TuneLab

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Chapter 1

What is TuneLab ?

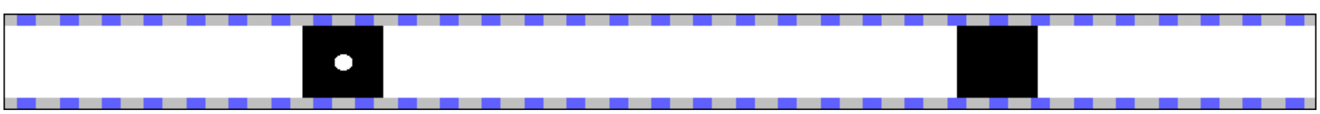
TuneLab is software that helps you to tune pianos. Currently this software comes in two forms - TuneLab Pro (for Windows laptops) and TuneLab Pocket (for the Pocket PC). Although these two platforms are quite different, most of the features of TuneLab are implemented similarly. Therefore most of this manual covers both programs. Where there are differences between the two programs, the unique features of each program will be described separately.

TuneLab software got its start in 1997 with the introduction of TuneLab 97, a shareware program for Windows computers. Through the development of TuneLab 97, several different approaches to the challenge of piano tuning aids were tried. Some of these approaches worked well, while others proved to be difficult to use. Based on the experience of TuneLab 97, a new approach was designed, which became TuneLab Pro and TuneLab Pocket. While this manual is not meant to document TuneLab 97, there is a section that describes the major differences between TuneLab 97 and the two programs that followed it.

Visual Tuning

TuneLab is one of the class of devices called "Visual Tuning Aids". These are devices or programs that provide a piano tuner with real-time guidance on how a note should be tuned. 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 a visual pattern. In the case of TuneLab, there are two main visual patterns that are displayed - the phase display and the spectrum display. Both of these displays indicate if the note should be raised or lowered, but each display has its own unique advantages. Having both displays visible simultaneously gives the piano tuner the best of both worlds.

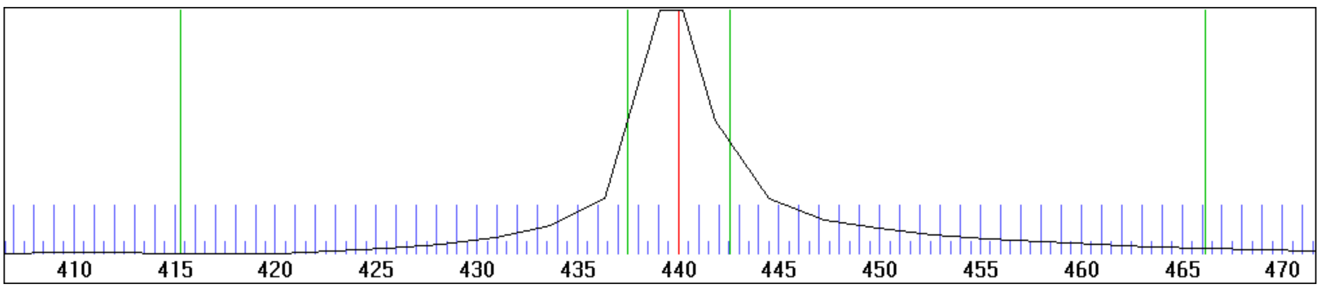
Phase Display



The phase display is the horizontal band shown above for TuneLab Pro. The image for TuneLab Pocket is similar. 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 square come as much to a stop as possible. If the piano string has any false beats then the black squares will appear to move a little in one direction and then a little in the other direction. When there is no note playing, or when the note being played is far from the correct pitch, the black squares will disappear.

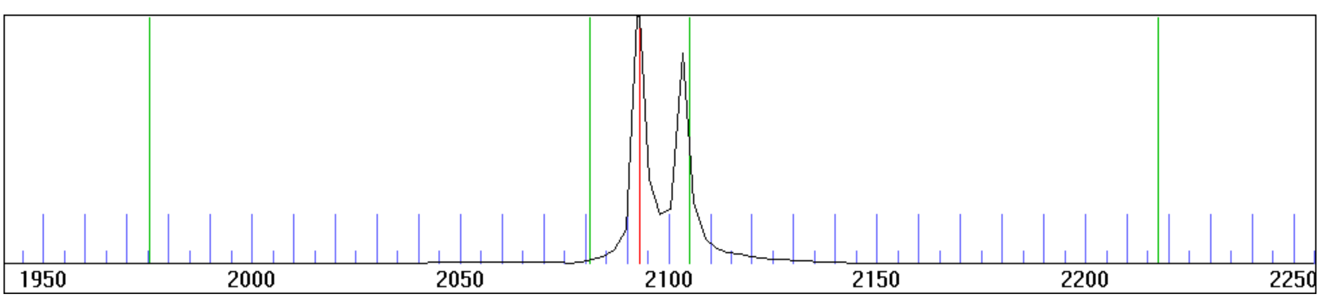
This display is called a phase display because it displays the phase of the note being played as compared to the phase of an internally generated reference tone. The movement of the squares can be compared to listening to beats between a tuning fork and a note on the piano. When a square makes one complete trip around the display, that corresponds to one complete beat that you would hear when comparing two tones. Actually, that is only true below A-440. Above A-440, the phase display is artificially slowed down by TuneLab. This makes it easier to see which way the squares are moving as you progress to the higher pitched notes. If TuneLab were to keep to a strict one-for-one relationship between beats and cycles of the black squares, then the display would be moving very fast when tuning a note in the highest octave, even when the note is quite close to its correct pitch.

Spectrum Display



The spectrum display is the graph shown above for TuneLab Pro in the zoomed-in mode. The image for TuneLab Pocket is similar, except that the numeric labels at the bottom of the graph are more widely spaced. 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. The example seen here was made from a A-440 tuning fork that was actually a little 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 green lines far from the center mark the points that are 100 cents above and below the correct pitch, i.e. the previous note and the next note. The object 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. This is what you would get when playing a poorly tuned unison:

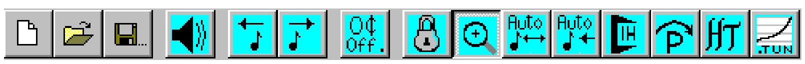


Here the piano note C7 is being played with one string tuned nine cents higher than the other two strings. By looking at individual peaks it is possible to tune notes in the high treble without mutes! You simply tune one of the strings and watch which peak moves. You can move that peak to the red line and then that string will be at the correct pitch. However, tuning this way is not as accurate as tuning by sounding one string at a time, because the multiple peaks tend to become blurred as they merge into one another.

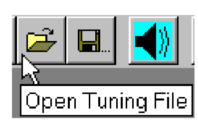
One disadvantage of the spectrum display is that it generally does not provide as much resolution as the phase display, except in the highest octave, where the resolutions are about the same. For this reason the spectrum display is used for rough tuning and the phase display is used for fine tuning. False beats can confuse the phase display, though. Therefore the spectrum display is preferred even for fine tuning in the high treble. In any case, both displays are available, so you can use whichever display seems to be giving the clearest indication.

Toolbars

Both TuneLab Pro and TuneLab Pocket use toolbars in their user interface. Here is the toolbar from TuneLab Pro:



New Tuning File - prepares for creation of a new tuning
Open Tuning File - selects an existing tuning
Save Tuning File - saves the current tuning in a file so it can recalled later
Sound On/Off - toggles the sound generation mode on and off
Note Lower - switches to the next lowest note. (🡐 on the keyboard also works.)
Note Higher - switches to the next higher note. (🡒 on the keyboard also works.)
Zero Offset - clears the offset to zero. (**Z** on the keyboard also works.)
Lock Mode - begins locking onto the note by automatically adjusting the offset
Zoom Spectrum Display - toggles the spectrum display between zoomed-in and zoomed-out
Auto Note Switch, Both Direction - enables auto note switching in both directions
Auto Note Switch, One Direction - enables auto note switching in just one direction
Measure Inharmonicity - measures inharmonicity or current pitch in over-pull (pitch raise) mode
Over-pull - enables/disables over-pull (pitch raise) mode
Historical Temperaments - selects optional non-equal temperaments
Tuning Curve - displays the tuning curve for adjustment or review



All these toolbar buttons have associated tooltips. To see a tooltip, merely move the mouse cursor so that it rests on one of these buttons. After a short pause a box will appear with a reminder about what that button does, as shown to the right. If there is a keyboard key that performs the same function, the tooltip will tell you about it.

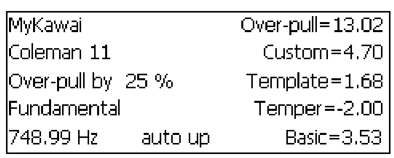
TuneLab Pocket also has a toolbar to perform many of its functions. Here is the toolbar for TuneLab Pocket shown with over-pull mode enabled. Without over-pull, the percent-changing buttons would be absent.

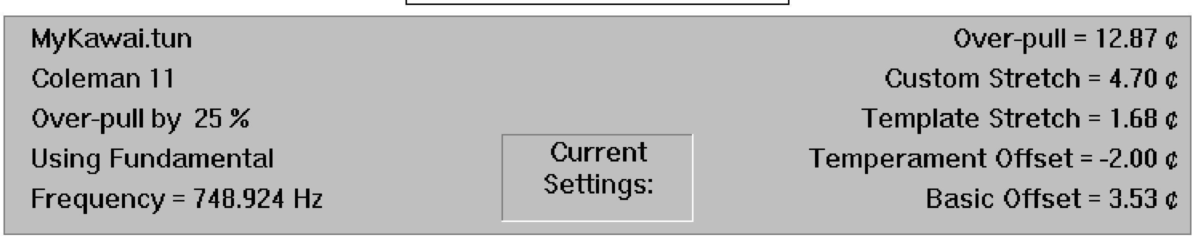
 **Open Tuning File** - selects an existing tuning
 **Save Tuning File** - saves the current tuning in a file so it can be recalled later
 **Lower Partial** - switches to the next lower partial for tuning
 **Higher Partial** - switches to the next higher partial for tuning
 **Measure** - measures inharmonicity or current pitch in over-pull (pitch raise) mode
 **Tuning Curve** - displays the tuning curve for adjustment or review
 **Lock Mode** - begins locking on to the note by automatically adjusting the offset
 **Over-pull** - enables/disables over-pull (pitch raise) mode
 **Over-pull Percentage Lower** - reduces over-pull by 1% (absent when not in over-pull mode)
 **Over-pull Percentage Higher** - raises over-pull by 1% (absent when not in over-pull mode)

Because of the limited screen size, many of the functions that were provided on the TuneLab Pro toolbar have been moved into menus in TuneLab Pocket.

Current Settings Displays

In the middle of the main TuneLab display screen in large letters there is a display of the currently selected note. Above the phase display is a display of current settings. Usually most of these fields are blank; but here is an example with all the fields active (for both TuneLab Pocket and TuneLab Pro).





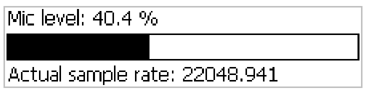
Here is a description of each of these fields, reading down the left column and then the right column:

1. **Tuning File Name** - the name of the tuning file currently in use
2. **Temperament Name** - the name of the temperament file (if one is selected)
3. **Over-pull Percentage** - the current over-pull percentage (if over-pull mode is selected)
4. **Tuning Partial** - which partial (or fundamental) is used for tuning the current note
5. **Frequency** - the calculated frequency, taking into account all offsets

6. **Over-pull** - the offset due to over-pull mode (or the temporary offset if over-pull is not selected)
7. **Custom Stretch** - the offset (if any) manually programmed for the current note
8. **Template Stretch** - the offset calculated from the tuning curve
9. **Temperament Offset** - the offset from the optional historical temperament in effect
10. **Basic Offset** - the offset (if any) applied to all notes uniformly

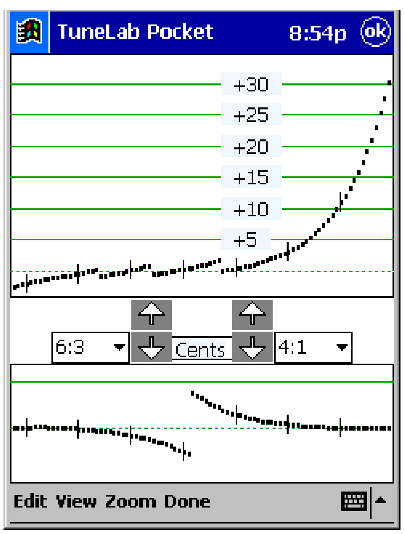
In addition the TuneLab Pocket display shows the current statue of auto note switching, which, in TuneLab Pro, is indicated by the state of the auto note toolbar buttons.

Microphone Level Indicator



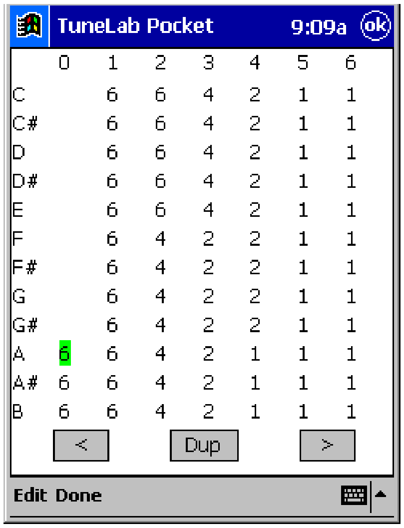
To help verify that your microphone is working properly, TuneLab provides a display of the microphone level. The display on the left is found on TuneLab Pocket by selecting the **Tools** menu and then selecting **About**. The display on the right is the same thing for TuneLab Pro. It is found in the upper right corner of the main TuneLab display screen. When all is quiet, the level should be below 0.5%. Normal talking into the microphone should produce a level of at least 50%.

Tuning Curve Adjustment



The image to the left is of the tuning curve adjuster screen in TuneLab Pocket. The tuning curve adjuster for TuneLab Pro is similar. The tuning curve adjuster contains two different graphs. The upper graph is the tuning curve. For each note it shows the calculated stretch in cents. It is this calculated stretch that appears in the current settings display under the name "Template". The arrows below the tuning curve are for adjusting different aspects of the curve. The display shown here includes just four adjusting arrows because the adjustment of the endpoints of the tuning curve are automatic. There is an option whereby this automatic feature can be disabled and you can adjust these endpoints manually. When that option is selected, then two more sets of up and down arrows will appear on the screen. The lower graph is called the deviation curve. It displays information about the two intervals that are selected in the selection boxes just above the graph. As shown we have selected 6:3 octaves for the bass and 4:1 double octaves for the treble. Other intervals may be selected, depending on the kind of tuning you want to achieve. The deviation curve is divided into a left half and a right half. The left half is based on the interval selected for the bass (6:3 octaves in this case) and the right half is based on the interval selected for the treble (4:1 double octaves in this case). The deviation curve shows how these intervals work out in the tuning. Where the deviation curve shows zero, the selected interval is beatless. Where the deviation curve shows a positive number, the selected interval is wider than beatless. Where the deviation curve shows a negative number, the selected interval is narrower than beatless. When you use the adjuster arrows to adjust the tuning curve, you are directly affecting the tuning curve. As a consequence of your adjustment of the tuning curve, the deviation curve will also change. Generally, you make your adjustments to achieve a certain appearance in the deviation curve. The procedure for making these adjustments is described in detail in a later section.

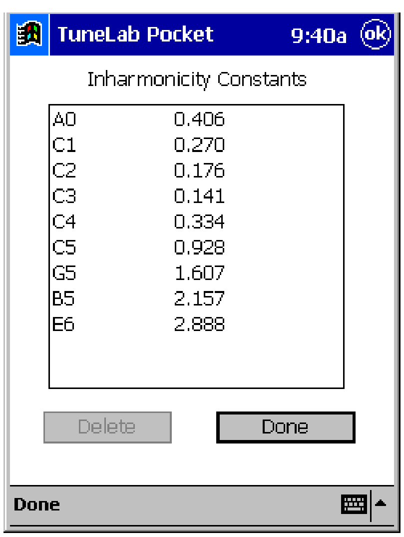
Partials



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. This selection of partials comes from a table of partials. This table may be modified from the screen shown to the left, which is from TuneLab Pocket. The screen for TuneLab Pro is similar. The table shows the partial number for each note from A0 to B6. (C7 through C8 are assumed to be using the fundamental.) Using the **<** and **>** buttons you can lower or raise the partial for the highlighted note. You can highlight a different note by tapping or clicking on the partial number for that note. Since partials generally come in groups, the **Dup** button is provided to duplicate the highlighted partial into the next note and move the highlight. 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 from the special tuning file, **DEFAULT**, which is installed when you install TuneLab. If you want to make a change to the table of partials that will apply to all new tuning files that you create, then you can explicitly load **DEFAULT** as a tuning file, edit the table of partials, then save the modified **DEFAULT**, which will replace the original **DEFAULT**. Partials can also be changed on-the-fly using the toolbar in TuneLab Pocket or the F3 and F4 keys in TuneLab Pro. These on-the-fly changes are not stored in the table of partials and are canceled when a new note is selected.

Inharmonicity

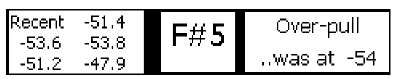


Inharmonicity is the name given to the phenomenon whereby the partials of a piano string do not fall exactly into the pattern of being multiples of the fundamental frequency. TuneLab uses a model for inharmonicity that is described in the help file. Basically, the partials are assumed to be offset from their exactly whole-number multiples of the fundamental by an amount that increases with partial number and is proportional to the inharmonicity constant. When TuneLab measures inharmonicity, the pitches of all the partials of a given 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 can also review and modify this table using the screen shown on the left for TuneLab Pocket. (TuneLab Pro is similar, except that you can enter numbers explicitly, too.) In a well-scaled piano you can expect to see the inharmonicity constants at a minimum somewhere near C3. 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 find a best-fit 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 are affected by the tuning of other notes that you tune later. 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. Even the notes that you tuned last will drop somewhat do to the delayed settling of tension.

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 making a quick one-second pitch measurement before you start tuning each note. The collection of these measurements is called the "over-pull history". The most recent portion of the history list is displayed to the left of the selected note as shown below from TuneLab Pocket.



The main purpose in displaying this list is to provide verification that the over-pull calculations are based on valid measurements. Sometimes during a pitch raise, extraneous noise can trigger a false reading to be entered into the history list. The false reading can be corrected by re-measuring the current note. When in over-pull mode, the field normally used for the temporary offset is used to display the over-pull offset as shown earlier in the current settings. Temporary offsets are not permitted in over-pull mode. When over-pull mode is first entered you have an opportunity to adjust some parameters that affect how over-pull is calculated. The parameter that is most often changed is the over-pull percentage, and this can be done either from the keyboard (TuneLab Pro) or the toolbar (TuneLab Pocket) without re-opening the over-pull parameter window. For details on how the over-pull is calculated, see the help file.

Calibration

TuneLab must be calibrated before you can trust its absolute pitch. Without calibration, TuneLab assumes the nominal crystal oscillator frequency in its sound system and makes all pitch calculations from that. By doing a calibration you are refining that nominal value based on a comparison to a trusted pitch source. You can experiment with the calibration procedure using a tuning fork, but your final calibration should be with some more trusted source, such as the NIST phone service described later. You can verify the results of the calibration from the **Help** - **About** menu item (TuneLab Pro) or the **Tools** - **About** menu item (TuneLab Pocket). There the actual sample rate based on the most recent calibration is displayed.

Auto Note Switching

Using the menu or the toolbar you can enable various forms of auto note switching. When auto note switching is enabled, TuneLab is constantly listening for nearby notes. When it hears a nearby note, it switches to that note just as if you had performed the note switch manually. Extraneous musical tones can sometimes cause a false note detection and switch. For this reason it is a good idea to use limited (one-direction) note switching whenever possible. In order to reduce the instances of false note detection, auto note switching has been programmed to require a certain clarity of tone before switching. This clarity is sometimes difficult to produce in the low bass and in the high treble, so manual switching is sometimes necessary if auto note switching does not respond.

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. A historical temperament file contains a list of 12 offsets for each of the 12 notes of an octave. When a 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 for 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, however they are saved in a separate place in the file so that they can be removed at any time in order to return to equal temperament.

Tuning Files

A tuning file is a file on your laptop or Pocket PC where all the factors necessary to re-create the current tuning are stored. The exact format of a tuning file is shown in the help file, in case you are interested in looking at a tuning file directly. Normally you do not need to do that because TuneLab reads tuning files for you and extracts all the information needed. It is useful, however, to know what is and what is not stored there. Here is what a tuning file contains:

1. The inharmonicity constants for all the notes that you measured.
2. The adjustment of the tuning curve (the template).
3. The name of the historical temperament (if any) and all 12 offsets from that temperament.
4. The partial and custom offset (if any) for each of the 88 notes.

The tuning file does not contain the individual partial frequencies from the inharmonicity measurement nor the selection of intervals in the tuning curve adjuster.

Sound Generation

Although the 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 spectrum display and phase display are disabled. The pitch of the sound generated 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. Sound generation using low pitches may not be audible due to the limitations in the frequency response of the speakers found in laptop computers or Pocket PCs.

Sound generation is generally used to aid in stringing operations where precision is not important. If you intend to use sound generation for precise tuning in TuneLab Pro, you should be aware of the fact that some laptops use different crystal oscillators in their sound output and sound input operation. This is not a problem with the Pocket PC because the Pocket PCs use only one frequency source. The consequence of using two independent frequency sources is that a separate calibration may be needed for the sound generation mode. If this is the case with your laptop, you can use the special output calibration procedure described in the help file.

Differences from TuneLab 97

TuneLab Pro and TuneLab Pocket differ from TuneLab 97 in two essential ways. One is the way tuning curves are created and the other is the structure of the tuning file. In addition to these essential differences, there are a number of superficial differences. For example TuneLab 97 does not adjust its display sizes to fill the screen and does not have numeric frequency labels on the spectrum display.

Tuning curves in TuneLab 97 are created and adjusted using a variety of somewhat incompatible methods. There is a numeric tuning curve editor that allows piecemeal tinkering with individual stretch numbers as well as linear and quadratic curve fitting. There is also a graphic tuning curve editor that shows an overlay of the tuning curve together with a set of inharmonicity guide lines that come from the raw inharmonicity readings. No attempt is made to unify the inharmonicity readings into a consistent model as is done in the other two programs.

The tuning file structure used by TuneLab 97 contains only the end product of the process of tuning curve construction. The individual components are not stored separately. These components include the parameters for the template tuning curve, the historical temperament offsets, and the inharmonicity data. Although the TuneLab 97 tuning file is sufficient to duplicate a tuning at a later date, it is not sufficient to make intelligent changes to the tuning. For example the historical temperament data is combined with the template tuning curve. It is impossible to "undo" a historical temperament starting with the tuning file. TuneLab Pro and TuneLab Pocket solve this problem by storing all the individual components of the tuning separately in the tuning file. Merely by loading an old tuning file you can revise the overall stretch based on the inharmonicity readings and change which historical temperament (if any) you wish to use.

Despite these differences there is still a great deal of compatibility between TuneLab 97 tuning files and the format used by the newer programs. All programs can load and use tuning files from the other programs. If you take a tuning file that was created by TuneLab 97 and load it into TuneLab Pro, the stretch numbers for each note will appear as custom offsets from a zero-based template tuning curve. You will still not be able to make intelligent modifications to the old tuning curve, but you will be able to use the tuning curve as is. And if TuneLab 97 reads a TuneLab Pro tuning curve, it will use the overall tuning curve that results from adding up all the components, but it will ignore the extra data the TuneLab Pro puts into a tuning file to allow separation of the individual components.

Chapter

2

Normal Tuning Procedure

This chapter takes you through a step-by-step tuning of a typical piano. To keep things simple at this point we will not be using over-pull mode. If you need to do a pitch raise and want to use over-pull mode, first become familiar with normal tuning and then go to the section on using over-pull mode. This description also assumes that you have not tuned the present piano before. If you had tuned this piano before and had saved the tuning file then you could skip the initial setup and just load the saved tuning file and begin tuning.

Initial Setup

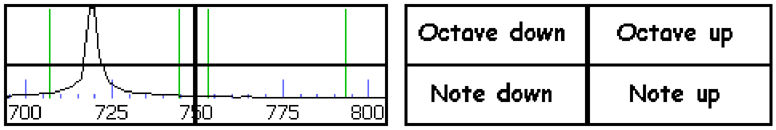
Tuning with an electronic tuning aid does not usually require strip muting the piano. You can tune with just two mutes. First check the condition of the existing tuning to see if there are any major problems with the piano and to see if a pitch raise is necessary. Assuming that a pitch raise is not necessary, the next step is to measure the inharmonicity of the piano.

When TuneLab is started it will have a tuning file name such as "untitled-1". If you have some other tuning file loaded as the current tuning you should clear out that tuning by selecting the "New Tuning File" toolbar button (TuneLab Pro) or using the **New** menu item (TuneLab Pocket). This will clear out any old inharmonicity constants and reset the table of partials to the default. You are now ready tune a new piano.

Measuring Inharmonicity

In order to form a model for the inharmonicity pattern of the specific piano you are about to tune, TuneLab requires that you measure the inharmonicity of at least four notes and preferably six to eight notes. Measuring more than eight notes is probably a waste of time because it adds very little to the overall inharmonicity model. If the piano is a typical well-scaled instrument, you can measure the C notes from C1 to C6. If one of these notes is difficult to measure or otherwise seems atypical, then you can just measure some other note nearby the first note. An example of a difficult note would be one with a serious false beat. In any case, 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. If one string sounds a little false then try a different string on that same note or try a different note. There is no advantage to measuring notes at a break. Just measure notes that are typical for that piano.

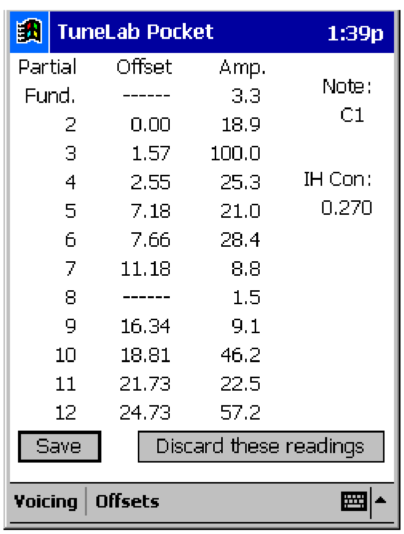
To measure the inharmonicity of a note, select that note in TuneLab. For TuneLab Pro you can select a note by pressing that letter and then the octave number for the note on the keyboard. To select a sharp, use the right arrow key. Note that if upper case is on, the note will be selected as the sharp of that letter. To avoid confusion, leave the CAPS LOCK off. To select notes in TuneLab Pocket you can change the octave or the note selection up and down by tapping in the following quadrants of the spectrum display:



By a combination of changing the octave and changing the note you can select any note in any octave. The targets are large enough so that you can use the back of your fingernail instead of the stylus. To keep the screen from becoming smudged, use your fingernail rather than the front of your finger. You can also change notes using the Pocket PC Navigation Button, which is the four-way rocker switch below the screen.

Now that TuneLab is showing the note that you want to measure, begin a measurement by pressing **M** on the keyboard (TuneLab Pro) or tapping on the **M** icon in the toolbar (TuneLab Pocket). This will cause a status box to appear showing "Measuring, waiting for trigger". TuneLab will begin listening to the note as soon as you play it. The sudden rise in sound level is the trigger. If you do not play the note shortly after initiating a measurement it is quite likely that some extraneous noise may trigger the sampling period and you will get a false reading. If this happens, just wait for the calculation to finish and then discard the reading and start over.

When sampling for inharmonicity you should play the note that you want to measure and then watch the status box change from "waiting for trigger" to "listening". This listening period is about six seconds for low notes and progressively shorter for higher notes. If the piano is in good condition the sustain period of the note should last to the end of the "listening" period. After the listening period is over the status display will switch to "calculating". At this time you can stop holding the note because TuneLab is no longer listening to it. After a short calculation time TuneLab will display the results of the measurement.



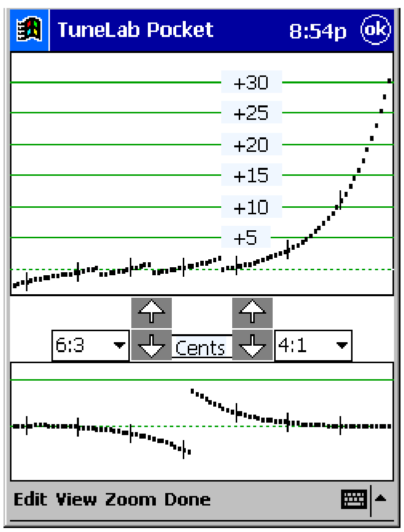
Here is the screen from TuneLab Pocket after the inharmonicity of C1 was measured. The display for TuneLab Pro is similar but includes the graphical display of the voicing amplitudes, which TuneLab Pocket displays in a separate screen. Here we see that pitches were detected for partials 2 - 12 except for the eighth partial, which was very weak. The offset column shows the offset in cents for the individual partials as compared to what they would be if there were no inharmonicity. You can see that 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. TuneLab analyzes the pattern of partial offsets and calculates an inharmonicity constant for the string - in this case 0.270. If things look reasonable at this point then you would select "Save", which will save the inharmonicity constant for the note C1. At this point you can also view the partial amplitudes in graphical form by selecting **Voicing** from the menu bar. In TuneLab Pro, the graphical display of partial amplitudes is already visible.

Repeat this measurement process for C2, C3, C4, C5, and C6, or for whatever notes you have decided to include in your inharmonicity measurement. If you measure the same note several times, TuneLab will average the inharmonicity constants for that note.

Adjusting the Tuning Curve

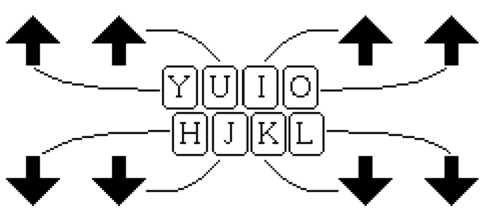
Now that the inharmonicity readings have been taken, TuneLab has a model for the inharmonicity of all the notes of the scale, not just the notes that you measured. Using that model, TuneLab can predict how various intervals will sound. You can use that prediction to find an adjustment of the tuning curve that suits you. This tuning curve is sometimes called the template tuning curve because it follows a four-parameter template.

There are many ways to adjust the tuning curve and subjective value judgments play a role in how these adjustments should be made. This manual presents one particular method. However, once the tools in TuneLab become familiar, you may decide to develop your own individual criteria for setting up the tuning curve. For this typical tuning we will continue with the typical suggested criteria for a good tuning curve.



Here is the tuning curve adjuster again as shown in the first chapter. The adjustment screen for TuneLab Pro is similar, but the TuneLab Pocket is easier to show in this manual because it is more compact. You get to this screen by pressing **T** on the keyboard (TuneLab Pro) or tapping on the tuning curve button in the toolbar (TuneLab Pocket). In case you did not read chapter one, it might be a good idea to go back and become familiar with the components of this screen.

The first thing to do is to become familiar with the operation of the adjuster arrow buttons. Two sets of adjuster buttons are shown. Two other sets of buttons can be optionally enabled, but right now the parameters they would adjust are being adjusted automatically. Each set of adjuster buttons controls one of the four parameters that determine the template tuning curve. Tapping or clicking on one of the up arrows moves a portion of the tuning curve in one direction while selecting the corresponding down arrow moves that portion of the curve the other way.



Although TuneLab Pro tuning curve adjustments can be carried out using the mouse, it is generally easier on laptops to use the equivalent keyboard keys for these actions. The mappings shown to the left are effect. This mapping shows the inner four adjuster arrows mapped to U, I, J, and K. These four arrows are the only adjuster arrows that you normally will see. The outer four adjuster arrows which map to Y, O, H, and L are only visible if you select the option to manually adjust the endpoints of the tuning curve. Since we are considering the simplest case right now, it is best to leave that portion of the tuning curve adjustment on automatic and use only the inner four arrows.

Whether you tap the buttons or use the equivalent keys, the amount by which these adjuster buttons change the tuning curve varies depending on how the buttons are used. If you hold any button down the amount of adjustment increases faster and faster the longer you hold down the button. If you change between up and down the amount of adjustment decreases. So if you want the adjustment to proceed faster, just hold down the desired button (or its equivalent key in TuneLab Pro). If the adjustment is too fast, then you will probably overshoot your goal, so you naturally will change to the opposite adjuster arrow. Doing so will reduce the size of the adjustment, so that you can adjust as finely as you want merely by changing directions. To become familiar with how this all works, now might be a good time to experiment. Try holding down one of the adjuster arrows until the adjustment reaches its limit and the word "limit" is displayed in place of the arrow. Then hold down the opposite direction arrow until the adjustment reaches the limit in that direction. Notice how a portion of the tuning curve moves as you vary the adjustment. Now experiment with single taps on the adjustment arrows. Change direction several times. Notice how the adjustment becomes finer and finer.

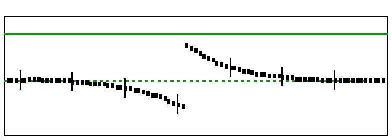
In the course of doing an adjustment you may find that a portion of the tuning curve goes off the scale. If this happens and you want to see the whole curve, select **Zoom** from the menu (TuneLab Pocket) or press the **Z** key (TuneLab Pro). This will reset the graphical limits to exactly contain the current curve.

Now that you have become familiar with the mechanics of adjusting the tuning curve, it is time to adjust the tuning to match your tuning criteria. You may want the 6:3 octaves in the low bass to be as pure as possible and the 4:1 double octaves in the treble to be as pure as possible. Do that by selecting these intervals in the selection boxes located around the adjuster arrows. Open these drop-down selection boxes by tapping or clicking on the little triangle after the interval name. Scroll through the choices and tap or click on 6:3 in the left selection box and 4:1 in the right selection box. You need to do this only once. Afterwards TuneLab will remember your preference and these intervals will always be selected for you until you change the selection at a later date.

Now that you have the proper intervals selected, the deviation curve (the lower curve) shows you how your selected intervals will sound. The goal is to adjust the tuning curve until the deviation curve is as flat as possible at both ends. You will notice that the right-hand adjuster buttons control the shape of the treble end of the tuning and hence the shape of the treble end of the deviation curve. If the deviation curve is bowed up in the middle, press the down adjuster arrow. If the deviation curve is bowed down in the middle, press the up adjuster arrow. If you have the default automatic adjustment of the endpoints of the tuning curve enabled, the ends of the deviation curve will always be at zero. Your goal in adjusting the shape is to get as much of the deviation curve as possible to lie close to zero.

When you adjust the shape of the bass end of the tuning curve you will notice that the deviation curve moves in the opposite direction as the tuning curve. This behavior is a necessary consequence of the way the deviation curve is defined. If the bass end of the deviation curve is bowed up in the middle, press the up adjuster button. If the bass end of the deviation curve is bowed down in the middle, press the down adjuster button.

The Zoom function was mentioned earlier in relation to containing the tuning curve. The Zoom function also scales the graphical display of the deviation curve. When the deviation curve is quite close to zero you can get an enlarged view of the deviation curve by invoking the Zoom function again.



When you get the deviation curve to look like the one shown here then you are done. Notice that the deviation curve does not hold very close to zero at the transition in the middle. That is normal and expected. As you move from the bass to the treble, your criterion for a good tuning gradually changes from making 6:3 octaves beatless to making 4:1 double octaves beatless. Midway through that transition the 6:3 octaves will be a little narrow and the 4:1 double octaves will be a little wide. It is impossible to get both intervals to be beatless at once throughout the scale. You should find that in the vicinity of the transition you have other criteria for a good tuning (such as 4:2 single octaves) and those criteria will be satisfied quite well. The criteria for a good tuning that we suggested here are just a starting point. Some TuneLab users report getting better results by selecting 4:2 octaves in the treble. Feel free to experiment to find the settings that most closely correspond to your tuning style.

Saving the Tuning File

After the tuning curve has been adjusted to your satisfaction, exit from the tuning curve adjuster by pressing **ESC** (TuneLab Pro) or by tapping on **Done**. 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 tapping on the Save Tuning File icon in the toolbar and entering the name of the tuning file. Use a name that is short enough to fit in the space allotted in the current settings box but long enough to remind you which particular piano this is 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 brand you may decide to keep one tuning file that you use for all pianos of a particular 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 and for all but the most critical uses, a generic tuning may be acceptable. In TuneLab Pro, you can delete tuning files from the Open File box using the right mouse button. In TuneLab Pocket you cannot delete tuning files, but you can delete them by running the File Explorer program that comes with the Pocket PC.

Beginning to Tune

Now that you have a custom tuning file for this piano and that tuning file has been saved, you can turn your attention to actually doing the tuning. Because aural tuning always starts by setting a temperament, aural tuning sequences start in the middle of the scale and work downwards and upwards from there. When tuning to a calculated TuneLab tuning file, you need not conform to this sequence. You can use other factors to decide how you want to tune. Although you may not be considering a pitch raise at this time, remember that you will get less interaction between notes if you tune from the low bass to the high treble in order. That is the recommended sequence. However there is at least one possible advantage to tuning the treble first. Tuning the treble requires more concentration and it might not be a good idea to leave the treble to the end when you may be tired. 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 in the ballpark before blindly trusting the spectrum display or the phase display. 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. On TuneLab Pro you can press F3 or F4 to change the partial. On TuneLab Pocket you can use the partial-changing icons on the toolbar.

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 pressing the arrow keys in TuneLab Pro or by tapping on the lower quadrants of the spectrum display in TuneLab Pocket.

When you finish the monochord section of the bass and come to the bichords, always mute one of the strings before tuning the other. 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 machine tuning.

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 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.

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 switch over to using 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 and better the higher you go in frequency. You can see this by noting the jagged look of the spectrum display around A-440 in the picture in chapter one 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

On the second piano you tune, you should use auto note switching. To enable this feature click on the appropriate toolbar button (TuneLab Pro) or use the **Tools** menu (TuneLab Pocket). When auto note switching is enabled, TuneLab will be constantly listening for nearby notes; and when it hears one, it will switch to it. The range of auto note switching is up to 300 cents from the current note, but 100-cent auto note switches are performed more easily than the larger jumps. 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 use the arrow keys (TuneLab Pro) or tap in the lower quadrants of the spectrum display (TuneLab Pocket) to correct the problem.

When you select auto note switching in just one direction, TuneLab will switch only in the specified direction. But if you manually change to the next note in the opposite direction, the allowed direction for auto note switching will also change. This can be a problem if you are correcting an unintended auto note switch. If you were auto-switching in the upward direction and got an unintended auto note switch in that direction, then you would correct the problem by manually switching down to the previous note. This will condition auto note switching thereafter to look for downward switches. If that is not your intent, then the solution is to switch two notes down and one note up to undo the first unintended switch and to set the direction for auto note switching back to the upward direction.

Chapter 3

Over-pull (Pitch Raise) Tuning Procedure

Over-pull tuning is sometimes called pitch raising, although it may just as well be applied to pitch lowering. When large overall changes are made to the tuning of a piano, the notes that you tune first tend to change 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.

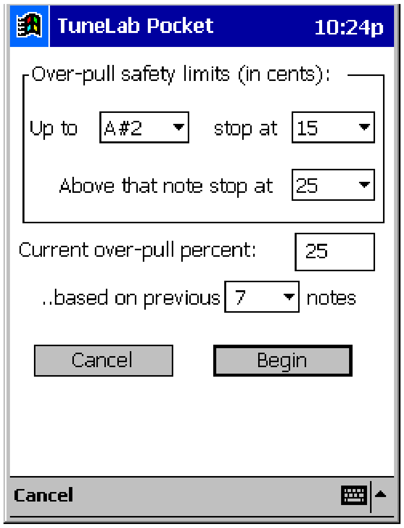
Measuring Inharmonicity Before an Over-pull

When over-pull is enabled you cannot measure inharmonicity. Therefore if you want to create a custom tuning for the piano as described in the previous chapter, you must measure the inharmonicity and adjust the tuning curve before enabling over-pull mode. There are some special considerations that need to be taken into account when making inharmonicity measurements on a piano that is seriously out of tune. Inharmonicity is greatly affected by the way the string bends at the termination points. When you make a major change in the tuning of a piano (50 cents or more) it is quite likely that the string will need to move so far that a different portion of the string will be at the termination point. Therefore the inharmonicity of the string will change. To make sure that the inharmonicity that you measure is representative of what the string will be like after it is properly tuned, you should rough tune the one string before you measure its inharmonicity. You do not need to rough tune the other strings of the unison since they will be muted during the measurement.

If the pitch raise is so severe that rough tuning the inharmonicity measurement strings is required, this raises the question of which tuning file to use for this purpose. You do not yet have a custom tuning file for this piano. Fortunately, it does not matter much which tuning file is used at this point. You are trying only to get valid inharmonicity readings. Normally you would have the settings from the default tuning file, called **DEFAULT** loaded at this point. Actually the full name of the file is **DEFAULT.TUN**, but the **.TUN** extension is usually dropped. The loading of those default settings happens every time you start a new tuning file. The default tuning file has zero stretch because its main purpose is to define the partials to use for tuning. But if you want to make **DEFAULT** into a more realistic tuning file, then you could prepare it ahead of time. Simply take any average tuning file with some stretch in it and load it into TuneLab. Then delete all inharmonicity constants using the Edit menu. This is important. **DEFAULT** should not contain any inharmonicity data or else these data will pollute the new inharmonicity readings every time you start a new tuning file. Finally, save the modified file as **DEFAULT**. This will replace the original **DEFAULT** file. You need to do this only once. From that point on, every time you begin a new tuning file, the initial stretch will come from your modified **DEFAULT**.

Enabling Over-pull Mode

If your pre-tuning evaluation of the piano convinces you that the overall pitch change is large enough to need an over-pull, then you can enter over-pull mode by tapping or clicking on the over-pull icon in the toolbar or by pressing F2 in TuneLab Pro. A dialog box like the one shown here for TuneLab Pocket will open up. Most of the time all you need to do at this point is select **Begin**, but you can also use this opportunity to set various preferences relating to over-pull. TuneLab will remember your settings so you need only to enter them once. If you are not going to change any of the settings, just select **Begin** and skip ahead to the next section on Beginning Tuning in Over-pull Mode.

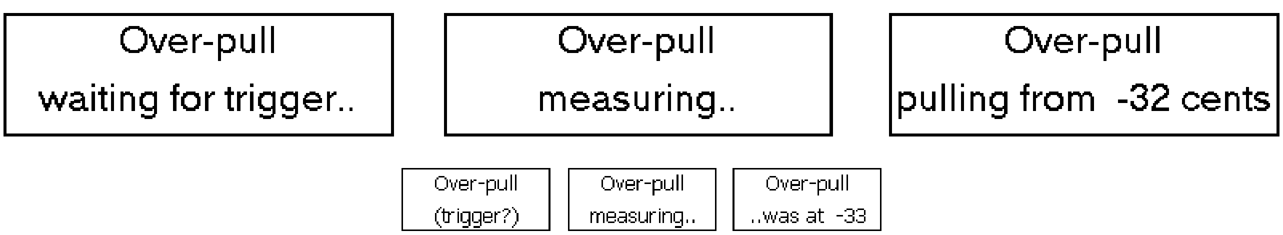


The first group of fields sets safety limits for over-pull in cents. You can change these entries by tapping on the small triangle in the drop-down selection boxes. The purpose of these overriding limits is to reduce the likelihood of breaking strings in an extreme pitch raise. These limits do not come into play in small to moderate pitch raises. They define the maximum over-pull in cents for two groups of notes. If the calculated over-pull is higher than the limit shown here, then TuneLab will use the specified limit value and not the calculated value for over-pull. The current over-pull percentage and the number of notes used to calculate the over-pull are explained later.

Beginning Tuning in Over-pull Mode

Before each note can be tuned in over-pull mode, TuneLab must listen to each note for one second to get a rough measurement of its pitch. TuneLab keeps this information in a history list as described in chapter one. You can follow your progress through the over-pull sequence by watching the status box that appears in over-pull mode.

Here is what you would see in TuneLab Pro (top) and TuneLab Pocket (bottom):



The first status box on the left is what you would see after changing to a new note or after requesting a re-measuring of the current note. When you play the note you will see the second status box briefly followed by the third status box which will show what the measurement was for the current note. When you see the third status box you may then tune the current note in the usual manner.

If the measurement shown in the third status box looks unreasonable, then perhaps an extraneous sound triggered the measurement before you actually played the note. If that is the case you can re-measure the current note by tapping on the measure icon in the toolbar or by pressing the **M** key in TuneLab Pro. Every time you request a re-measuring of the current note, the most recent measurement is removed from the history list and TuneLab returns to waiting for you to play the note again. If you somehow get several bad readings in the history list, you can remove as many entries as you like by repeatedly requesting a new measurement without playing the note.

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 the history list. The history list is the list of measurements taken before each note is tuned. The list is ordered from most recent to oldest. Only the most recent few measurements are displayed, but these recent measurements are the most important.

The over-pull amount is an offset in cents that is added to any other offset or stretch values. The over-pull amount is displayed in the upper right corner of the current settings box in the place normally used to display the temporary offset (if there is one). Note: The use of the temporary offset is not permitted in over-pull mode. If you must use an overall offset in over-pull mode, use the basic offset. The over-pull amount is calculated by starting with the most recent few measurements in the history list. How many are actually used is determined by the number that you have selected in the box shown when you first enabled over-pull mode. By default TuneLab uses the last seven notes. Assuming that seven measurements are used, TuneLab takes a weighted average of these seven measurements using weightings that give the most weight to the most recent measurement and progressively less weight to the older measurements. Finally TuneLab multiplies the weighted average by the over-pull percentage and uses the opposite of that number as the over-pull in cents (subject to the safety limits, of course).

Changing Over-pull Percentage

The over-pull percentage is one parameter that you may want to change frequently as you tune in over-pull mode. To make such changes fast and easy, use the F7 and F8 keys in TuneLab Pro or the percentage-changing icons in the toolbar in TuneLab Pocket. The initial default over-pull percentage is 25%. The current over-pull percentage is always displayed in the current settings box when you are tuning in over-pull mode. For small to moderate pitch raises, simply use 12% when tuning in the bass bridge and 30% when tuning elsewhere. For more precise control of the tuning, use the following guidelines for over-pull percentage. These guidelines assume that you will tune unisons as you go up the scale from A0 to C8.

bass bridge	12%
tenor bridge to G5	29%
G5 to G6	29% increasing to 37%
G6 to C8	37% decreasing to 14%

Using Auto Note Switching with Over-pull Mode

There are some special considerations that need to be taken into account when using these two features together. Auto note switching works by hearing and recognizing notes that are nearby the current note. TuneLab assumes that the notes that have not yet been tuned are still close enough to their correct pitch for TuneLab to recognize them. If you are raising the pitch 50 cents or more it is quite likely that many notes will not be recognized by auto note switching before they have been tuned. Instead, simply use manual note switching whenever auto note switching doesn't work. You can sometimes trick TuneLab into switching to the next note by playing the (already tuned) note from an octave below. As soon as TuneLab has switched notes, play the actual note for the over-pull measurement. If you play the note from an octave below several times, TuneLab may make a measurement on that note and put the measurement into the history list. This would not be valid. Until you become more familiar with TuneLab, you should turn off auto note switching when doing a pitch raise of more than 50 cents.

Saving the Entire History List

This feature is available only in TuneLab Pro. After tuning a piano in over-pull mode, the entire collection of over-pull pitch measurements made before each note was tuned may be saved to a disk file for later off-line study. From the File menu select Save Over-pull Measurements. You will be prompted to enter a file name. The entire history list will be written in text format to the file that you specify.

When to Tune Unisons in a Pitch Raise

There are two schools of thought when it comes to this issue. You can tune unisons as you go, or you can use a strip mute and postpone the tuning of unisons until the end. Aside from any general considerations that may enter into your decision of which way to choose, there are special considerations relating to over-pull mode.

Over-pull works by estimating how far the pitch of a string will fall as the rest of the piano is tuned. The current note is then tuned sharp by that same amount. If you tune unisons as you go, the notes below the current note will all have been tuned and the notes above it will not have been tuned yet. Therefore the current note will be affected only by the subsequent tuning of the notes above it. On the other hand, if you use a strip mute and postpone tuning unisons, the outer strings of the notes below the current note will not have been tuned yet. Therefore the current note will be affected both by the tuning of notes that lie above the current note and by the tuning of the unisons of the notes that lie below the current note. This subjects the current note to the almost twice as much pitch-fall after it is tuned. To compensate for this extra expected drop in pitch, you would have to use a higher over-pull percentage.

The guidelines shown for over-pull percentage are based on the assumption that you will tune unisons as you go. If you want to use a strip mute and tune unisons later, then plan on using a somewhat higher over-pull percentage. Warning! This may increase the chance of breaking strings on extreme pitch raises. Use the over-pull safety limits to prevent extreme over-pull.

Chapter 4

Calibration Procedure

Chapter one described the need for calibration. This chapter takes you through the process of actually doing a calibration. Normally you need to do a calibration only once when you first install TuneLab on your laptop or Pocket PC. The results of the calibration are stored permanently and used every time you run TuneLab.

A Trusted Source of Pitch

To do a calibration you need to have a trusted source of pitch. The most accurate source of pitch that you can get is 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 (after you pay the usual long-distance charges), and the shortwave radio service may be heard on 2.5, 5, 10, 15, and 20 MHz. Another source of accurate pitch is a Sanderson Accu-Fork or Accu-Tuner. In most areas of the U.S. 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 procedure described here involves the use of the NIST standard frequency service.

NIST Broadcast Schedule

The NIST standard frequency service is broadcast on shortwave radio station WWV on the frequencies listed above. The audio portion of this broadcast is also available by telephone by calling (303) 499-7111 in Colorado. This is a very popular number. 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 broadcast schedule for WWV. 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.

	0	1	2	3	4	5	6	7	8	9
0	- - -	600	440	- - -	- - -	600	500	600	- - -	- - -
10	- - -	600	500	600	- - -	- - -	- - -	600	- - -	600
20	500	600	500	600	500	600	500	600	500	- - -
30	- - -	600	500	600	500	600	500	600	500	600
40	500	600	500	- - -	- - -	- - -	- - -	- - -	- - -	- - -
50	- - -	- - -	500	600	500	600	500	600	500	- - -

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 and 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. See the TuneLab help file for more details on the Hawaii service and schedule.

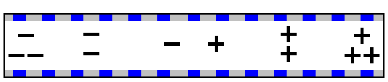
Special NIST Tuning File for Calibration

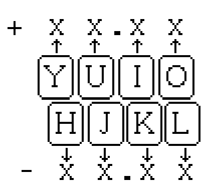
To use the NIST standard frequency service to do a calibration on your TuneLab, start by opening the tuning file **NIST-303-499-7111-C5-D5** which was installed with TuneLab. This tuning file contains special custom stretch offsets for C5 and D5 so that they come out to 500 Hz and 600 Hz respectively. The name of the tuning file also contains the Colorado phone number for the NIST service as a reminder. If you select C5 and then D5 you can see the frequency reported as 500 Hz and 600 Hz to correspond with the tones from NIST. Do not make any changes to this tuning file, and of course do not try to tune a piano with it!

Manual Locking onto NIST

When TuneLab begins listening to an NIST tone, your goal is to trim the offset of TuneLab so that the phase display is perfectly stopped. There are two ways to do this - manually and automatically. The manual method is more accurate but the automatic method is easier to use. In either case, you will have to select C5 or D5 depending on which tone is coming from NIST. Don't bother trying to figure out which tone is present from the broadcast schedule. Instead, just use trial and error. Select C5. If the spectrum display doesn't show a peak near the central red line then you probably have the wrong note, so switch to D5. If you run out of tone before you can get the phase display stopped, then switch to the other note because the 500 Hz and 600 Hz tones alternate each minute.

How you manually trim the offset is different for TuneLab Pro and TuneLab Pocket. In TuneLab Pocket, tap on some portion of the phase display. You will see the offset go up or down in the current settings box. How much the offset changes depends on where in the phase display you tap. Tapping near the center produces the smallest changes. Tapping toward the right side raises the offset, while tapping near the left side lowers the offset. Finer adjustments can be made by tapping closer to the center of the phase display.





In TuneLab Pro, use the following keyboard keys to change the offset manually in different increments. Using these keys you can raise or lower the offset by 10 cents, 1 cent, .1 cents, or .01 cents. When using these keys to stop the phase display, start by using the **U** and **J** keys. (It is unlikely you will need to adjust the offset by 10 cents when calibrating.) When you need finer adjustment, switch to the **I** and **K** keys. For the finest adjustment of all, use the **O** and **L** keys. Adjusting the offset by .01 cents will produce a change so small that you will not be able to tell that anything has changed unless you observe the phase display for more than 15 seconds, so don't worry about getting that last hundredths place right unless .01 cent absolute tuning accuracy is really that important to you.

Whether you are using TuneLab Pro or TuneLab Pocket, adjust the offset to make the phase display stop. You will quickly see that raising the offset makes the phase display move to the left while lowering the offset makes the phase display move to the right. The slower the phase display moves the finer the adjustment that is needed. When the phase display is as stopped as you can make it, you are done.

Automatic Locking onto NIST

As an alternative to the manual adjustment of offset to make the phase display stop, you can use the locking mode in TuneLab. When this mode is active, TuneLab listens to the sound coming in and automatically adjusts the offset to make the phase display come to a complete stop. The process takes some time and is somewhat sensitive to noise; but if you find manual adjustment frustrating, the automatic locking mode may be a better choice. You can enable locking mode by tapping or clicking on the lock icon in the toolbar. When locking mode is enabled, the status box as shown to the left will appear. Initially the box will display "waiting for trigger". A trigger is a sudden rise in sound level as you would get when playing a note. When locking to a tone on the telephone, there may not be a rise in volume sufficient to be detected as a trigger. You can force the detection of a trigger by taping on the microphone to make a little noise, or by tapping or clicking a second time on the lock icon in the toolbar. Then the status box will appear as shown for TuneLab Pocket. TuneLab Pro is similar.

When locking mode is active (as indicated by the status box) the adjustments to the offset will proceed continuously. If the sound that TuneLab is supposed to lock to is stopped, TuneLab will continue to attempt to lock onto whatever sound it hears. If it hears just normal background noise, the offset will seem to change randomly. Therefore it is important to stop locking mode before removing the tone. In the case of the NIST tones, if the tone stops before you have achieved a satisfactory lock, then you should turn off locking mode as soon as possible and wait for another tone to begin. Since the NIST tones alternate between 500 Hz and 600 Hz, you should take this opportunity to switch between C5 and D5.

If the phase display appears to have stopped completely, then turn off locking mode. This is done by pressing the ESC key (TuneLab Pro) or by tapping on the current note display box (TuneLab Pocket). In the case of TuneLab Pocket, make sure that you only tap once on the current note display. Tapping a second time on this display will zero out the offset which you have just gotten so carefully adjusted. If you have time, make one final check of your offset adjustment after turning off the locking mode. If the phase display is still stopped, then you are done listening to the NIST tone and you can hang up the phone.

Completing the Calibration

At this point you should have a temporary offset showing in the current settings box. This is the offset that caused the phase display to come to a stop. You should also have a frequency showing in the current settings box. If you were locked onto one of the NIST tones, this frequency will be very close to either 500 Hz or 600 Hz, but it will not be exactly 500 Hz or 600 Hz unless the offset that stopped the phase display just happened to be zero. The reason for this difference is that TuneLab has not been calibrated yet; so what it thinks is 500 Hz is not necessarily exactly 500 Hz. Do not change notes or anything else but proceed directly to finishing the calibration.

From the **File** menu (TuneLab Pro) or the **Tools** menu (TuneLab Pocket) select **Calibrate to external ref**. A box will appear with a field labeled "actual frequency". The actual frequency field will already be filled in with the same frequency that appeared in the current settings box but rounded to the nearest 1 Hz. This may be exactly what you need if the calibration error was small. If not, you may need to enter the correct frequency. If the calibration tone came from NIST, then the correct actual frequency should be 500.000 or 600.000, depending on which tone TuneLab was listening to last. Make sure that frequency is entered and the click or tap on OK. The calibration is now done. At this point you should zero out the offset because it is no longer needed. You can zero the offset on TuneLab Pro by pressing the **Z** key. On TuneLab Pocket, you can zero the offset by tapping on the current note display.

NIST Calibration Checklist

(1) NIST tuning file is loaded.
(2) C5 is selected with 500 Hz showing.
(3) Spectrum display set for zoomed-in view.
(4) Phone is heard by the microphone.
(5) Broadcast schedule shows tones are available for the next few minutes.
(6) Place the call to NIST.

Before calling NIST, make sure you can situate the telephone so that TuneLab can hear the tones. You can use the dialtone just to verify that it will work. Try to situate the telephone receiver directly over the microphone in your Pocket PC or laptop so that you are not holding it in your hands, because movement of the receiver will create noise that could interfere with the sounds TuneLab is trying to hear. When the call is answered, listen for a tone. Remember that the last 15 seconds of every minute has no tone, so you may have to wait up to 15 seconds. When a tone is heard, determine if it is 500 Hz or 600 Hz by selecting C5 or D5 until you see an indication in the phase display or the spectrum display. As soon as you find out which tone is being heard, use the locking mode or manually adjust the offset in order to make the phase display stop. Remember that NIST will disconnect you after three minutes, so plan your usage accordingly.

Verifying Calibration

After a calibration is complete, you may wonder if it completely properly. You can check this in several ways. From the **Tools** menu (TuneLab Pocket) or the **Help** menu (TuneLab Pro) select **About**. A box will appear that shows, among other things, the actual sample rate. This is the actual end product of doing a calibration. The actual sample rate is stored in the registry to be used every time you start up TuneLab. If you are curious as to how far off TuneLab would have been without calibration, compare the actual sample rate shown in the About box with the nominal sample, which is 22,050 Hz for TuneLab Pro and for TuneLab Pocket on the Compac iPAQ. The nominal sample rate for TuneLab Pocket on the Cassio Cassiopeia is 11,025 Hz. Now that you have done a calibration, it will not matter that the actual sample rate is different from the nominal rate because TuneLab knows about the difference, and is taking it into account in all its calculations. Another way to check calibration is to go back to NIST or some other trusted source of known pitch. Select the note and offset that makes the phase display stand still. If TuneLab is properly calibrated, the frequency display in the current settings box should be absolutely accurate and it should agree with the frequency of the trusted source.

Chapter

5

Menu Items

TuneLab Pro and TuneLab Pocket both use menus extensively. Here is an item-by-item list for both programs.

TuneLab Pro

File

New Tuning File - clears out any existing tuning file data and loads from **DEFAULT**.
Open Tuning File - lets you choose an existing tuning file to load.
Save Tuning File - saves the current tuning data into the current tuning file name.
Save Tuning File As… - saves the current tuning data and lets you choose a new file name.
Read Temperament File - lets you choose an existing unequal temperament file.
Cancel Temperament - returns the current tuning to equal temperament.
Calibration

Calibrate to External Reference - Choose this item **after** you have matched TuneLab to an external frequency source of pitch, such as NIST tones.

Calibrate Sound Gen from Listen Mode - Choose this item only if you need precise sound generation capability and have already done a basic calibration of TuneLab in the listening mode. See the help files for more information on this operation to determine if it is necessary.

Save Overpull Measurements - Use this function after you are done tuning a piano in over-pull mode if you want a record of all the pre-tuned pitches for off-line study.

Make New Unequal Temperament File

..by manually entering offsets - If you know the 12 offset numbers that define an unequal temperament that is not provided with TuneLab, you can enter them here and make your own temperament file.

..from current Custom Stretch values - If you have a piano that has just been tuned (perhaps aurally) in an unequal temperament and you would like to make a temperament file that duplicates that tuning, then first match at least one octave from that tuning using Custom Stretch values and then choose this menu item to use those Custom Stretch values to make an unequal temperament file.

Exit - Exit from TuneLab. TuneLab will prompt you if you need to save a tuning file first.

Edit

Edit Inharmonicity Constants - Review and possibly edit the inharmonicity constants that resulted from inharmonicity measurements. (Not generally needed.)

Edit Template Tuning Curve - Switches the screen to the tuning curve adjuster. This menu item is here for educational purposes only. It is much easier to go to the tuning curve editor by pressing the **T** key on the keyboard.

Edit Partials - allows you to review and possibly change the table of partials currently in use. This table will be saved with the current tuning if you save the tuning file.

Temporarily Change Partial Lower - overrides the tuning file and changes to a different partial. Use the F3 key to do the same thing more easily.

Temporarily Change Partial Higher - overrides the tuning file and changes to a different partial. Use the F4 key to do the same thing more easily.

Transfer Offset to Custom Stretch - If you have adjusted the offset for the current note and would like to make that offset a permanent feature of the tuning for the current note only, then use this menu item. Use the F9 key to do the same thing more easily.

Transfer Offset to Basic Offset - If you have adjusted the offset and would like to make that offset apply to all the notes of the current tuning (as in tuning to A-442 instead of A-440) then use this menu item. Note that the basic offset is not saved in the tuning file.

Use RPT Exam De-tuning Offsets - If you need to prepare a piano for the RPT exam, use this function to enable the special offsets defined for this purpose. After preparing the piano you can use this same menu item to disable the special offsets.

Record A4 Fundamental for RPT Exam - If you have adjusted the offset so that TuneLab matches the examinee's tuning of A4 with the partial set to fundamental, use this function to record that offset for later inclusion on the report that can be generated when grading the RPT tuning exam.

Zero All Custom Stretch Values - Use this function to remove all Custom Stretch values from the current tuning. This will not affect the template tuning curve or the historical temperament (if any).

View

Toggle Zoom for Spectrum Display - toggles the spectrum display between a view of the whole audio spectrum at once and the audio spectrum within 120 cents of the current partial of the current note.

Compare with Master Tuning File - If you have matched an examinee's tuning by transferring all his/her offsets to Custom Stretch values then use this function to compare the resulting tuning with a previously saved master tuning which was also recorded using the Custom Stretch values.

Modes

Generate Sound Output - switches to making tones instead of listening to them. Use the **S** key to do the same thing more easily.

Listen to Sound Input - switches back to listening instead of generating tones. Use the S key to do the same thing more easily.

Auto Note Switching, Both Directions - enables auto note switching in either direction.

Auto Note Switching, One Direction Only - enables auto note switching in whatever direction was last used in manual note switching. After this mode has been enabled you can still change the direction of auto note switching by doing another manual note change with the arrows keys.

Cancel Auto Note Switching - turns off auto note switching.

Locking Mode - enables the mode where TuneLab automatically adjusts the offset to match the tone that it is listening to. Use this function when recording a tuning for the RPT tuning exam or when doing a calibration.

Help

Help Topics - invokes the complete help file for reference.

Tutorial - invokes a special help file that leads you through a step-by-step tutorial.

About this version - gives information about this version of the program.

TuneLab Pocket - main menu

New - clear out any existing tuning file data and loads from DEFAULT.TUN

Edit

Enter Current Settings - allows you to enter exact values for offset, custom stretch for the current note, basic offset, and over-pull percentage.

Review Inharmonicity - allows you to review inharmonicity contants and possibly delete some entries.

Change table of partials - allows you to review and possible change the table of partials currently in use. This table will be saved with the current tuning if you save the tuning file.

Zero all custom stretch - Use this function to remove all Custom Stretch values from the current tuning. This will not affect the template tuning curve or the historical temperament (if any).

Transfer to custom stretch - If you have adjusted the offset for the current note and would like to make that offset a permanent feature of the tuning for the current note only, then use this menu item.

Transfer to basic offset - If you have adjusted the offset and would like to make that offset apply to all the notes of the current tuning (as in tuning to A-442 instead of A-440) then use this menu item. Note that the basic offset is not saved in the tuning file.

View

Spectrum Zoom In - makes the spectrum display show the audio spectrum within 120 cents of the current partial of the current note.

Spectrum Zoom Out - makes the spectrum display show the entire audio spectrum.

Tools

About - gives information about this version of the program. There is also a mic level indicator.

Calibrate to external ref. - Choose this item **after** you have matched TuneLab to an external frequency source of pitch, such as NIST tones.

Sound Generation On/Off - toggles between the listening mode and the sound generation mode.

Temperament Select - lets you choose an existing unequal temperament file.

Temperament Cancel - returns the current tuning to equal temperament.

Auto Note Up - enables auto note switching in the upward direction. After this mode has been enabled you can still change the direction of auto note switching by doing another manual note change.

Auto Note Down - enables auto note switching in the downward direction. After this mode has been enabled you can still change the direction of auto note switching by doing another manual note change.

Auto Note Up or Down - enables auto note switching in either direction

Auto Note Off - turns off auto note switching

Close - Exit from TuneLab. TuneLab will prompt you if you need to save a tuning file first.

TuneLab Pocket - tuning curve editor

Edit

Undo Changes - returns the tuning curve adjustment to the way it was when the tuning curve editor was entered.

Freeze Custom Offsets - enables or disables the mode whereby the effect of custom offsets remains fixed when the template tuning curve is adjusted. The setting of this mode does not matter unless you are adjusting a tuning after establishing some Custom Stretch values.

Auto A0, C8 Adjust - enables or disables the mode whereby the adjustment of the overall stretch in the bass and the treble is done automatically so as to make the deviation curve read zero at A0 and C8. When this mode is disabled, two more sets of adjuster arrows will appear to allow manual adjustment of these parameters that would otherwise be adjusted automatically.

View

Cents - selects the cents display mode for the deviation curve.

Beats - selects the beats display mode for the deviation curve.

Zoom - resets the graphical scaling in both the tuning curve and the deviation curve so that the full range of each curve is just containing in the available space.

Done - exits from the tuning curve editor back to the main screen.