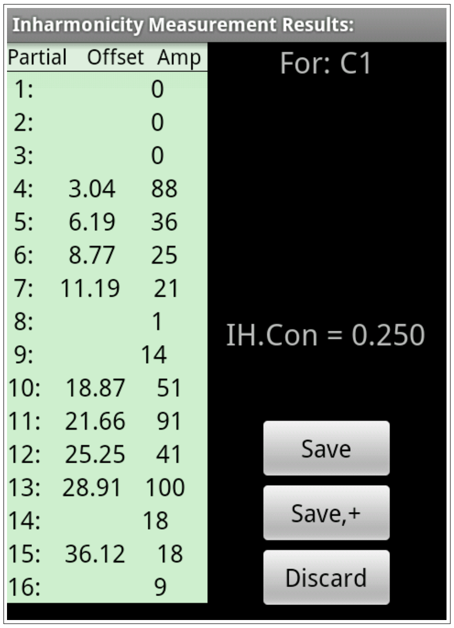
To measure the inharmonicity of a note, first make sure the note you are about to play has been selected in TuneLab. Now that TuneLab is showing the note that you want to measure, tap on the measure button shown on the right. This will cause a yellow status box to appear:



This means TuneLab is waiting for you to play C1. The sudden rise in sound level when you play the note is the trigger. If you don't play the note shortly after initiating a measurement, it is quite likely that some extraneous noise may trigger the measurement period and you will get a false reading. If this happens, press the stop button (red stop sign) and start over. The stop button can also be used to cancel a measurement if you didn't really want it now. When you play the note and the the trigger is recognized, the status box will change to the following:

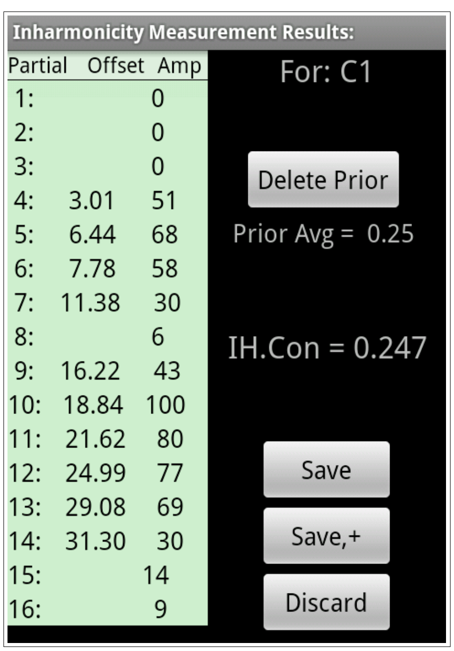


The listening period is about six seconds for low notes and progressively shorter for higher notes. If anything happens to interrupt or interfere with the note during the listening period, then cancel that measurement and try again. After the measurement is done, you will see a display like the following:

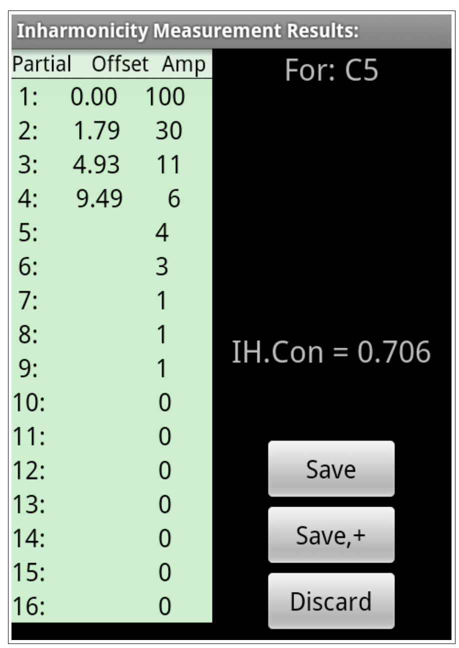


This page shows the results of the inharmonicity measurement for the note C1. Here we see that pitches were detected for partials 4, 5, 6, 7, 10, 11, 12, 13, and 15. The offset column shows the offset in cents for the individual partials as compared to what they would be if there were no inharmonicity. Generally there is more inharmonic offset the higher you go in the partial series. The amplitude column shows the relative strengths of the specific partials. These amplitudes are not used by TuneLab, but are presented for your interest. TuneLab analyzes the pattern of partial offsets and calculates an inharmonicity constant for the string - in this case 0.250. If things look reasonable at this point then you could press the **Save** button, which will save the inharmonicity constant for the note C1. Or you can select **Save,+** which will save the measurement and began another measurement of the same note to form an average of several measurements.

This information is presented to you so you can confirm that a valid measurement has been taken. If you save an erroneous inharmonicity reading, you could throw off the accuracy of the tuning curve that you generate. The only item that is saved is the IH.Con (0.250 in this case). This inharmonicity constant is derived from the offsets shown.



If you take several measurements of the same note, then you will see a results page like the one on the left. Here we see that the average of the prior readings is 0.25, and that the current reading is 0.247, which will be combined with the average thus far if you choose to **Save** it. If you decide that the current reading is the only one that you want to keep and you want to delete all prior readings for this note, then tap on the **Delete Prior** button.



An example of inharmonicity results for a higher note is shown above and to the right. The higher notes have fewer partials that can be measured. Here we see four partials that produce an inharmonicity constant of 0.706. On some pianos the higher notes may not yield an inharmonicity constant at all. TuneLab needs the offset of at least two partials to calculate the inharmonicity. Sometimes higher notes with poor voicing have such weak partials that you don't get the needed two partials. In that case you can either try a different note, or do without that particular measurement.

The measurement results screen shows a lot of data, but the most important measurement is the inharmonicity constant. The graph in Chapter 1 shows the typical pattern of inharmonicity constants from a Kawai 6'8" grand. Other pianos may have more or less inharmonicity, but the pattern should be approximately the same. Knowing the typical inharmonicity pattern will help to eliminate obviously bad readings.

After you tap on **Save** to save the inharmonicity measurement, and if an automatic measure sequence is defined, then TuneLab will automatically switch to the next note in that sequence. You still will have to start the measurement by tapping on the measure button, but at least the note will be selected automatically. See **Edit Measure Sequence** in the **Settings** to select which notes to have measured for inharmonicity.

Adjusting the Tuning Curve

Now that the inharmonicity readings have been taken for several notes, TuneLab can form a model for the inharmonicity of all the notes of the scale, not just the notes that you measured. Using that model, TuneLab can predict how various intervals will sound. Using that model, the tuning curve will be adjusted to match the inharmonicity. For now, we will assume that you are using the default configuration where the tuning curve is adjusted automatically, and the adjustment is based on the selected intervals of 6:3 octaves in the bass and 4:1 double octaves in the treble. See the next chapter for more information on how the tuning curve is adjusted, particularly if you want to change the default settings, which means the tuning curve is adjusted automatically.

Saving the Tuning File

After all inharmonicity measurements have been made and the tuning curve has been adjusted if necessary, then return to the main tuning page and begin tuning. If you want to save this tuning file for later recall, now would be a good time to do so. Save the tuning file by using the **Save tuning as..** item in the **Files** menu. Assign a name to the file that so that you can recognize it in a list of other tuning files. If you are tuning a lot of new pianos of the same make and model, you may decide to keep only one tuning file that you use for all pianos of that same make and model. If you have the time, it is best to measure inharmonicity and adjust a tuning curve for each piano. However new pianos of the same model do not vary that much; for all but the most critical uses, a generic tuning may be acceptable.

Beginning to Tune - the Tuning Sequence

Now that you have a custom tuning file for this piano and and you have saved the tuning file, you can turn your attention to actually doing the tuning. Because aural tuning always starts by setting a temperament, an aural tuning sequences starts in the middle of the scale and works downwards and upwards from there. When using a calculated TuneLab tuning, you need not conform to this sequence. You can tune in any order that you want. The most common sequence when tuning with an electronic aid is to start with A0 and go up from there. In any case, the decision on the tuning sequence is yours to make.

If tuning the bass first, select A0. Play the A0 on the piano and watch for a peak on the spectrum display. The bass requires some special consideration. Because you are tuning to a high partial, it is quite easy for a wrong partial to masquerade as the correct partial if the note is seriously mis-tuned. When in doubt, use aural methods to verify that the note is at least grossly at the correct pitch before trusting the spectrum display or the phase display. One way to confirm that you are tuning to the correct partial is temporarily to select a different partial. If several partials appear at the same relative position in the spectrum display, then you probably have the partials identified correctly. If you do not see a very prominent peak in the spectrum display, it is not necessarily a cause for concern. The phase display will work even with partials that are almost too small to see in the spectrum display. Especially in the bass, feel free to select a different partial on the fly if you are having trouble getting a reasonable indication on the current partial. You can change to a different partial by swiping horizontally through the spectrum display. Swipe from the left side to the right side to go to the next higher partial. Swipe from the right side to the left side to go to the next lower partial. If you have enabled auto partial selection in **Settings**, then TuneLab will search for a stronger partial as you tune and switch partials automatically if one is found.

We recommend that for your very first tuning with TuneLab you leave auto note switching disabled. That way you will not be confused by unintentional note switches. Later on, you can enable auto note switching to speed up your tuning. For now you can manually switch notes by tapping a quadrant in the spectrum display, as described in Chapter 1.

Using your Mutes - Tuning Unisons

When you finish the monochord section of the bass and come to the bichords, always mute one of the strings before tuning the other string in the unison. After one string is tuned, remove the mute and tune the unison aurally. There are times when machine tuning of the unisons is an advantage, but those instances are usually in the high treble. In the bass there are many partials that need to be balanced. Tuning these unisons aurally allows you to make the needed compromises to get the best-sounding unisons. Also, aural unison tuning is faster than using any electronic aid.

Proceed up through the bi-chords and into the tri-chords. Here you can mute the outside two strings and tune the middle string. Then move the right mute over one note to expose the right-hand unison. Tune that unison aurally and then move the left-hand mute over one note. That will expose the left-hand unison and also re-mute the right-hand string. In case your right-hand unison was off at all, it is better to tune the left-hand unison to the middle string than to tune the left-hand unison to the combination of the middle and right-hand strings sounding at once. Also, having all three strings sound at once increases your chances of having to deal with false beats. So always tuning unison strings in pairs is recommended.

Tuning the High Treble

Continue tuning through the high treble. Here you may have some trouble with the phase display. Even though TuneLab has artificially slowed down the movement of the phase display in the high treble, false beats together with a short sustain can produce a confusing picture in the phase display. It is here that we recommend that you direct your attention to the spectrum display. The resolution of the spectrum display is in term of cycles per second, not in terms of cents. Therefore the cents-wise resolution of the spectrum display gets better the higher you go in frequency. You can see this by noting the coarse look of the spectrum display around A-440 in the picture in Chapter 1 as compare to the somewhat more precise look of the graph following that one which is based around C7 (at about 2100 Hz). Therefore, in the high treble we recommend just trying to get the peak to be centered on the central red line in the spectrum display.

Using Auto Note Switching

You can use auto note switching to make tuning easier. To enable this feature, use the **Auto note switching** item in **Settings**, or swipe from current note display to the right as described in Chapter 1. When auto note switching is enabled, TuneLab will be constantly listening for nearby notes; and when it hears one, it will switch to it. Auto note switching can be enabled for switching up, down, or in both direction. The range of auto note switching is plus or minus 300 cents from the current note. If you use aural checks while tuning, be aware that auto note switching may occur while you are doing these checks. If an unintended auto note switch occurs, simply switch back to the correct note manually.

The Tuning Curve

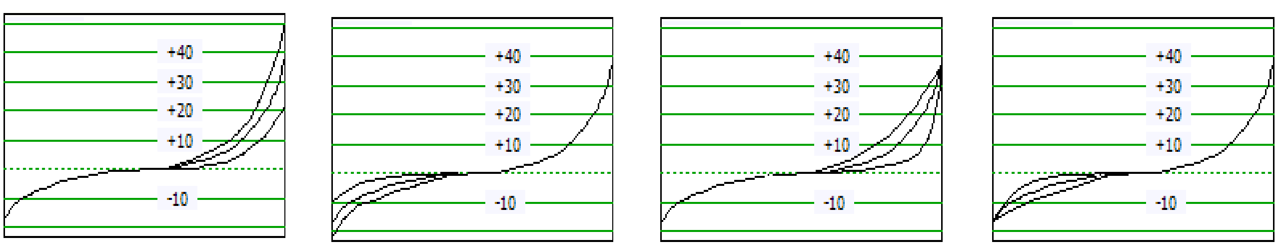
Chapter 3

The tuning curve is the source of the "*TCurve*" offsets that appear on the main tuning screen. The tuning curve determines how much stretch there is in the bass and the treble. You do not need to look at the tuning curve if you are using a saved tuning file, or if you are using automatic tuning curve adjustment. But it is advisable to take a look at it when making a new tuning. And you will certainly need to look at it to make manual or semi-automatic adjustments. Also, you will need to visit the tuning curve adjuster to select which intervals are used to adjust the bass and treble portions of the curve, as described later in this chapter.

If the tuning curve adjuster is configured for automatic adjustment, then the tuning curve will be adjusted automatically after every inharmonicity measurement, using the bass and treble intervals you have selected. You can see this in action by noticing that the *TCurve* offset changes for whatever note is currently selected after you make an inharmonicity measurement (provided there are at least four measurements recorded). Therefore you can just start tuning after making the final inharmonicity measurement for a new tuning. The rest of this chapter will describe what aspects of the tuning curve can be adjusted and how to accomplish those adjustments.

Tuning Curve Variations

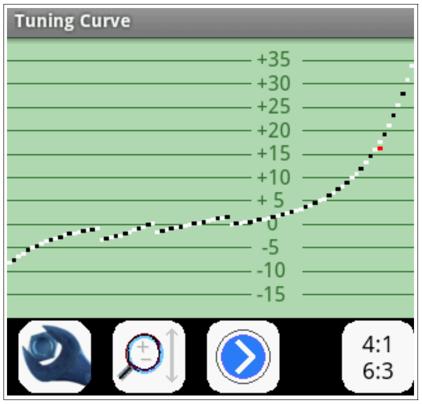
The tuning curve is variable in four different ways, as illustrated here:



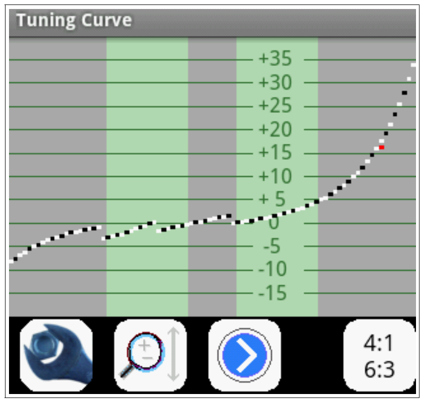
over-all treble stretch | over-all bass stretch | treble shape | bass shape

Each of these graphs shows the stretch for all the notes from A0 to C8. The first graph shows three variations of a tuning curve where the thing that is being adjusted is the overall stretch in the treble. The second graph shows three variations of a tuning curve where the thing that is being adjusted is the overall stretch in the bass. The third graph shows variations of the shape of the tuning curve in the treble. The overall stretch at C8 remains the same, but the way in which it gets there is different. One graph shows a stretch that gradually increases as you approach C8. Another shows a stretch that goes up very little at first, and then abruptly goes up to the same value for C8 as before. And yet another variation is midway between these two extremes. Of course there there are infinitely many such variations, but these few have been presented to illustrate the kind of variation we are talking about. And finally the fourth graph shows variations in the shape of the bass portion of the tuning curve.

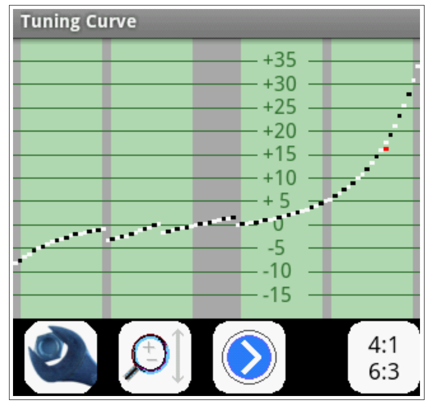
Every tuning curve generated by TuneLab is some combination of these four kinds of variations. So it is not surprising that in manual adjustment mode, you have four different adjustments that you can make. Here is what the top part of the tuning curve adjustment screens look like in each adjustment mode:



FULLY AUTOMATIC



SEMI-AUTOMATIC



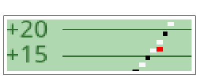
MANUAL

You might notice that these graphs have breaks and do not appear continuous, like the idealized curves shown previously. These breaks represent places where the tuning switches to a different partial. The jumps in the tuning curve are necessary to compensate for the fact that different partials are being used. The jumps in the curve do not represent actual jumps in the tuning, which is in fact still continuous.

In the manual mode on the far right there are four green bands in the background. Swiping you finger up or down in those bands will adjust one of the four aspects of the tuning curve. The left-most and right-most bands adjust the overall stretch in the bass and the treble. The middle two bands adjust the shape of the tuning curve in the bass and the treble. This kind of adjustment gives the most flexibility, but it is the most tedious, especially if you don't know what you want to do to the tuning curve.

In semi-automatic mode only the middle two adjustment bands are active. That is because the overall stretch in the bass and the treble is being adjusted automatically. As before, you adjust the shape of the tuning curve by swiping up or down in the appropriate green band. In the semi-automatic mode, TuneLab will adjust the overall stretch to make the deviation curve (described below) read zero at A0 and C8.

The fully automatic mode shows a solid green background. In this mode, just one tap anywhere in that background will cause all four aspects of the tuning curve to be adjusted automatically. TuneLab will adjust the tuning curve overall stretch to make the deviation curve read near zero and be fairly flat at the lowest and highest extremes of the scale.



You can select between fully automatic, semi-automatic, and manual adjustment modes by tapping and holding the adjustment wrench button shown to the right. Any custom offsets you may have defined will show up as red marks in the tuning curve graph, as show on the left and in each of the full tuning curve graphs shown above. Any manual adjustments you make will not move the red marks, so this is a good way to use custom offsets as a guide for making manual adjustments to match the tuning on certain notes, as determined by some aural means.

Deviation Curve

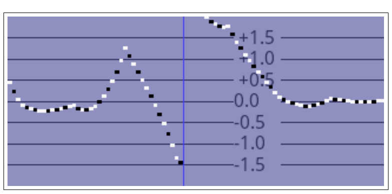
In order to understand how the tuning curve is adjusted automatically, we first have to examine the deviation curve, which is the graph shown below the tuning curve. The deviation curve is divided into a left and a right portion. The left portion shows the outcome of the interval selected for the bass, and the right portion shows the outcome of the interval selected for the treble. The bass and treble intervals are selected by tapping on the interval select button shown here. This particular display indicates that the treble interval is the 4:1 double octave, and the bass interval is the 6:3 single octave.

Using the intervals shown (4:1 and 6:3), the left portion of the deviation curve would show how wide or narrow the 6:3 octaves are in the bass. A positive number of cents means wide and a negative number means narrow. In the bass portion, each interval is specified in the graph by the left-most note in that interval. So for example, the left-most portion of the deviation curve says how wide or narrow is the 6:3 octave formed by A0 and A1.

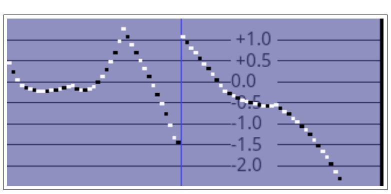
Similarly, the right portion of the deviation curve would show how wide or narrow the 4:1 double octaves are in the treble. In this case, each interval is specified by the right-most note of that interval. Therefore the right-most portion of the deviation curve says how wide or narrow is the 4:1 double octave formed by C6 and C8.

Common selections for bass and treble intervals will generally give these results:

- 6:3 in the bass = low to moderate bass stretch
- 8:4 in the bass = higher bass stretch
- 4:1 in the treble = moderate treble stretch
- 4:2 in the treble = higher treble stretch
- 2:1 in the treble = low treble stretch

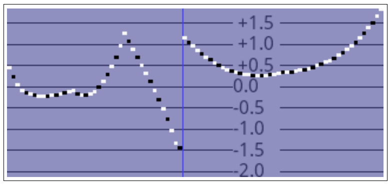


The graph shown here is the deviation curve for a particular piano and tuning curve. The selected intervals were 6:3 in the bass and 4:1 in the treble. It was adjusted in the fully automatic adjustment mode. As we said before, this causes the deviation curve to be near zero at the extremes (A0 and C8) and to be as flat as possible in the vicinity of A0 and C8. In this case we see that is so. The 6:3 octave is nearly beatless (neither narrow nor wide) at A0-A1. Then as we move up the scale the 6:3 octave becomes as much as 1.2 cents wide at about C3-C4. Then it becomes 1.5 cents narrow at about D4-D5, at which point the left side of the deviation curve ends. Looking at the right side of the graph, we see that the 4:1 double octave is beatless at C6-C8 and remains so for quite a ways down the scale, finally becoming much wider near D2-D4.



Now, without changing the tuning curve adjustment, we can select the 4:2 octave in the treble, in place of the 4:1 double octave. If we did that, then the deviation curve would become the graph as shown here. Notice that where the 4:1 double octave was nearly beatless, the 4:2 octave is very narrow. But the 4:2 octave is much closer to beatless in the region where the 4:1 double octave was wider (in the midrange).

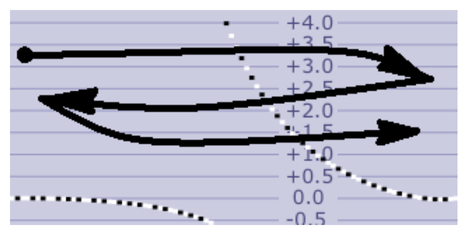
Finally, we can select the 2:1 octave in the treble (still without re-adjusting the tuning curve) and then the deviation curve looks like this. Here we see that in region where the 4:1 double octave was just and the 4:2 octave was narrow, the 2:1 octave is wide by up to 1.8 cents. This shows how tuning is a compromise. In actual practice, many of these very wide or very narrow intervals are not very loud in the regions where they are wide or narrow. Therefore a reasonable tuning can be achieved by using either the 4:1 or the 4:2 intervals in the treble for automatic adjustment. Similarly we could show how the 6:3 and the 8:4 octaves differ in the bass.



As you can see, there are many possible ways to adjust the tuning curve even if you use the fully automatic adjustment mode. And after an adjustment has been made, you can temporarily select a different interval just to see how that interval would work out with the current tuning curve adjustment. We recommend that at first you simply select 6:3 in the bass and 4:1 in the treble and do an adjustment in automatic mode and use it. If you prefer more stretch in the bass, use the 8:4 octave instead of the 6:3. If you want more stretch in the treble, use the 4:2 octave instead of the 4:1 double octave.

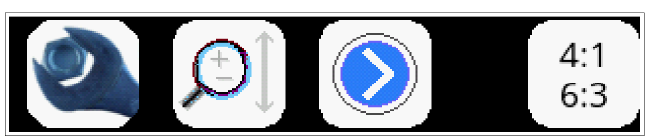
Displaying Beats in the Deviation Curve

The deviation curve normally shows the condition of the selected intervals in cents. But you can also show beats. To switch to beats, swipe the deviation curve with a "Z-shaped" gesture, as shown here. Starting on the left side, drag your finger to the right, then to the left, then back to right and lift it off. This will switch the deviation to displaying beats instead of cents. It can also be used to switch back to cents. When beats are being displayed, the background of the deviation curve switches from the light blue shown here to a reddish color.



Mode Buttons

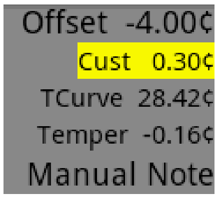
The following buttons appear between the tuning curve and the deviation curve:



The first button makes it possible to adjust the tuning curve. We saw earlier that tapping and holding this button lets you select between manual, semi-automatic, and fully automatic adjustment mode. The second button lets you pan the tuning curve graph up and down. It also enables a two-fingered pinch zoom on that graph. (Such zooming and panning is always enabled on the deviation curve.) The third button shows the details on individual notes in the tuning curve. After tapping on this button, you will see details about a single note. In this mode, you can touch anywhere in the tuning curve to select which note's details are reported. The fourth button lets you select different intervals for the bass and the treble, as described earlier.

Chapter
4

All About Offsets



TuneLab uses several kinds of offsets. The offsets are specified in terms of cents. The offsets in effect are all displayed on the right side of the Current Settings box, as shown here. TuneLab combines them to calculate the desired pitch for each note. In normal tuning, only the tuning curve offset is used and the other offsets are all zero.

Main Offset

This is the offset shown in the upper right corner after the word "**Offset**". When this offset is left at zero, A4 will be 440 Hz, and the offset display field will be blank. If you want to tune to a non-standard reference (like A-442, A-435 or A-415), then you can adjust the offset until you get the pitch that you want. You can change the offset by swiping your finger across the phase display. Swiping to the right increases the offset. Swiping to the left decreases it. The first time you adjust the offset you will get a message asking you to confirm that you want to adjust the offset. This is to prevent an accidental offset if you happen to brush the phase display. <u>The background of the Phase Display turns yellow to remind you that offset adjustments are enabled</u>. Tap on the displayed offset to reset it back to zero. This offset can also be modified by **locking mode**, as described later.

Custom Offset

This is a rarely-used optional note-by-note offset and it is stored in the tuning file. It is sometimes used to record an existing tuning that was done aurally, specifically in the PTG Tuning Exam. It can be used to make note-by-note corrections to the tuning curve. But if you find yourself making many such corrections, then you should consider readjusting the whole tuning curve instead. This offset is not displayed if it is zero, and when present, it appears after the word "**Cust**". The space where this offset would appear is also used to display the location of the break when split-scale tuning is in effect. In that case you will see the word "**Split**" instead of "**Cust**".

The **Custom offsets** item in **Settings** lets you set any and all offsets for individual notes. You can also transfer the main offset to the custom offset for the current note by tapping on the display of the main offset and choosing the "**Transfer offset ..**" item in the menu that pops up. For use in the PTG Tuning Exam, see the chapter on the Tuning Exam for a faster way to transfer the main offset into the custom offset for capturing an aural tuning.

One possible purpose of custom offsets is to establish an aural tuning at several notes by locking on to each note that was tuned aurally, and then transferring the offset to the custom offset for that note. These custom offsets will show up as red marks in the tuning curve display. There you can make manual adjustments to the tuning curve to make it agree with the aural tuning at the specified notes.

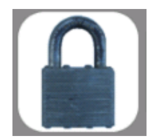
Tuning Curve Offset

This offset comes from the tuning curve for the current tuning. It is calculated based on the adjustment of the whole tuning curve, taking into account the selected note, the partial that is selected for that note, and the inharmonicity. The only way it can be adjusted is to adjust the tuning curve as a whole. The tuning curve offset is displayed after the word "**Tcurve**".

Temperament Offset

The offset after the word "**Temper**" is shown only when a unequal (historical) temperament is selected. For normal equal temperament, this display field is blank. When an unequal temperament is in effect, this offset shows the temperament offset for the current note, which is the same for all other notes of the same name in different octaves. The 12 temperament offsets for a given historical temperament are stored in the tuning file when it is saved while an unequal temperament selected.

Locking Mode



Locking mode is entered by tapping on the **lock** button, shown here. Then TuneLab will show a status box on the left side of the page saying "**Locking**". When you are in locking mode, TuneLab listens to the sound in the microphone and tries to lock to it by automatically adjusting the offset. It will automatically make changes to the main offset so as to make the phase display stop moving. Depending on conditions, it may take several seconds for a good lock to be achieved. This function may be used to measure the existing pitch of a note, or to determine a non-standard reference to match an existing tuning. Make sure to turn off locking mode promptly when the target sound is no longer available, or else TuneLab will continue trying to lock to random noise from the microphone. Locking mode can be turned off by tapping on the stop-sign button that appears in place of the lock button.

Storing Main Offset in Tuning Files

When a tuning file is saved while a non-zero main offset is in effect, then this offset will be stored in the tuning file. But the stored offset will not be automatically restored when that same tuning file is loaded later. Instead you will see a prompt asking you if you want to adopt the offset that was stored with the tuning file or keep the existing offset in effect. If you respond with "Yes", then the offset stored in the tuning file will be loaded. If you tap on "No", then the offset will be left as it is. In this way you can treat the main offset as something that is tied to the various tuning files or as something that is independent of them.

Chapter 5

Over-pull (Pitch Raise) Tuning Procedure

Over-pull tuning is most often used in pitch raising, although it could also be used for pitch-lowering. When large overall changes are made to the tuning of a piano, the notes that you tune first tend to change pitch as you tune later notes. Over-pull tuning mode compensates for this change by setting the pitch a calculated amount beyond the desired pitch. In this way the settling that occurs as later notes are tuned will leave the notes right where you want them. In many cases using just one pass with over-pull tuning can take the place of tuning the piano twice. And even if do use two passes, doing the first pass in over-pull mode will leave the piano closer to the correct pitch than if you hadn't used that mode, and thus the second pass will be easier.

Measuring Inharmonicity Before an Over-pull

When over-pull mode is activated, TuneLab will not let you measure inharmonicity. Therefore if you want to create a custom tuning for the piano as described in the Chapter 2, you would have to measure the inharmonicity and adjust the tuning curve before enabling over-pull mode. For small to moderate pitch raises, the normal inharmonicity measurements will be sufficient. However, for very large pitch raises, the act of pulling the string up to pitch will change the inharmonicity of the strings. For such pitch raises, you are not going to get away with doing a one-pass tuning anyway. So when you do the second pass, discard the old inharmonicity readings by starting over with a new tuning file, and take fresh inharmonicity readings. In fact, you would probably be better off skipping the inharmonicity readings on the first (extreme) pass and using the **Average** tuning file, or a generic tuning file from a similar model piano for that pass. Then only the final pass would need to have custom inharmonicity measurements taken.

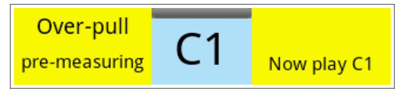
Enabling Over-pull Mode

If your evaluation of the piano convinces you that the overall pitch change is large enough to need an over-pull, then you can begin the process of over-pull tuning by pre-measuring the piano. This must be done before any tuning has been started, in order to get an accurate measure of how flat the piano was to start with. This will enable TuneLab to calculate an amount of over-pull appropriate to the particular piano.

Pre-measuring for Over-pull Mode

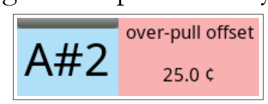
If an appropriate tuning file is already loaded, then go to **Settings** and select **Over-pull**. It is important to have some reasonable tuning file loaded when the pre-measurements are taken, because the pre-measurements are going to be interpreted with respect to whichever tuning file is currently loaded. If you had, say, a no-stretch tuning file loaded, then the pre-measurements would not accurately reflect how flat the piano was from what it should be.

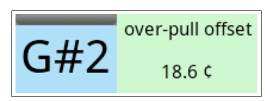
On the over-pull control page, tap on **Start** at the top of the screen. This will switch back to the main tuning page with two yellow status boxes showing. The right status box shows which note you should play, and how flat each note was as it is measured. Make sure to play each note only once and make sure you stay in sync with TuneLab. It is important that you play the note that TuneLab is expecting.



Here is what the display looks like when you first start the pre-measurement. TuneLab asks you to play the selected note. After you play the selected note and TuneLab has captured its pitch, then the display will change to the next picture. Here you see the results of playing E2 (-58.6 cents). Then you see that TuneLab has switched to G2 and is asking you to play it. In this example we have configured the over-pull pre-measurement to pre-measure just the notes of a C-major arpeggio. You can also configure it to pre-measure all white notes or every note (chromatic scale). Pre-measuring every note gives a more accurate picture of the pre-tuned state of the piano, but it also takes four times longer than pre-measuring only the notes from a C-arpeggio. If the piano is approximately flat by the same amount across the scale, then pre-measuring only the C-arpeggio notes is usually sufficient.

Over-pull Tuning





After the last pre-measurement has been made, TuneLab automatically switches to tuning in over-pull mode by selecting A0. Then the display will look like the picture to the right. The calculated over-pull offset is shown next to the current note display. In this example, the calculated over-pull would have been more than 25 cents, but it is being limited to 25 cents by the safety limits in effect. You can tell that from the color of the background. Whenever a safety limit is causing the over-pull offset to be limited, then that offset will be displayed with a pink background, as shown above. If the over-pull offset is low enough to avoid the safety limit, then it will appear with a light green background, as shown in the next picture. You may now tune the piano normally, except that you should tune straight from A0 to C8 tuning unisons as you go, and each note will have an over-pull offset added on to it. You should tune unisons as you go because TuneLab assumes that you do that when it calculates the over-pull offset.

You can turn off over-pull mode by tapping on the stop button (red stop sign). And you can resume over-pull tuning from the **Over-pull** section of the **Settings** menu.

How Over-pull is Calculated

You do not need to understand the exact formula for over-pull to take advantage of over-pull mode. TuneLab performs the calculation automatically based on all the pre-measurements, and on the setting of the over-pull parameters. There is no longer any concept of an over-pull percentage, as found on earlier versions of TuneLab. Nor is there a running average of pre-measurements done during tuning. Instead each individual pre-measurement contributes to each individual over-pull amount with a proprietary formula. This means you do not have to worry about pre-measurements while you are tuning, nor do you have to worry about auto note switching interfering with pre-measurements. If a note is too far off pitch to trigger auto note switching, then just start tuning it and TuneLab will switch to it when it comes in range of the correct pitch.

Over-pull Options

There are some settings that you can change which affect how over-pull operates. These options are changed from the **Over-pull** page in **Settings**, as shown here. Tapping the **Start** button will start the pre-measuring process from the beginning, discarding any pre-measurements that have already been made. Tapping **Resume** will continue pre-measuring, keeping existing measurements. The pattern of pre-measurements (shown here as "*Pre-measure every C, E, G, etc.*") can be changed by tapping the adjustment wrench next to it. The other choices are "*All white notes*" and "*Every note*". If there are any pre-measurements already made, tapping on **Edit pre-measurements** will allow you to view those pre-measurements, and possibly delete some of them. If you delete a pre-measurement, then TuneLab will simply interpolate between the neighboring entries to calculate the over-pull offset.

In the Tuning section of over-pull, tapping on **Begin using over-pull tuning** will return to the Main Tuning screen with over-pull mode enabled, using whatever pre-measurements have been made to calculate the over-pull offset.

There is also a setting for the location of the highest note on the bass bridge and the highest wound string. Tapping on the adjustment button next to those settings will allow you to change them. TuneLab uses this information in the calculation of the over-pull offset, as well as to qualify the next two options - the safety limits.

The next two options are the safety limits. They set an overriding upper limit on how high the over-pull offset is allowed to go. In the example shown earlier, where the over-pull offset was shown as 25 cents with a pink background, the actual calculated offset, based on all the pre-measurements that were taken, would have been about 45 cents sharp. But this is above the specified safety limit of 25 cents, so the over-pull offset was limited to 25 cents. You can set these safety limits however you want by tapping on the adjustment buttons next to them. But you take all responsibility for what may happen with higher safety limits. TuneLab is initially installed with conservative limits in effect. If you want more permissive limits, then you will have to change them.

The final option is the over-pull factor, which should normally be left at 1.00. If you can it, the factor will be applied to all over-pull calculations for a more aggressive or less aggressive over-pull tuning.

On small screens, the bottom of the screen shown here may not be visible. This screen can be scrolled up or down to access the entire screen.

Chapter 6

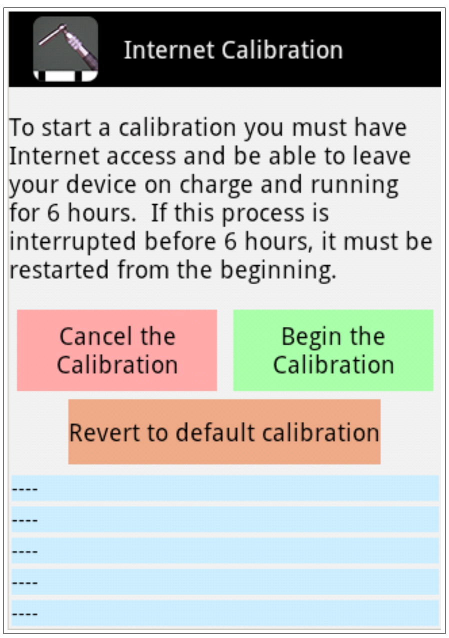
Calibration Procedure

This chapter takes you through the process of doing a calibration. Normally you need to check calibration only once when you first install TuneLab on your Android device. The results of the calibration are stored permanently on your device and used thereafter every time you run TuneLab. You can check the need for a calibration by comparing TuneLab to some trusted source of pitch.

Internet Calibration

A new feature introduced with version 2.0 is calibration by means of Internet Time Servers. You can use this Internet Calibration if your Android device has connection to the Internet. Internet calibration takes **six hours**, so it is best done overnight when you would not be using your device anyway. **Any other use of your device during this time, such as receiving a phone call, will interrupt the calibration, so the calibration would have to be started over from the beginning.**

From the Settings list select "**Do a Calibration**". Then select "**Internet Calibration**". You will then see a screen like the one below. To start the calibration, simply tap on the "**Begin the Calibration**" button. An automatic sequence will begin that will last six hours. Ensure that your device is plugged into a charger so that the calibration operation will not run down the battery. No further input is needed from you. But you should watch to see that things get started properly. Here is what you can expect.



1. The software will attempt to contact up to four different Internet Time Servers to establish an initial time reference for the calibration run. The status of those communications will be displayed in the first four rows with the light blue background at the bottom. This normally takes less than 10 seconds. Make sure there are no error messages before leaving the device for the night.

2. After the initial time reference has been made, the software will proceed to count audio system data block for six hours. During this time the amount of time remaining in the six-hour run will be displayed on the screen.

3. After six hours are up, the software will again access Internet Time Servers to establish a final time reference. You need not be present when this happens. Based on the number of audio system data blocks received in the six-hour period and the difference in the two Internet time references, the software now has all the information to calculate the actual audio system sample rate, which is the basis for all pitch measurements in TuneLab. These results will be displayed on the screen, and will be waiting for you whenever you finally get back to your device, even if it is several hours later. At this point an interruption like receiving a phone call will not abort the calibration because the calibration has completed. Then you will only have to confirm that you want to accept those results as the new calibration for TuneLab, and the process is done.

If you wish to "forget" all calibration data (including a calibration that was done some other way) and cause the device to revert to the default calibration, tap on the **Revert to default calibration** button.

The rest of this chapter relates to the traditional form of calibration by means of comparing to a trusted source of pitch.

A Trusted Source of Pitch

To do a traditional calibration you need to have a trusted source of pitch. The most accurate source of pitch that you can get is from the National Institute of Standards and Technology (NIST). This agency of the U.S. government has a telephone service and shortwave radio service that disseminate standard time and frequency. The telephone service is free of charge (but the call is not toll-free), and the shortwave radio service may be heard on 2.5, 5, 10, 15, and 20 MHz, if you have a shortwave radio. Another source of accurate pitch is a Sanderson Accu-Tuner, or other calibrated tuning device that can produce a tone. In most areas of the USA, the telephone dial tone contains an A-440 that might be used for calibration, but this frequency is not certified by the phone companies and may be in error. The example described here involves the use of the NIST standard frequency service, but you can use other sources.

NIST Broadcast (and Telephone) Schedule

The NIST standard frequency service is available by telephone by calling (303) 499-7111 in Colorado. This is a very popular number. What you hear when you call this number is exactly the same as what is being transmitted by the NIST shortwave radio stations as mentioned above. NIST reports that they get over two million calls per year. In order to use these services effectively, you need to know something about the schedule for this service. The following schedule is followed each hour. It shows what tones are present during each minute of the hour. When a tone is present, it is present for the first 45 seconds of the minute and it is silent for the last 15 seconds. There are also time ticks every second, but they do not interfere with calibration since TuneLab is able to ignore the ticks.

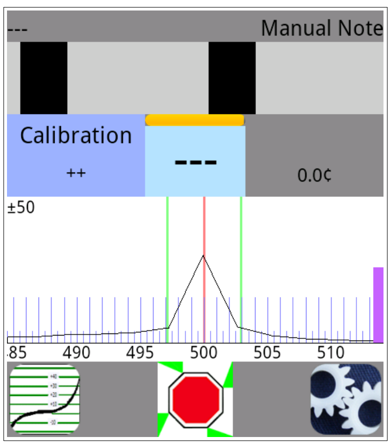
0: - - -	10: - - -	20: 500	30: - - -	40: 500	50: - - -
1: 600	11: 600	21: 600	31: 600	41: 600	51: - - -
2: 440	12: 500	22: 500	32: 500	42: 500	52: 500
3: - - -	13: 600	23: 600	33: 600	43: - - -	53: 600
4: - - -	14: - - -	24: 500	34: 500	44: - - -	54: 500
5: 600	15: - - -	25: 600	35: 600	45: - - -	55: 600
6: 500	16: - - -	26: 500	36: 500	46: - - -	56: 500
7: 600	17: 600	27: 600	37: 600	47: - - -	57: 600
8: - - -	18: - - -	28: 500	38: 500	48: - - -	58: 500
9: - - -	19: 600	29: - - -	39: 600	49: - - -	59: - - -

Although the 440 Hz tone in minute #2 is tempting, do not try to use it. That pitch is only present for 45 seconds each hour. The difficulty in calling at just the right time and the shortness of the tone make this choice inadvisable. Instead you can use the 500 Hz and 600 Hz tones. The telephone service will disconnect you after three minutes, so make sure that when you call you have everything set up and time your call so that you will be assured of at least three minutes of 500 Hz or 600 Hz tones. If you happen to be closer to Hawaii than to Colorado, you can receive WWVH by shortwave radio or by calling (808) 335-4363 in Hawaii. For more information on both of these sources, see the website:

`www.boulder.nist.gov/timefreq/stations/iform.html`

Using NIST Tones for Calibration

To use the NIST standard frequency service to do a calibration, start by selecting **Do a calibration** from the **Settings** menu. Then select **500 or 600 Hz NIST tones** as the reference source. Do not try to make the call to the NIST with your Android phone. You need to use a different phone because TuneLab cannot be running at the same time as you are making a phone call. Position the Android device so that its microphone is right over the speaker of the phone that is calling NIST. Follow the on-screen instructions and make sure the microphone of your device is close to the telephone speaker. TuneLab automatically will determine which tone is currently sounding (500 or 600) and lock to it. When TuneLab has heard enough it will display a message saying that calibration is done.



Here is what the lower portion of the main tuning page looks like during a calibration. It is similar to locking mode in that the offset is being adjusted automatically to lock on to the sound it hears. But unlike locking mode, there is no note displayed in the current note display. You can cancel a calibration at any time before it finishes by tapping on the stop button (red stop sign).

Using Other References for Calibration

Besides the 500 and 600 Hz NIST tones, TuneLab offers other choices. If you have a precise 440 or 1760 Hz tone source, you can use that. 1760 Hz was chosen because it is the fourth harmonic of 440 Hz. Finally, there is a completely general choice where you can enter whatever frequency you like. But whatever frequency you enter, it must be the true frequency of the source that you intend to use for calibration. If you have a calibrated CyberFork (from Reyburn Piano Services) then you can use it as a calibration source by entering the exact pitch in Hz. The exact pitch of a CyberFork is offset from 440 by the amount written on the CyberFork. The offset on the CyberFork is in cents, so you first need to convert that to Hz. You can use TuneLab to do that by selecting A4 (440 Hz) and then offsetting it by swiping the phase display, as described in Chapter 1. Adjust the offset until it matches the offset written on the CyberFork, then read the frequency in Hz from the lower left of the current settings box. It should be near 440. For example, if the CyberFork is -0.56 cents, then the frequency of that CyberFork is 439.858 Hz, and that is the value you should enter if you want to use that tone for calibration.

Chapter 7

Historical Temperaments

TuneLab normally produces an equal temperament. But historically this was not always the norm. Even today there is a strong interest in non-equal temperaments. With a non-equal temperament, different key signatures have different musical characteristics. It is said that the classical composers were aware of these differences and wrote their music to take advantage of these differences. A full treatment of historical temperaments and their musical characteristics and advantages and disadvantages is beyond the scope of this manual. But if you are interested, there is a lot of published literature on this subject.

For our purposes an historical temperament is defined by a set of 12 offsets from equal temperament. These 12 offsets are repeated in every octave. TuneLab comes packaged with a set of historical temperaments that can be applied to any tuning file. If you know of a historical temperament that is not included with TuneLab, it is easy to add that temperament to your device by entering the 12 offsets, as described below.

Loading Temperament Files

To add a historical temperament to the current tuning, go to **Settings** and select **Non-equal temperaments**. This will show you the list of historical temperaments that are currently on your device. If you see one that you want to use, just tap on it. If you have an historical temperament applied to the current tuning and would like to remove it, tap on the button that says "**cancel current**" at the top of the list.

When an historical temperament has been added to the current tuning, you will see the name of that temperament just below the tuning file name on the main tuning page. Also you will see an offset for each note showing as **Temper xx.xx**. As you change notes, the "temper" offset changes.

Making Temperament Files

If you want to use a temperament that was not provided with TuneLab, you can create your own new temperament files by tapping on the "new" button at the top of the list of temperaments. All you need to know is the 12 offsets that define the temperament. Enter those 12 offsets along with an appropriate name for the new temperament so you can select that temperament by name. Then tap on the "**Save**" button at the bottom of the list of the 12 offsets. When you make a new temperament file, you can then select it into any tuning curve just like the original historical temperaments that came packaged with TuneLab. Note that creating a temperament automatically selects that temperament into the current tuning.

Options for Applying Temperaments

Whenever you select a non-equal temperament into the current tuning you will be given a chance to normalize and/or transpose that temperament before it is applied. These are rarely used features, and normally you would just tap on the "**Done**" button when presented with these options.

Normalizing the temperament refers to shifting all 12 offsets by the same amount before they are used. There are three normalizing options:

1. The default is to do no normalizing at all. The 12 offsets are used as-is.

2. You can choose to normalize the temperament so the offset for A is 0 cents. This is normally not needed because all the temperaments that come with TuneLab have already been set up to that the offset for the "A"s is 0 cents. But if you happen to create a new temperament that does have some non-zero offset for A, then choosing this option will shift all 12 offsets so that A comes out to zero.

3. You can choose to normalize the temperament so that the average of all 12 offsets is 0 cents. This is also not normally needed since most temperaments are already presented so that some of the offsets are positive and some are negative and so the average is not too far from zero. But if you want to make that average offset exactly zero then you can choose this normalization option. The reason for this option is that it is easier to tune a piano when there is not an overall pitch change. Having a large average pitch change means the tuning likely to be less stable.

In addition to the normalization options, there is also the option to transpose the temperament before it is applied. The default is to do no transposing so that the offset for C is actually applied to C, etc. But if you want to make, say, the key of A sound like the key of C in Werkmeister III temperament, then you can choose to "rotate C to A". This will rotate all 12 offsets so that the offset specified for C actually gets applied to A, and so on. This is also a rarely used feature, and normally you would just accept the temperament as it is by tapping on the "**Done**" button.

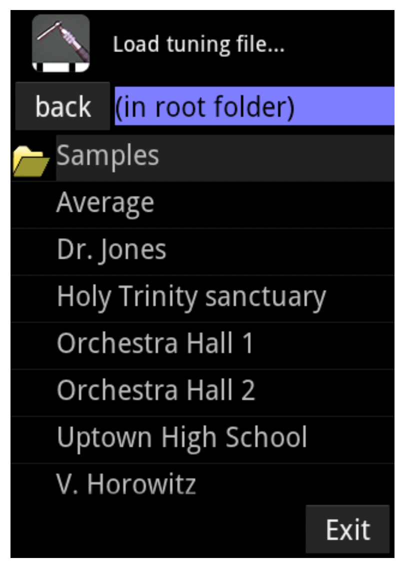
Chapter 8

Working with Tuning Files

It is possible to use TuneLab without ever saving a tuning file. Just make a new tuning for every piano you tune. But if you tune the same piano regularly you can save time by saving the tuning file for that piano. If you save the tuning file, the next time you tune that piano, or some piano that is very much like it, you can skip the initial setup of measuring the inharmonicity and the adjustment of the tuning curve. You will be able to proceed directly to tuning. Even if it is not the same exact piano, you may want to use a tuning file from a similar make and model piano.

Saving tunings, loading tunings, and other tuning file operations are performed through the **Files** button that looks like the one on at the top of the main tuning screen.

Loading Tuning Files



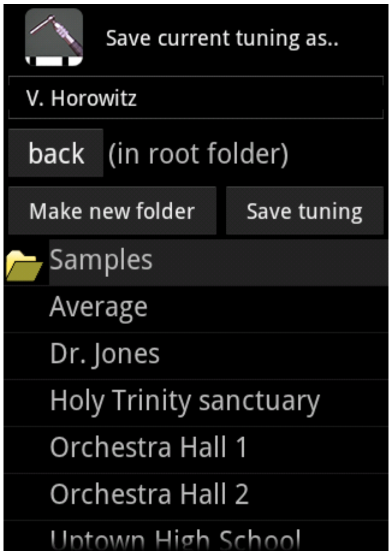
To select an existing tuning file (either a tuning that came packaged with TuneLab or a tuning you had saved earlier), tap the **Files** button as shown above, then select **Load tuning** from the menu. This will bring up a display like the one shown here. You have the option of organizing your tuning files into folders, or you can keep all your files in the root folder. Notice that the example shown here shows "(in root folder)" at the top of the page to show what folder we are looking at. Folders are indicated by the yellow folder icon to the left of the folder name, as shown here for the Samples folder. You can tap on any folder to enter that folder. To navigate back to a previous folder, tap the **back** button shown here to the left of the current folder name. If you are already in the root folder, tapping on the **back** button will return control to the main tuning screen.

Suppose we wanted to load the tuning file "Holy Trinity sanctuary". Then we just tap on that name and the tuning file will load.

While navigating the folder hierarchy, you can delete tuning files and folders by tapping and holding on the item you want to delete. If you want to delete a folder, you must delete all the files in that folder first.

Tapping on the **Exit** button will take you back to the main tuning screen without loading any tuning.

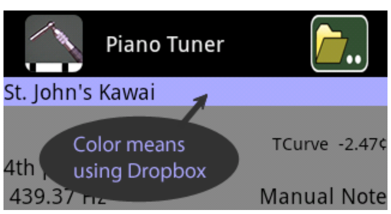
Saving Tuning Files



To save a tuning, select "**Save Tuning**" from the **Files** menu. Then a screen will appear as show here. The top line (shown as "V. Horowitz" here) is where you can enter the name of the tuning file as you want it saved. The box is pre-loaded with the current tuning name to save you time if you want to use the same name. Below that there is an indication of which folder you are in, along with a back button for navigating up and down the folder hierarchy. You can also make a new folder by tapping on **"Make a new folder**". Below that there is a list of folders and previously saved tuning files. Tapping on a tuning file name simply inserts the name of that file in the top box. Then you can use it as is, or make some change to the name before saving it by tapping on the **Save tuning** button.

Cloud File Storage

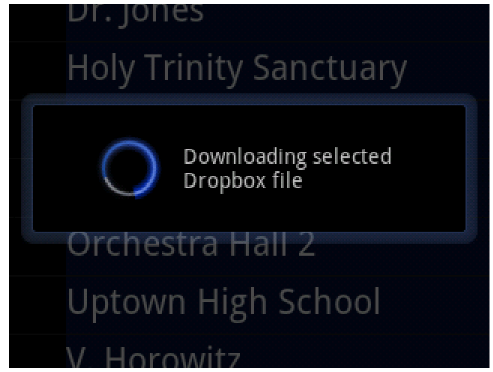
In addition to the usual local file storage for tuning files, you also have the option to use Internet cloud file storage provided by Dropbox. To use this option you will need to register for a Dropbox account. Although there are fees for premium services from Dropbox, you only need the basic free service to manage tuning files from TuneLab. See www.dropbox.com for details on how to sign up for the free service.



After you have registered a Dropbox account, you can switch to Dropbox file storage for your tuning files. This is done by selecting **Use Dropbox** from the **Files** menu. After you have successfully switched to Dropbox file storage, all tuning file names will be displayed in TuneLab with a light blue background, as seen here, for both the current tuning name on the main tuning screen, and all the file names in the lists of files when navigating the file system. In this way you can be constantly reminded of which file system you are using.

When the Dropbox cloud file system is enabled, all files are ultimately stored in Dropbox through the Internet. But you may not always have an Internet connection when you want to use TuneLab. So it is important to understand the caching method used by Dropbox.

All files that you write to Dropbox and all files that you open from Dropbox have a copy of them kept locally on your device. This local copy is not to be confused with your normal local tuning files. This local copy is called a *cache*, and it is only accessible through the Dropbox interface, even when you are not connected to the Internet. This caching should be transparent to you. However, you will notice that when you open a Dropbox tuning file that has never been opened before, the screen briefly pauses while the file is being downloaded from the Internet.



Normally, if an Internet connection is available, either by wi-fi or by a cellular data plan, this message (as shown on the right) will only appear for second or so. But if the Internet is not available at the time, this message will remain until you cancel it by using the Android **back** button on your device.

In most cases, all the files appearing in the list of Dropbox files are already cached on your device. But if you have recently deposited a tuning file into your Dropbox by some other means than writing it from TuneLab running on your device, and if you expect to need access to that file at a time when Internet access is not available, all you have to do is open that file once when you do have Internet access. After that, a copy of the file will be in the Dropbox cache on your device, and you will be able to access it from TuneLab whether or not the Internet is available.

Dropbox Operations

You can switch back and forth between Dropbox and local file storage at any time. One way to transfer a file from one file system to the other is to load the file from one file system, switch to the other file system, and then do a **Save As..** in that other file system. This is fine if you only want to transfer one file. But it could get tedious if you wanted to transfer many files this way. In particular, if you already have a large number of tuning files stored locally on your device, you can copy all of them, all at once, to Dropbox. Just tap on **Dropbox Ops** in the **Files** menu. Then tap on **Copy local files to Dropbox**. This menu can only be done when TuneLab is in the cloud file storage mode.

The other operation available under **Dropbox operations** is **Unlink**. The only real purpose of this function is to enable you to change which Dropbox account is in use. Normally, the first time you use TuneLab with Dropbox, you sign in and give your Dropbox account information. This information is stored on your device so you never have to enter it again. But what if you decide to use a different Dropbox account? There is no way to get Dropbox to ask for your account information without first unlinking from the existing account. So if you tap on **Unlink**, this is exactly what happens. The next time you switch to cloud file storage, the prompt from Dropbox will appear, just as it did the very first time you switched to Dropbox.

Tuning Exam Report Files and Dropbox

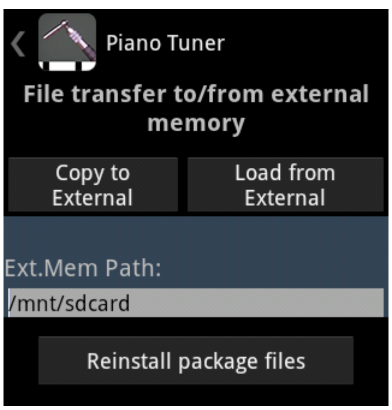
Although tuning files are the primary reason for using Dropbox with TuneLab, Dropbox will also be used (if it is enabled) to receive Tuning Exam reports. So if you want to copy a Tuning Exam report to a desktop computer for printing or some other use, simply switch to cloud file storage before generating the Exam Report. Note that this implies the master tuning used to generate the report must also be in the Dropbox file system. If it is not, make a copy of it in Dropbox before trying to generate a report with it.

Transferring Files To and From your Device

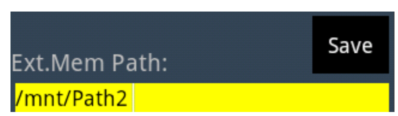
Note: The methods described below are for transferring files **without** the use of Dropbox. Generally it is easier to use Dropbox for this purpose, but if you cannot use Dropbox, the following methods apply.

The local tuning files that you save in TuneLab are saved in memory that is internal to your Android device and associated exclusively with the TuneLab Piano Tuner application. This file memory normally is not accessible externally. But sometimes it is desirable to transfer local files into or out of your device. You may have tuning files from some other version of TuneLab that you would like to import into your Android version of TuneLab. Or you might want to export tuning files from your Android device to store somewhere else for backup or to load into some other device running TuneLab. These operations are possible through the use of **external memory** on your Android device.

There are two kinds of **external memory** in Android devices. One is the truly removable kind of memory, like SD cards. The other is a built-in memory that is called "external" by Android even though it is built-in to your device. You can use either kind of external memory to transfer tuning files into or out from your Android device by going to the "**About this version**" page in **Settings**, and tapping on External memory file transfer, which will display the screen shown below.



The button labeled "**Copy to External**" will copy all the tuning files, temperament files, and tuning exam report files to external memory. The "**Load from External**" button will copy these files from external memory into TuneLab. The box at the bottom that says "`/mnt/sdcard`" tells which external memory will be used for these transfers. TuneLab starts out by using whatever external memory path the manufacturer of your Android device chose to specify. If you want to change that path then tap inside that box and make corrections with the keyboard. The it will look like the image to the right. The yellow background is to remind you that the change you made is not yet in effect. To complete the change you must tap on the "**Save**" button. In addition, the "**Copy..**" and "**Load..**" buttons will disappear until you save the changes to the external memory path. If you want to restore the system default for the external memory path, just change the path name by trying to make it blank. TuneLab will recognize a blank path name as a special case and will replace it my the factory default value.



The actual directory used for transfers to and from external memory will be whatever was shown in the box with "`/tunelab`" added at the end. In the example shown in the picture above, the files will be transferred to and from

`/mnt/sdcard/tunelab`

Therefore you should look for your files in the "`tunelab`" directory of the external memory.

If the preset external path name does not work for you then you need to find out what path name does work. Unfortunately that procedure is different with each Android device. What you need is a file explorer app. Many Android devices come with some kind of file explorer app already installed. For example, in the Acer Tablet the app is call "**AndExplorer**". In some other devices it might be called simply "**Files**". The reason you need to explore the file system from the Android side and not from a connected PC is that the Android file path name is not shown when viewing the file system through an attached PC. By whatever means you can, find out the Android path name of the external memory you want to use. In most cases it will be the preset path name and you will not have to worry about it any more. But for those devices that have several kinds of external memory you might just have to do some exploring to find out what the preferable path name is. For example, in the Acer Iconia Tablet the two external memory path names are:

`/mnt/external_sd` (the actual removable SD card)

`/mnt/sdcard` (built-in "external" memory)

Now that we have established transfers to and from external memory, then next step is to move those files to some other computer. There are two ways to do it.

Transfer Using Removable Media

If the external memory is truly removable you can just remove the media and plug it into a compatible media reader, such as an SD card slot on a PC. Then you can copy files using the PC's explorer or finder utility. Remember to look in the directory "`tunelab`" found in the root of this media.

Transfer Using Built-in Memory

If the external memory is built-in to your Android device then if you plug that Android device into your desktop computer with a USB connection then the external memory will appear in your desktop computer's files, the same as if you had plugged in a USB memory stick. As before, make sure to look in the `tunelab` directory of this memory in your desktop computer.

The PTG Tuning Exam

Chapter
9

The Piano Technicians Guild administers a series of examinations for the Registered Piano Technician (RPT) classification. One of those examinations is the tuning exam. Certain electronic tuning devices are used to aid in the administration of several phases of this exam.

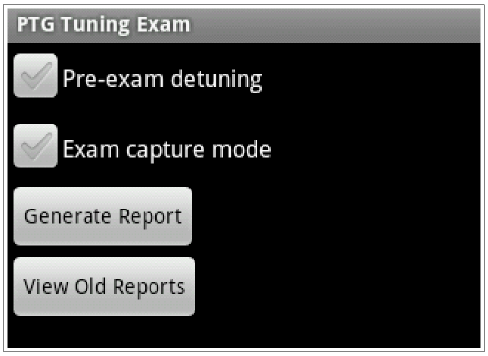
The first step in the tuning exam is the recording of a master tuning. This is normally done ahead of time by a committee of PTG-certified tuning examiners. The master tuning is determined on a specific piano, and that piano may then be used to administer the tuning exam for a number of examinees. Although an electronic tuning device may be used by the committee to establish a first pass at the master tuning, the final master tuning is normally arrived at after intensive scrutiny and aural adjustment by the members of that committee. As the tuning is finalized, the offsets from a no-stretch tuning are recorded into what becomes known as the master tuning. This tuning is used as a standard with which to compare and grade various examinees' tunings. Sometimes the master tuning is recorded all at once after the whole tuning has been established, and sometimes the committee will record small sections of the tuning as they are developed in order to minimize the possibility of tuning shift before the notes are measured.

The second step is the preparation of the piano for the examinee. The preparation involves detuning the piano according to a pattern set by the PTG so that the examinee will not be able to benefit from the previous tuning, but at the same time will not be overly inconvenienced by having to do a pitch raise in addition to a normal tuning. The PTG-specified detuning pattern contains alternating positive (+) and negative (-) offsets that average out to zero. TuneLab produces that pattern of offsets when put into the detuning mode, as described later. After the detuning has been accomplished, the examinee may now tune the piano.

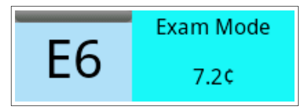
The third step is to record the examinee's tuning. This is done in the same way as the master tuning was recorded. The resulting tuning file should be saved under a name that identifies the examinee.

The fourth step is to create a grading report that compares the examinee's tuning with the master tuning. This report is used by the tuning examiners as a basis for assigning penalty points and for aural investigation of discrepancies. During these investigations the examinee is given the opportunity to demonstrate the correctness of his or her tuning through aural verification. Based on these demonstrations, the examiner may erase penalty points for some of the discrepancies to arrive at a final point score. In addition to these comparisons, there is also a separate evaluation of the examinee's ability to set the fundamental of A-440 to his or her own reference tone. This evaluation is also included in the final assessment of the examinee's performance.

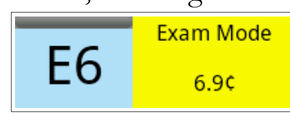
Exam Capture Mode



This mode of TuneLab Piano Tuner is used to record the master tuning and to record the examinee's tuning. To enter this mode, go the **Settings** and select **PTG Tuning Exam**. Then you will see the screen shown on the left. From this screen you can switch on the **Exam Capture Mode**. In this mode the main tuning screen will show a status box on the right side of the current note display, as shown in the box on the right. The offset in cents shown in that box is the offset that will be recorded for that note. This offset is rounded to the nearest 0.1 cents, as specified by the PTG. Also, in the Exam Capture Mode, the partials for each note are no longer adjustable. The partials are forced into the selection specified by the PTG for the Tuning Exam.

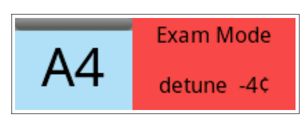


This captured offset can be modified by adjusting the custom offset for the current note by first adjusting the main offset. The main offset can be adjusted by the same methods as described in Chapter 4 - *All About Offsets*. That includes swiping through the Phase Display for manual offset adjustment, or using Locking Mode for automatic adjustment. Whenever a non-zero main offset is showing in this mode, the background of the status box is yellow, as shown here, which indicates that an offset is pending, but not yet transferred to the custom offset for the current note. The transfer can take place using the methods described in Chapter 4, but in Exam Capture Mode, there is an easier way. Just tap on the status box with the yellow background. That will instantly transfer the main offset to the custom offset for the current note, and at the same time turn the status box background to blue, indicating that there no longer is any pending offset that needs to be transferred. If Locking Mode is used to lock on to the piano tone, then tapping on the status box will not only capture the offset but will also turn off Locking Mode. All this is done to streamline the process of capturing a master or examinee's tuning. After the entire tuning has been captured, save the tuning file under an appropriate name and then turn off Exam Capture Mode.



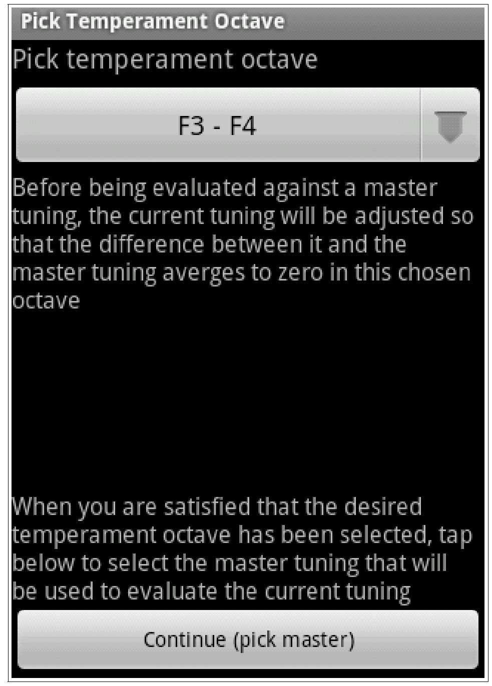
Pre-exam Detuning

Go to **Settings / PTG Tuning Exam** and turn on the switch for **Pre-exam detuning**. This will cause the status box to the right of the current note to appear as shown here. The reddish background is to warn you that detuning is in effect. It also shows the detuning offset that would be used for the current note. In order to make the detuned piano conform closely to the overall stretch of the master tuning, the master tuning should be loaded before switching on **Pre-exam detuning**. As with Exam Capture Mode, this mode also will enforce the PTG-specified partials for each note.



Generating a Report

After recording the examinee's tuning, you can generate the report that compares this tuning with the master tuning that was captured earlier. First load the examinee's tuning. If the examinee's tuning has just been captured and saved, then it is already loaded as the current tuning. Then from the PTG Tuning Exam page, tap the button labeled **Generate Report**. The first step in generating a report is to select the temperament octave, as shown on the right. The PTG Tuning Exam specifies that the examinee's tuning will be offset before comparison with the master tuning so that the average error in the temperament octave is zero. After setting the spinner to the appropriate octave, tap on the "**Continue (pick master)"** button. This will show the tuning files in much the same way as when a tuning file is loaded. But now, instead of loading the file that you select, the selected file will just be used as the master tuning to create the report. After you select the master tuning, the report will be generated and shown to you at once. You have the option to view the report that was just generated. Or you can tap come back to that report at a later time. The report has already been written, and it will continue to exist in your device under the name of the examinee's tuning file name. If you want to come back to view this report later, then you can tap on **View Old Reports** from the **Tuning Exam** page. This will display a list of all stored reports according to the name under which they were originally stored. You can select any stored report in order to look at it again. If you want to delete old reports from your device, this also is the page where you would do that. Simply tap and hold on the report name and follow the prompt.



This Tuning Exam Report does not automatically take into account the evaluation of the examinee's ability to set A-440 to an absolute standard. That evaluation must be done separately and taken into account manually by the examiner. In order to measure the examinee's A-440 you must turn off any exam mode in order to be able to force the fundamental to be used for A-440, because in the exam modes, the second partial is used for that note. With exam mode turned off, you can simply lock onto the examinee's A-440 using any tuning file and no offsets. Then from the main offset you can read the examinee's error.

Split-Scale Tuning

Chapter

10

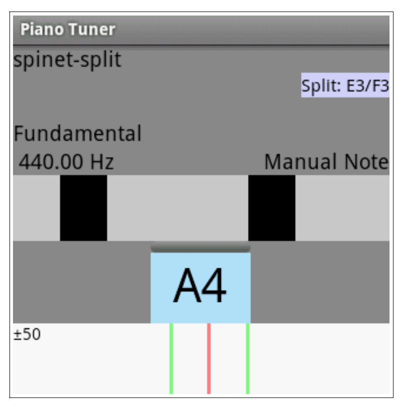
When a piano has a large jump in the inharmonicity at a break (such as between wound strings and plain strings), it may be desirable to create a custom tuning that has special provisions to accommodate that break. TuneLab has such a provision and it is called "**Split-Scale Tuning**".

A normal TuneLab tuning is based on a smooth function that changes gradually from A0 all the way up to C8. But a Split-Scale tuning is based on a function that abruptly changes at the break. Above the break the tuning is normal, making it a blend of competing criteria. But below the break the Split-Scale tuning switches abruptly to satisfy just one criterion - the 6:3 octave. Ensuring that the 6:3 octaves are perfect may compromise some other tuning goals, such as uniformly progressive thirds and tenths. But the thought is that for these pianos the beatless 6:3 octaves are the only achievable goal.

If you are considering using Split-Scale tuning, then measure the inharmonicity on both sides of the break. If the inharmonicity jumps by more than double, then it might be a good idea to use Split-Scale tuning. A high-quality well-scaled piano normally will not have such a large change in inharmonicity at the break, so Split-Scale tuning is normally considered only for lower-quality pianos, especially spinets. However there are exceptions. Some spinets have a surprisingly smooth inharmonicity change through the break. And some grands (like the Yahama GH-1) have quite a bad jump in inharmonicity. So it is best to decide to use Split-Scale tuning only after evaluating the inharmonicity for the specific piano at hand.

Triggering Split-Scale

If you have decided to try Split-Scale tuning, here is how to do it. Measure inharmonicity as you normally would, either manually or with the aid of automatic measure sequencing. Then afterward measure the inharmonicity on both sides of the break. If the ratio between the two neighboring inharmonicity readings is more than 1.6 then TuneLab will enter **Split-Scale Mode** and the main tuning screen will indicate this mode by displaying the location of the break, as shown here on the right where readings were taken at E3 and F3. If TuneLab decides to go into Split-Scale Mode and you decide you don't want to use Split-Scale Mode, then just go to **Edit IH Constants** in **Settings** and delete one of the two neighboring readings around the break. This will turn off Split-Scale Mode.

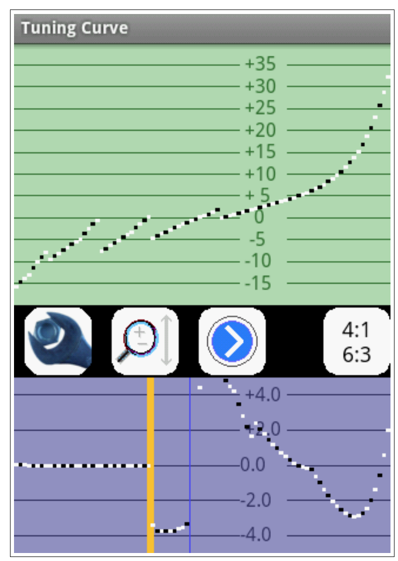


If the inharmonicity measurements have more than one potential "break" (that is, a place where you measured two adjacent notes) then TuneLab will determine the location of the real break by seeing which pair of adjacent notes has the largest jump in inharmonicity. This is useful because the standard set of inharmonicity readings might happen to include a note very near the break so that when you add in two more readings around that break you could end up with three adjacent notes. If we didn't evaluate the size of the jump we would have no way of knowing which pair of readings you meant to designate the break.

Normally you use "**New Tuning**" to start the process of measuring inharmonicity. Go ahead and follow that process as usual, letting TuneLab automatically switch through the notes in your measure sequence (usually C1, C2, C3, C4, C5). Then manually go back to the two notes around the break and make measurements for those two notes as well. For example, if we measure A0-A6 and then go back and measure E3 and F3 then the following set of inharmonicity readings would trigger Split-Scale tuning:

```
A0: 0.227
A1: 0.060
A2: 0.073
E3: 0.150  (just below the break)
F3: 0.090  (just above the break)
A3: 0.240
A4: 0.647
A5: 1.920
A6: 5.453
```

Split-Scale Indicators in the Tuning Curve Adjuster



When a Split-Scale tuning is in effect, you can see a yellow vertical line drawn through the deviation graph at the break. You will also notice that the deviation graph to the left side of the yellow line is a flat line. That is consistent with the fact that Split-Scale produces perfect 6:3 octaves below the break at the expense of everything else.

Intervals Other Than 6:3 in the Bass

It is strongly recommended that when you use Split-Scale tuning you always use the 6:3 bass interval in the tuning curve adjuster. But if you should decide to pick a different interval for the bass, here is what TuneLab will do. TuneLab will create a blend between the interval you select and the 6:3 octave in the bass. Starting at the notes just below the break the 6:3 interval will be optimized. Then as you move lower in the bass, the tuning will be a blend of the 6:3 octave and the other interval you selected for the bass. Finally, at the lowest notes in the other bass the interval you selected will be optimized. You can see this effect by viewing the deviation curve with another bass interval selected.