

# Organ Tuner

## OPERATIONS MANUAL, VERSION 1.2 FOR ANDROID

### What is Organ Tuner?

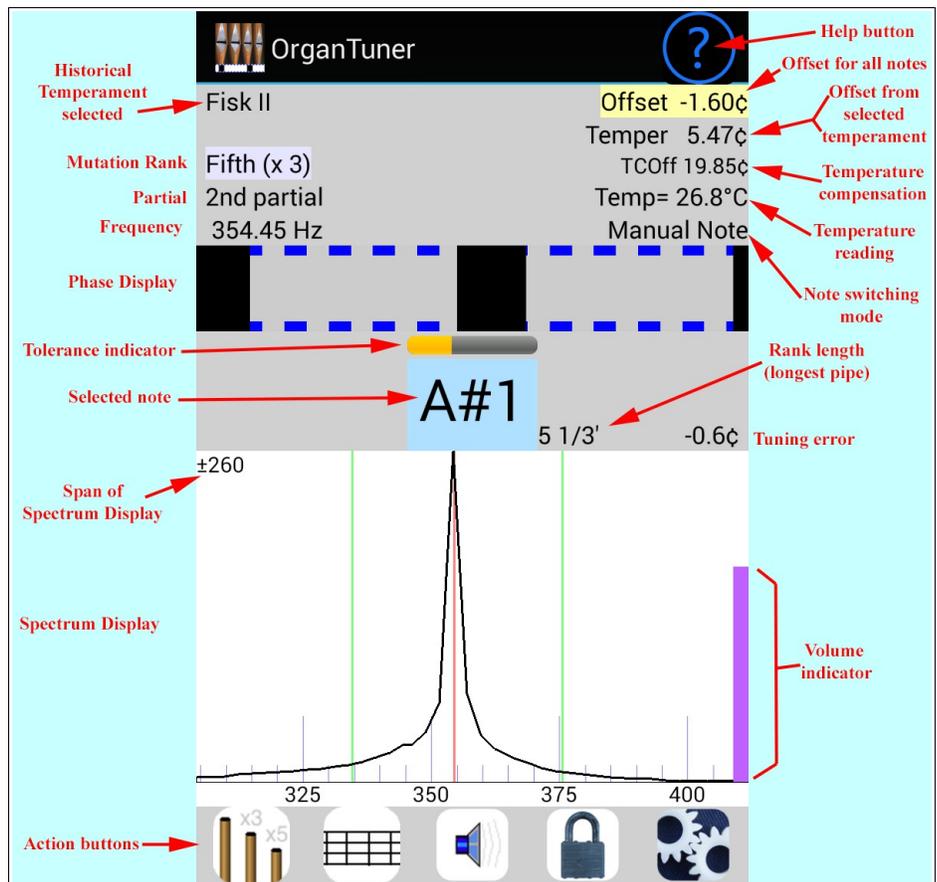
Organ Tuner is an app that provides a wide range of tuning and voicing functions for the building and maintaining of pipe organs. The app is designed for professional organ technicians and builders. It relies on the user's knowledge of terminology and principles. Notes are referred to by note name and octave number where C0 is the 32-foot stop (16 Hz), and C8 is the 1/8-foot stop (4186 Hz). However the app never attempts to measure the fundamental frequency of extremely low notes but instead it measures these notes by means of their higher partials. In addition to tuning functions, this app provides guidance in cutting pipes to length and in evaluating the voicing of a pipe by means of measuring the strength of the various partials of that pipe.

### Main Tuning Screen

Most of the action takes place on this screen. Many of the fields shown here are normally blank, but all these options have been turned on for illustration. Temperaments are not used if you are tuning in equal temperament. Likewise, the mutation rank field will be blank if you are tuning a normal unison rank. The overall office is for tuning to a non-standard pitch reference, and so it is normally blank.

The main tuning displays are the Phase Display and the Spectrum Display. Both of these displays indicate tuning error in different ways, but each display has its own advantages, as described later.

Of the action buttons on the bottom of the screen, the Settings button on the right (the two gears) provides access to all the functions that are not available on the main tuning page.



## Notes, Partial, and Mutation Rank Multipliers

In addition to selecting the note (C0-C9) you also can select the partial and the mutation rank multiplier. The mutation rank multiplier is either 1, 3, 5, 7, 4/3, and 5/3. It multiplies the frequency by the chosen multiplier to select either a *unison*, a *fifth*, a *third*, or a *seventh*, a *fourth*, or a *sixth* mutation rank. Besides the *unison*, the most common mutation rank is the *fifth*, sometime called a *Quint* rank. When the *fifth* is selected, the calculated pitch is multiplied by 3. The result is a pitch that is a little more than an octave and a fifth above the unison pitch. So if the selected note is C3, the actual pitch is close to G4. But it is not exactly the same thing as selecting G4 because G4 is an octave and a tempered fifth above C3. But C3 with the *fifth* mutation rank multiplier selected is an octave and a just, or pure fifth above C3. That is why we don't just select G4 when tuning a *Quint* rank for C3.

Very similar to the mutation rank multiplier is the selection of the partial (also called a *harmonic*), which specifies a multiple of the fundamental that ranges from 1 to 16. The purpose of the partial selection is to allow you to select a partial for a pipe if the fundamental is too low in pitch to register clearly through the microphone, or is not very strong. Most flue pipes have a fundamental that is stronger than any of its partials, so you would want to use the fundamental and not a higher partial most of the time. Since all the partials of organ pipes are true harmonics of the fundamental, the tuning turns out the same no matter which partial you select, as long as the partial you select is actually present in the sound of the note. So the only reason to select a different partial is if the fundamental is too low or too weak. Actually, you could get exactly the same pitch by selecting the 3rd partial as selecting the fifth (x 3) mutation rank multiplier. The difference is in how they affect automatic note switching (described later). So use the mutation rank multiplier only for pipes whose fundamental is a multiple of the selected note. Otherwise use the partial to select one of several harmonics of the selected note.

## Phase Display

The phase display is the horizontal band in the middle of the main tuning screen. 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. 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. For that situation you can use the Spectrum Display instead. This display is called the Phase Display because it displays the phase of the sound from the microphone as compared to the phase of a virtual signal of the correct pitch, in much the same manner as a strobe tuner. Therefore it could also be called the Strobe Display.

## Spectrum Display

The Spectrum Display is the graph shown below the current note selection. It shows how the sound energy is distributed across the frequency spectrum. It is like a standard spectrum analyzer, except that the portion of the spectrum around the selected note is expanded for better resolution. The sound of a pipe is represented by the peak in the graph. To use the Spectrum Display in tuning, tune the note to make the peak line up with the central red line in the graph. That is the tuning target. In general, the Phase Display is more accurate for fine tuning, but there are times when the Spectrum Display gives more information.

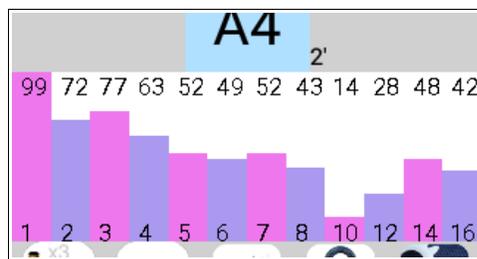
The Spectrum Display has several advantages over the Phase Display. One is that it shows where the pitch of the pipe is, even when that pitch is far from the target pitch. The other advantage is that the Spectrum Display can show several peaks at once if more than one pipe is sounding at the same time.

In addition to zoom levels of “wide”,  $\pm 260$  cents,  $\pm 130$  cents, and  $\pm 50$  cents, the Spectrum Display can also be zoomed in to show an expanded view of  $\pm 10$  cents around the target, while still showing  $\pm 130$  cents or  $\pm 260$  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 dual-zoom modes are useful because they show an area around the target pitch in high resolution but still have the range to show the spectrum 130 cents or 260 cents away from the target pitch.

The main 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. But both displays are available all the time; so you can use whichever display seems to be giving the clearest indication.

## Voicing Display

The area of the screen used for the Spectrum Display can also be used to show a Voicing Display when enabled from the Settings. The voicing display looks like this. The Voicing Display is a bar graph showing the strength of 12 specific partials of the fundamental tone. Partial 11, 13, and 15 are skipped in favor of more relevant partials. The numbers at the top of each bar indicate the relative strength of that partial, which is also indicated by the height of the bar itself. The graph is logarithmic (in dB) with a range of about 43 dB. The levels are shown as compared to the strongest partial as a reference level. Therefore there will always be at least one bar at full-scale (shown as 99%).

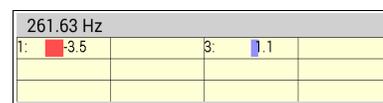


However this reference level can be frozen by tapping the Lock button. When the reference power level is frozen, the background of the Voicing Graph will turn yellow to indicate the condition. In this state, you may not see any power levels registering at full scale if the sound is weaker than when the reference level was frozen.

To use reference level locking, first play a pipe that is sounding louder than the rest. While the Voicing Graph is displaying the strength of the partials for that pipe, tap the Lock button to freeze the reference level. Now with the reference level frozen, play a weaker pipe to see how the levels compare with the stronger one. If any partial is stronger than the frozen reference level, its display will max out at full scale and display in a deep red color, so do not trust any level that are at full scale when the reference power level is frozen (and the background color is yellow).

## Multi-Pitch Display

The Multi-Pitch display that takes the place of the Phase Display when it is enabled. The display contains 12 cells. Each of the 12 cells shows the pitch of a different partial (or harmonic) in two ways. One way is numerically and the other way is graphically through a redish or bluish bar graph. A red bar growing to the left from the center means that partial is flat. A blue bar growing to the right means that partial is sharp. The picture here shows the fundamental of C4 (261.63 Hz) is 3.5 cents flat and the third partial is 1.1 cents sharp. They are not the same because in this case they were generated from two separate pipes, one of them being a *Quint* pipe. While the red and blue bars extend from -20 to +20 cents deviation, the numerical cents value is accurate beyond this range. Using these displays one can tune in a multi-pitch situation (mixtures, mutations,

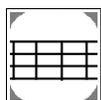


extended choruses) by watching the partial for whichever pitch you are tuning without having to stop and switch partials manually.

## Action Buttons



This button lets you select Mutation Ranks and Partials all on one screen. You can also raise or lower the selected partial by one through a swiping gesture, as explained later in Gestures. But this button allow you to go to any partial with just two taps.



This button toggles the Multi-Pitch Display option on or off. As described above, the Multi-Pitch Display takes the place of the Phase Display when it is enabled. It shows the pitch of partials 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, and 16.



This button toggles the speaker on and off. When the speaker is on, the normal listening mode of the software is suspended and the app becomes a simple tone generator. The tone it produces is exactly the pitch that would indicate a perfectly tuned note in the normal listening mode. You can use this mode to tune pipes aurally by matching them to the sound generated in the speaker.

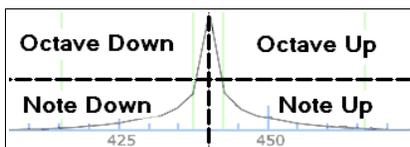


This is the Lock button. It toggles the Locking mode on and off. In Locking mode, the software listens to the sound from the microphone and tries to adjust the offset to match it. (You can learn more about the offset in the section “**All About Offsets**”, later in this manual.) You can see the offset 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 the software 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 a gesture described later in the section on Gestures. When the Spectrum Display is showing the Voicing Display, the Lock button does not engage this offset pitch locking. Instead it freezes the reference level as described earlier in the Voicing Display.



This is the Settings button that gives access to the various functions that are not found on the main tuning page. This includes features such as loading historical temperaments, enabling the Voicing Display, Celeste tuning and controlling temperature compensation.

## Selecting Notes and Partials



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, as shown here on the left. The two upper quadrants change the octave and the two lower quadrants change the note.

Another way to select notes is by tapping on the current note display. That will present a screen with buttons for selecting the octave and a one-octave keyboard for selecting the note. Just remember to select the note last because selecting the note immediately returns to the main tuning page. Another way to select the partial is through the screen that appears when you tap on the Mutation Rank button. That screen contains buttons for partials 1-16. Some combinations of note, octave, partial, and mutation rank would result in a frequency that is

either too high or too low for the software to process. When that happens an error message will be displayed and the selection will not be made.

## Automatic Note Switching

In addition to manually selecting each note, you can also have the notes selected automatically and save a lot of time not having to touch the screen. By using automatic note switching, the software 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. These modes appear on the main tuning screen as “**Auto Up**”, “**Auto Down**”, and “**Auto Both.**” If you are tuning from low notes to high notes, then it may be an advantage to use “**Auto up**” note switching so that the note selection will not follow you down the scale as you play notes you have already tuned for test purposes. Automatic note switching may be enabled by a gesture from the current note display. You can turn automatic note switching on or off, or you can cycle through the three different kinds of automatic note switching, as described in the section on Gestures. The auto note switching range is +/- 4 notes from the current note. This means it can follow you up to a major third away from the current note. This is useful for when a stop of pipes is arranged in up to four rows and you want to tune one row at a time.

## Unequal (Historical) Temperaments

By default, **Organ Tuner** assumes an equal-tempered scale. If you would like to tune in some unequal temperament, you can select an historical temperament 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. See the section on historical temperaments for information on using temperaments.

## Tuning Closeness Indicator

Just above the current note display there is a horizontal bar graph that indicates how close the tuning is to the target pitch. The bar is usually all gray. But when the tuning gets within 1 cent, the bar starts filling in from the left as show here. When the bar is half-way filled in the tuning is only 0.5 cents away from the target. As shown here the tuning is about 0.6 cents from the target pitch.



## Microphone Level Indicator

To help verify that your microphone is working properly, and to help you control how loud sounds appear to the software, there is a microphone level bar graph indicator at the right edge of the spectrum display. It is a violet-colored vertical bar. When the vertical bar reaches the top of the Spectrum Display, that corresponds to a microphone level of 100%, or full scale. If this indicator does not behave as expected, then you may have a problem with your microphone. The level indicator is logarithmic, not linear. That means the indication is proportional to the decibel level and is therefore more sensitive to very low sounds.

## Normal Tuning Procedure

This section takes you step-by-step through a typical organ tuning.

### Initial Setup

**Choice of Temperament** - Before you begin tuning, you should decide whether or not an historical temperament is called for. The choice of historical temperaments is beyond the scope of this manual, but there are many references available. If you do not have any reason to use a specific temperament, you should probably just skip this part, which will give you equal temperament for an organ that is for general use. Historical temperaments are most often used with certain periods of music.

**Temperature Compensation** - Another decision to make is whether to use temperature compensation. This is an optional feature that is most useful when the air temperature is changing during the tuning or is significantly different from the usual air temperature during performance. If you do not want to use temperature compensation, just make sure the TC Offset (short for Temperature Compensation Offset) is shown as zero.

To use temperature compensation, you need to set both the TC Offset and the temperature reading to what you want to consider the standard from which all calculations will be made. When you set the temperature reading, it automatically changes the TC Offset, so set the temperature reading first and then set TC Offset.

For example, suppose you examine the organ and find a certain “golden pipe” whose pitch you don't want to change. To make that pipe the reference, first set the temperature reading to the actual air temperature at the time. Then set the TC Offset so that this “golden pipe” appears in tune to the software. You have now established a standard that is consistent with that golden pipe. You can now begin tuning with those settings. But periodically during the tuning you should update the temperature reading to reflect the actual air temperature. When you do this, TC Offset will be refigured automatically, and if everything is working as it should, the golden pipe will still register as being in tune. Note that you could also accomplish the same thing by going back to the golden pipe and resetting the TC Offset, or even the main offset, to match the pipe. That would not require any special calculation, and that is what can be done with other tuning devices that don't have explicit temperature compensation. However the advantage of using the calculation in the app is that you don't need to return to sounding the golden pipe and selecting the proper note to read it, all of which takes time. Instead you simply update the temperature reading and the software figures the modified TC Offset from that.

Both temperature and TC Offset can be adjusted by tapping on the appropriate entry on the Settings page and following the on-screen instructions to swipe through the Phase Display to do the adjustment. If you happen to have one of the supported Bluetooth temperature sensors, you can simply enable automatic temperature adjustment from the Temperature Settings page and let the software measure the temperature every ten minutes automatically while you tune. See our support website for a list of supported sensors.

### Beginning to Tune - the Tuning Sequence

You can tune in any order that you want. The most common sequence when tuning with an electronic aid is to start with at the lowest note of the rank and go up from there. Because of the layout of pipes, it is often the case that a row of pipes that is most easily accessible in sequence is actually every 2<sup>nd</sup>, 3<sup>rd</sup>, or 4<sup>th</sup> note in the chromatic scale. This sequence is easy to follow by using auto note switching, because auto note switching is

capable of switching in jumps of up to four notes. Tap on the current note to start the sequence by selecting the starting note and octave.

For very low notes, the fundamental frequency may not be detected by the microphone in your device. In that case you should switch to a higher partial. Select different partials until you find one that produces a clear peak in the Spectrum Display.

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. Or you can select partials from the Mutation Rank selection page.

We recommend that for your very first tuning with Organ Tuner you leave auto note switching disabled, and switch notes manually. 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 earlier

## Coarse Tuning with the Spectrum Display

If the pitch of a pipe is too far from the target pitch, then you should use the Spectrum Display to get close to the correct pitch. You should see a peak in the graph. If that peak is to left of the red line, then the note is flat. If the peak is to the right of the red line, then the note is sharp. Make the adjustments to the pipe so as to move the peak to the red line in the center, which represents the target pitch.

## Fine Tuning with the Phase Display

If the pitch of the note is already close to the target pitch, then you should see a pattern of two black boxes in the Phase Display. If the note is sharp, the boxes will be moving to the right. If the note is flat, the boxes will be moving to the left. The slower the boxes move, the closer you are to the correct pitch. It does not matter where the black boxes are within the Phase Display. All that matters is how slowly they are moving. You can judge if you are close enough by seeing how slowly the boxes are moving. Or you can use the closeness indicator above the current note display, as described earlier.

## Tuning with the Multi-Pitch Display

When the Multi-pitch Display switch is turned on, the Phase Display changes to look something like the picture shown here. This display option is useful when tuning a group of harmonically-related pipes, sometimes speaking together. Even if they are speaking together, Organ Tuner will usually be able to detect the pitches of individual partials in the composite sound. Each cell shows the cents deviation for its associated partial. In addition to the numerical value, a graphical indication of this same information is shown in the red and blue bars. Red means the partial is flat. Blue means it is sharp. The red and blue bars are scaled so that they are much more sensitive for deviations close to zero. By having all these partials evaluated at once, you can tune the entire set of pipes for a given note without touching the screen.

1: -4.8	2: -0.2	3: -1.0	4: -2.7
5: -2.5	6: -2.5	7: -3.1	8: -4.9
10: 1.1	12: 3.5	14: 10.8	16: 23.2

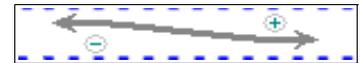
## All About Offsets

**Organ Tuner** uses three kinds of cents offsets. The offsets in effect are all displayed in the Current Settings box, as shown to the right. The software combines these offsets to calculate the desired pitch for each note. In normal equal temperament tuning, the first two offsets are zero. If you are using temperature compensation, then the TC Offset may be non-zero. To calculate the desired pitch, the software adds together the three offsets. If the celeste tuning option then yet another offset will affect the pitch. The Celeste Tuning option is described later.

Offset	-1.60¢
Temper	5.47¢
TCOff	19.85¢

### Main Offset

This offset shown in the upper right corner on the main tuning page, highlighted in yellow. When this offset is left at zero, A4 will be 440 Hz. If you want to tune to a non-standard reference (like A-442 or A-435), 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, as shown here. 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 adjustment if you happen to brush the Phase Display. To set the main offset to zero, swipe from the Phase Display down to the Spectrum Display. The offset can also be modified automatically by **Locking Mode**, as described later.



### Temperament Offset

The next offset is labeled “Temper”. It is the offset defined by the historical temperament you have selected. If you have not selected any historical temperament, then this “Temper” field will be blank. The temperament offset changes as you change notes. The temperament offset depends on the note name, and not on the octave. Therefore it only takes 12 offsets to completely define an historical temperament. The same 12 offsets are repeated in each octave.

### TC Offset

The “TC” stands for “Temperature Compensation”. This offset is much like the main offset described above, except that it will automatically change whenever you make a change to the temperature setting, which appears just below the TC Offset display. Both Temperature and TC Offset can be adjusted in much the same way as the main offset is adjusted, by swiping from the Phase Display, as described above, if you first enable such adjustment from the Settings. When do enable such an adjustment, the software will switch back to the main tuning screen, which will now have a message telling you to adjust either TC Offset or Temperature. Temperature compensation was described earlier in Normal Tuning Procedures.

### Locking Mode

Locking mode is entered by tapping on the lock button, shown in the picture here. Then **Organ Tuner** will show a status box on the left side of the page saying “**Locking**”. When you are in locking mode, the software listens to the sound in the microphone and tries to lock to it by automatically adjusting the offset. This function may be used to determine a non-standard reference to match an existing tuning. Make sure to turn off locking mode promptly when the sound is no longer available, or else the software will continue trying to lock to random noise. The locking mode can only



lock on to a pitch that is already somewhere near the target pitch. If the locking mode does not appear to be capturing the pitch you want, then use manual offset adjustment to get within range and then let locking mode do the rest.

## Celeste Tuning

A celeste rank of pipes is a rank that is tuned so that it produces a given beat rate when played along with other ranks. Usually the celeste rank is tuned sharp of normal, but sometimes it is tuned flat. When it is tuned flat then it is called "unda maris".

Since Celeste Tuning is based on beats, the celeste offset is specified in terms of beats. Historically there have been two general approaches to setting these beat rates. One is to use a constant beat rate (say, 3 beats per second) throughout the scale. The other approach is to use a gradually rising beat rate so that higher notes beat faster than lower notes. Both of these approaches are covered by the **Celeste Tuning** settings in the **Organ Tuner** app. These settings ask you to set the desired beat rate for two notes: C3 (4-foot) and C6 (1/2-foot). Based on your settings of these two beat rates the software calculates the beat rates for all the notes of the scale. If you want a constant beat rate then just set both the C3 rate and the C6 rate to the same value and that is the beat rate that will be used throughout. If you set a negative beat rate then the tuning will be "unda maris" and will be flat by that amount. The software will not allow you to set one beat rate positive and the other negative. The software will extrapolate the beat rate linearly (not exponentially) across the entire scale.

The set up **Organ Tuner** for a celeste rank go to **Celeste Tunings** in **Settings** and then make sure the switch for enabling Celeste Tuning is turned on. The screen should look like the picture here. This screen provides the means to adjust the beat rate at C3 and the beat rate at C6 as discussed above. From these two settings the entire pattern of Celeste beat rates will be calculated. The software enforces all the rules and limitations on these adjustments so sometimes you will see both parameters change when you adjust only one of them. If you want a flat "unda maris" tuning (flat of normal), then set the corresponding beat rates to a negative number by going below zero. When you are done with the setup, return to the main tuning screen and you will see the right status box showing the beat rate for the current note in beats per second (BPS). When Celeste mode is enabled you can turn it off quickly by tapping on the yellow right status box, or by going back to the Celeste settings page and turning off the enable switch explicitly.



## Historical Temperaments

**Organ Tuner** 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 literature on this subject.

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

### Loading Temperament Files

To use an historical temperament in your tuning, go to **Settings** and select **Historical 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 and would like to remove it from the current tuning, tap on the button that says “Cancel” on the Historical Temperaments screen.

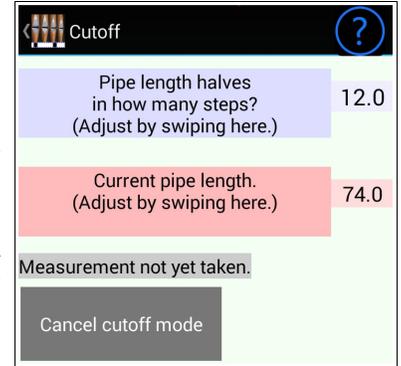
When an historical temperament is in effect, you will see the name of that temperament in the upper left of the Current Settings box on the main tuning page. Also you will see an offset for each note showing as **Temper xx.xx**. As you change notes, the “temper” offset changes.

### Making New Temperament Files

If you want to use a temperament that was not provided with this app, you can create your own new temperaments using the **Make New** button on the Historical Temperament page. All you need to know is the 12 offsets that define the temperament. Enter the name you want to assign to this temperament and enter the 12 offsets that define this temperament in the screen provided. Then tap on **Save**. After you have created and saved a new temperament, that temperament will appear at the top of the list of historical temperaments. If you want to delete a temperament that you made, tap and hold (long press) on the name of that temperament in the list and you will be prompted to confirm your intent to delete that temperament. You cannot delete any of the packaged temperaments that came with the app.

## Pipe Cutoff Calculations

If you are an organ builder, you may want to use the **Organ Tuner** app to help you cut pipes to length. Since it is a lot easier to cut a pipe shorter than to lengthen a pipe that has been cut too short, you normally start with a pipe length that you are sure is just a little too long for the desired pitch. The Organ Tuner app has a built-in function for calculating how much to cut off of a pipe to achieve the correct pitch. This function is enabled from the Settings by selecting “**Cutoff Mode**”, which will show a screen like this. In the picture on the right, the pipe length has been adjusted to 74.0 because the pipe I want to trim is currently 74 cm. long.



The first parameter on the pipe cutoff settings page is the number of steps in the chromatic scale in which the pipe length should be cut in half. For very thin pipes, the number of steps would be exactly 12, which represents one octave. But for any practical pipe, we know that in general the octave of a given pipe is shorter than half the lower pipe. This is due to pipe diameters (for consistent tone quality) halving on some other interval than the octave. Note that the halving interval for diameters and the halving interval for length are two different, but related parameters. The halving interval for diameters can vary from 16 step Principal halving (commonly call the Norm Measure) to 19-22 step Flute halving to 24-48 step reed halving. While this is commonly known and observed, and will not be discussed further here, this implies a variable length halving, which is less commonly known.

Specifically, narrow pipes are generally closer to a theoretical 12th step length having, and wider pipes diverge more significantly from the theoretical length halving. Experience has shown that Principal ranks (diameter halving around the 16th step) typically have a length halving around the 11.5th step. A Flute ranks (diameter halving around the 19th step) typically have a length halving around the 10.5th step. The length halving steps can be anything from 9.0 to 12.5. It need not be a whole number.

The above two examples are close enough for most practical work. Or if you really don't want to bother with such accuracy, just leave this setting at 12.0. Otherwise, a slightly more accurate way to estimate the length halving steps parameter in a specific rank is to measure two roughly tuned pipes separated by at least an octave. Measure them for both pitch error in cents and for length. Then count each chromatic step as 100 cents, adding in the cents error to get the total cents difference between the two pipes. For example, if a nominal C4 pipe is 23 cents flat and a nominal C5 pipe is 17 cents flat, the total cents difference between these two pipes would be

$$C = 12 \times 100 - 17 + 23 = 1206 \text{ cents.}$$

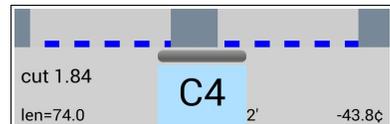
If we call this cents difference  $C$ , and the lengths of the two pipes  $L_1$  (for C4) and  $L_2$  (for C5), the length halving steps parameter,  $H$ , could be estimated as:

$$H = \frac{C \times \log_{10}(2)}{100 \times \log_{10}\left(\frac{L_1}{L_2}\right)}$$

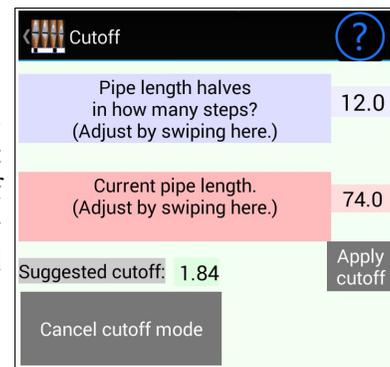
For example, if  $L_1 = 1360$  mm. And  $L_2 = 658$  mm., we would estimate the length halving steps as:

$$H = \frac{1206 \times \log_{10}(2)}{100 \times \log_{10}\left(\frac{1360}{658}\right)} = \frac{363.04}{31.53} = 11.51$$

When we return to the main tuning page in Cutoff Mode the left status box looks like this with the new C4 pipe sounding. In this picture we see that the pipe is currently quite flat, as expected for a new pipe that needs trimming. And we see the recommendation that we cut 1.84 cm. off of the pipe to bring it to the exact pitch. It is only an estimate and it might be too much, so you may want to cut off something less than this amount. But at least this gives you guidance as to how much cutting it would take to achieve a certain pitch.



If you tap in that left status box while a suggested cutoff value is showing the software will switch back to the Cutoff Mode page, freezing the recommended cutoff value and then giving you the option of applying that cutoff value to the current pipe length if you wish to do another round of measuring the pitch and trimming the pipe. There is also a button for canceling Cutoff Mode and returning to the main tuning page in normal mode.



# Gestures

In order to make most functions accessible quickly from the main tuning screen, many of those functions are implemented through gestures. A gesture is the action of touching the screen somewhere and without lifting your finger dragging it somewhere else on the screen. This action is also called “swiping.” Here are all the gestures that are available on the main tuning screen.

In the Phase Display we have gestures to the left and to the right. These adjust the main offset, or the temperature reading, or the temperature compensation offset, depending on what mode the software happens to be in. Although it is possible to set the offset to zero by swiping right or left, it is easier and more reliable to zero an offset by swiping down from the Phase Display all the way down to the Spectrum Display.

Starting from the current note display (A4 here) you can swipe to the left to turn off automatic note switching and go to manual-only note switching, or you can swipe to the right to turn on automatic note switch, or to cycle through the three different forms of automatic note switching.

In the Spectrum Display you can swipe from the left side of the screen to the right side of the screen to raise the partial number by 1. Or you can swipe the other way to lower the partial by one. Swiping vertically through the Spectrum Display changes the horizontal scaling of the display by changing between “wide”,  $\pm 260$  cents,  $\pm 130$  cents,  $\pm 50$  cents,  $\pm 260$  with expanded middle around the target pitch, and  $\pm 130$  with expanded middle. This gesture will also cancel Voicing Mode if that mode is currently using the Spectrum Display.

