

# Pitch Pipe

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## PC-Based Electronic Bagpipe Tuner

Pitch Pipe Tuner User's Guide, Version 1.0

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### SECTION 1 : OVERVIEW

The **Pitch Pipe Bagpipe Tuner** offers real-time pitch detection tuning software for the **Great Highland Bagpipe**. Using musical sound input from a conventional microphone, the Pitch Pipe Tuner shows the tuning status of the instrument and displays the performed note graphically on the user's interface.

The scale of the modern Great Highland Bagpipe differs from the scales used by most Western instruments. The Pitch Pipe Tuner's simple interface allows anyone to easily and exactly tune the bagpipes to any desired temperament without guesswork.

Pipe Bands and other ensemble groups will find that using the Pitch Pipe tuner will **GREATLY** increase the precision of their tuning, as the software acts as an unwavering and absolute reference that members can tune to before and during rehearsals.

Even an experienced, professional soloist's ear can become accustomed to hearing and playing notes whose frequencies are slightly off from the desired temperament. Using the Pitch Pipe Tuner program can help beginners and professionals easily and consistently tune their pipes to the desired temperament every time and train their ear to hear the unique harmonic ratios of the bagpipe.

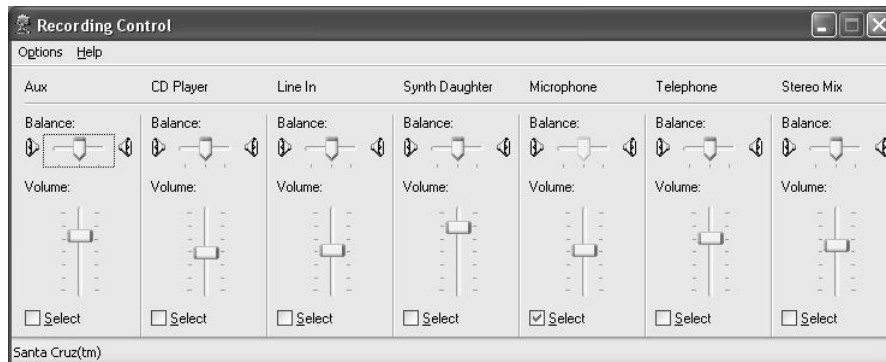
## **SECTION 2 : GETTING STARTED**

Before you start to use the Pitch Pipe Tuner, it is a good idea to familiarize yourself with the microphone and sound card settings of your computer. The software will use the default sound card of your computer. It is recommended to record your bagpipe using the Microsoft Windows 'Sound Recorder' prior to using the tuner. Doing so will allow you to become familiar with your computer's sound card configuration.

To record a tune on your bagpipe to verify that your microphone can 'hear' your pipes correctly, first launch your sound card's mixer. Click 'Start' -> 'Control Panel' -> 'Sound and Audio Device'. Next select the 'Audio' tab, then click on the 'Volume' button under 'Sound Recording'. Select your audio input source and adjust the volume/gain of the incoming signal.

To adjust the recording volume

1. On the **Options** menu, click **Properties**.
2. In the **Properties** dialog box, under **Adjust volume for**, click **Recording**.
3. Select the check box next to the device that contains the input volume you want to adjust, and then click **OK**.
4. Drag the **Volume** slider up or down to increase or decrease the input volume.




After you are certain you have selected the correct audio input (most users will select the 'Microphone' slider) launch the Microsoft Windows Sound Recorder by Clicking on 'Start' -> 'All Programs' -> 'Accessories' -> 'Entertainment' -> 'Sound Recorder.'



### Recording a tune:

1. Make sure you have an audio input device connected to your computer.
2. On the **File** menu, click **New**.
3. To begin recording, click **Record** .
4. Play the first part of your favorite tune on your pipes. For best results, place the microphone 4 to 8 inches from the chanter.
5. To stop recording, click **Stop** .

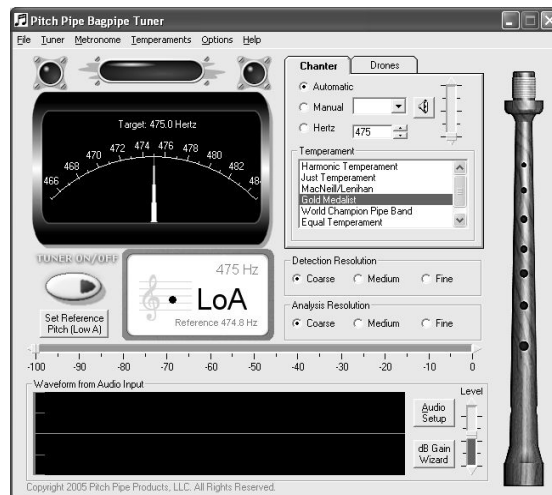
Listen to your recording by pressing **Play** . How does it sound? If the chanter is clear and not distorted then you will know for sure that the Pitch Pipe software will also hear your chanter loud and clear. If the recording sounds something like the Jimi Hendrix experience, or if it's too quiet, you will need to adjust the microphone gain up or down in the audio mixer (see above).

Note: Many sound cards include an 'Audio Boost' option for microphones. The volume of the bagpipes is such that you do not need to have an audio boost option enabled. Each sound card is different, but many have the boost enable toggle under an 'advanced settings' area of the mixer. If you have trouble getting your sound card to not 'clip' and distort, look for this setting and deselect it.

Your experience with the Pitch Pipe Tuner will be even more pleasant now that you have learned a little more about how your computer receives input from your microphone.

### Launch the tuner:

To launch the tuner software, select the Pitch Pipe Bagpipe Tuner icon under 'All Programs'.

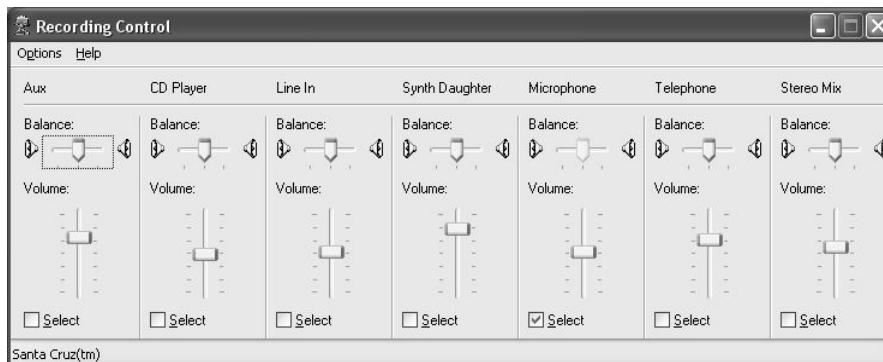


## Audio Settings:

In the lower right hand side of the display window, you will see an '**Audio Setup**' button, a '**dB Gain Wizard**' button, and a '**Level**' slider.



The '**Audio Setup**' button will launch the default sound card's recording mixer settings.

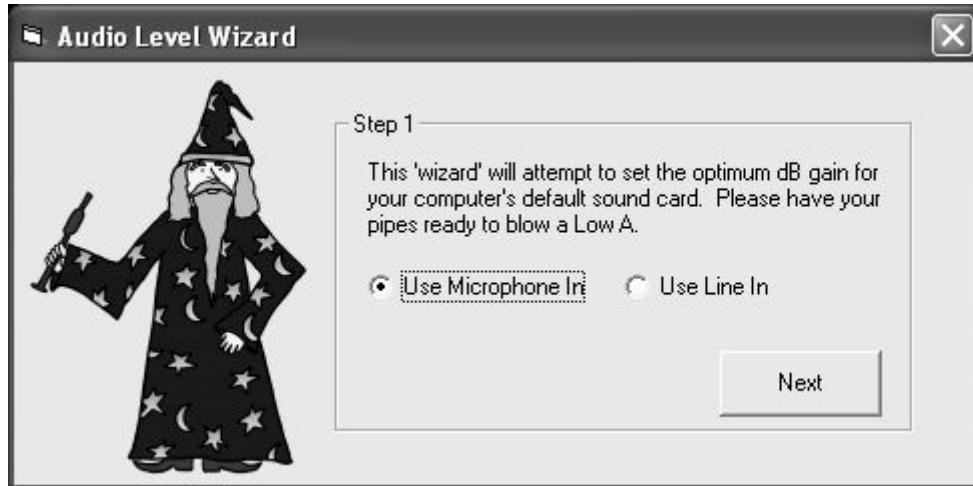


The '**Level**' slider will adjust the Microphone input level. This feature is on the main display window as a convenience. Its functionality is the same as the Microphone slider on the sound card mixer.

The '**dB Gain Wizard**' button launches the '**dB Gain Wizard function**'. This function will assist the user in setting the level of the input audio. Note: If you are experienced with recording audio on your computer, you do not need to use the function. The Wizard will do its best, but the human ear and eyes can do a better job when it comes to initial setups. For those who have had trouble setting up

their microphone, or don't really understand sound devices and computers, the Wizard should help quite a bit.

To use the db Gain Wizard function, click on the button.



Select 'Microphone In' or 'Use Line In'. Most users without advanced audio equipment will simply have a microphone connected to their computer's soundcard. 'Use Microphone In' should be selected unless advanced audio equipment is being used.

Have your pipes ready to blow a Low A and click 'Next'.



Play a Low A for about 20 seconds. You may play with or without drones. It is recommended to play with drones in order to ensure consistent air pressure through your instrument. For best results, place your microphone 4 to 8 inches from your chanter. When the system has determined the best levels, you will receive the following prompt:

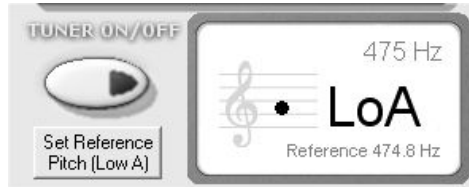


Clicking OK will return the user to the main tuner display window.

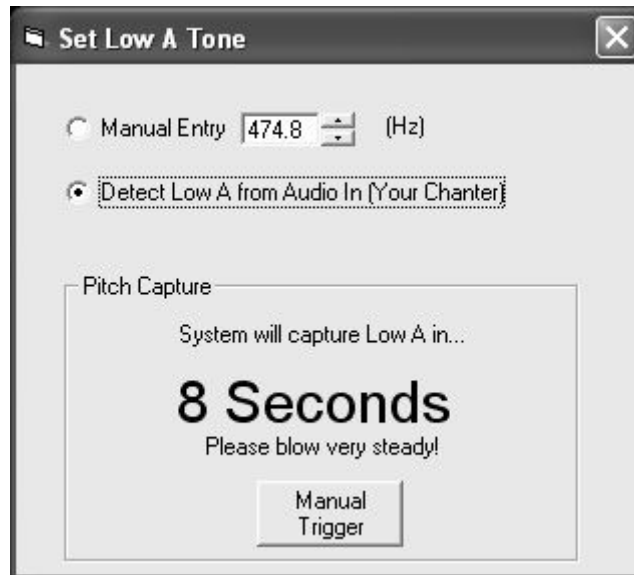
## **SECTION 3 : TUNING YOUR PIPES**

### **Setting the System Reference Pitch:**

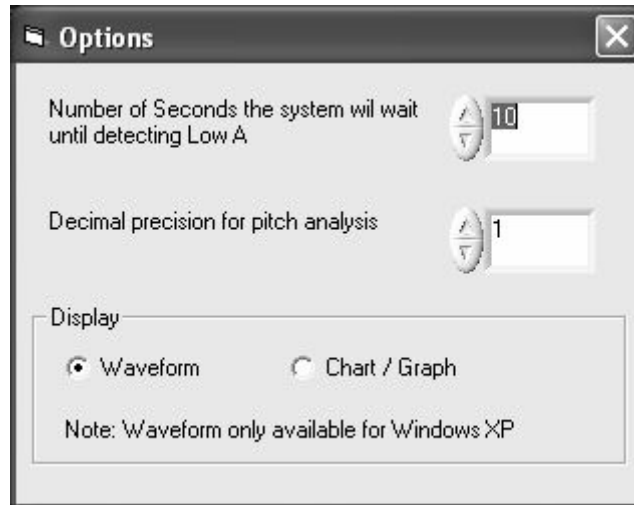
For the system to accurately tune your pipes, the target reference pitch must be established. The bagpipes are unique in that there is not a consensus on what Low A's pitch in Hertz should be. Before starting to use the tuner, this pitch must be set. It can be set by clicking on the 'Set Reference Pitch' button on the left of the screen.



The system will allow either manual entry (great for ensemble players) or automatic detection.



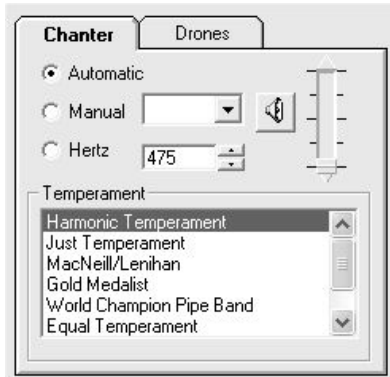
If the 'Detect Low A' option is selected, the system will start a timer and count down for 10 seconds. During this time, you need to start your pipes, position your chanter in front of the microphone, and blow a low A. If you are working with a friend, he/she can trigger the system by clicking on the 'Manual Trigger' button which will capture the pitch when pressed. The number of seconds the system waits before detecting the Low A can be configured under the 'Options' menu toolbar of the main display.



### Tuning:

After a reference pitch for Low A has been set you are ready to use the tuner to assist the tuning of your chanter and drones.

To tune your chanter, select the 'Chanter' tab on the right of the screen if it has not been selected already, and select the detection mode and temperament.

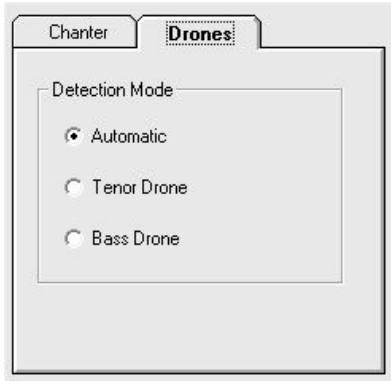


The Automatic detection mode will select the closest note to your pitch. The manual mode will allow the user to select the scale note from a drop-down list. The Hertz setting will allow the user to target a specific Hertz value.

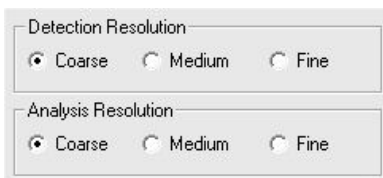
Note: To hear a note played on your computer for a scale name, select 'Manual', select a note from the list, and then click on the speaker icon. The tone will sound for 2 seconds.

The 'Drones' tab allows the user to select the drones detection mode. Most users will select 'Automatic'.





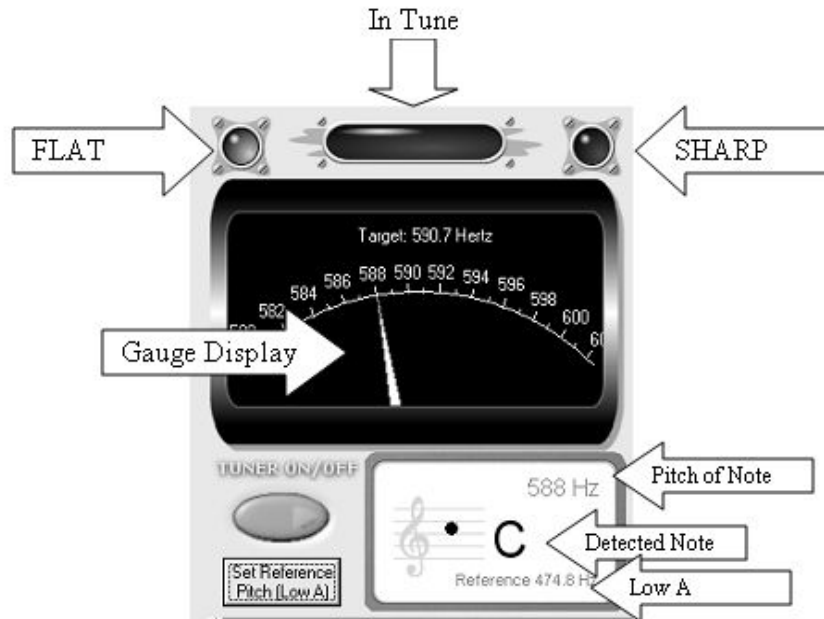
The user may also choose to adjust the resolution of the tuner by adjusting the detection and analysis resolution settings.



The detection resolution will round the detected pitch more for coarse, and less for fine. The analysis resolution will widen the 'in tune' area for coarse, and narrow it for fine.

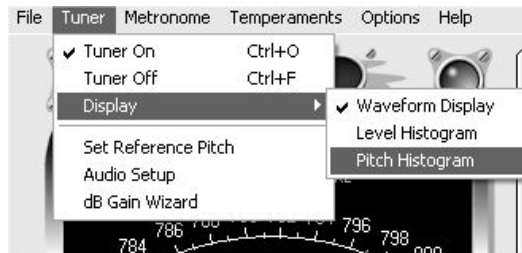
Clicking on the 'Tuner On' button will activate the tuner.





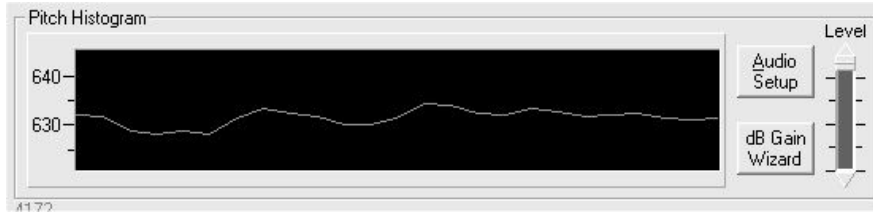
The system will display the status of each detected pitch as either flat, sharp, or in tune, as well as display the pitch in Hz on the gauge display, and in the area labeled 'Pitch of Note.' This system will also detect which note is closest to the detected pitch and display it in the area labeled 'Detected Note.' Please see the 'ADJUSTING THE PITCH OF YOUR PIPES' section below if you need help adjusting the pitch of your chanter or drones.

### Display:

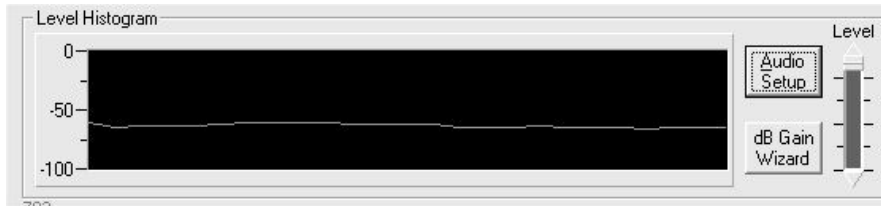


The Pitch Pipe Tuner has three options for the display window located at the bottom of the main interface. The user may select 'Waveform', 'Level Histogram' or 'Pitch Histogram' by selecting each option under 'Tuner' -> 'Display' on the menubar.

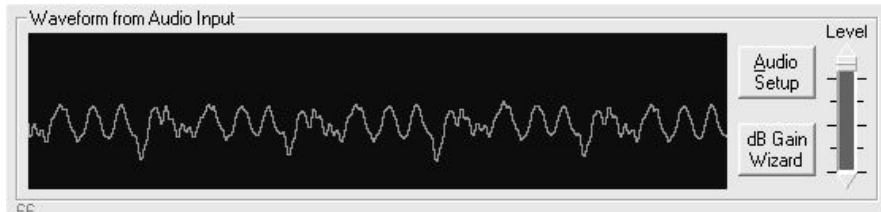
Note: Most Windows 2000/ME/98SE users will not be able to select the Waveform view.



The Pitch Histogram view graphs the last 50 captured pitches in realtime. This feature allows the piper to ensure that consistent pitch is maintained.



The Level Histogram view graphs the last 50 captured volume levels in realtime. This feature will help the piper to maintain steady air pressure and volume level.

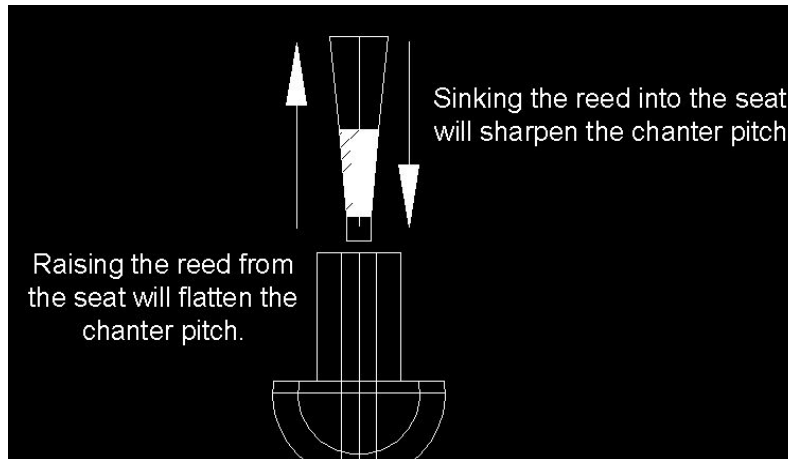


The Waveform display graphs the time domain sequence of the incoming captured audio.

### **ADJUSTING THE PITCH OF YOUR PIPES**

There are several 'tricks of the trade' that will be helpful to the user when attempting to adjust the pitch of the chanter. If the concept of adjusting individual notes is new to you, the following paragraph will be useful. You should also ask a local Open piper or a local Pipe Major how they adjust their instrument.

The easiest way to sharpen or flatten your chanter is to simply sink or raise the reed in the chanter's reed seat.



It is important to know that changing the seating of the reed affects the high hand notes more than the low hand notes. For example, if you sink the chanter reed, the High A will sharpen more than the Low A will sharpen. Changing the reed seat is how a piper will get the chanter close to a target pitch, or how a piper will establish the pitch the chanter 'wants' to be at by checking the Low A and High A until they are the desired pitch without any tape.

To adjust individual notes of the chanter, the size of the holes can be adjusted via tape and in extreme cases a knife.



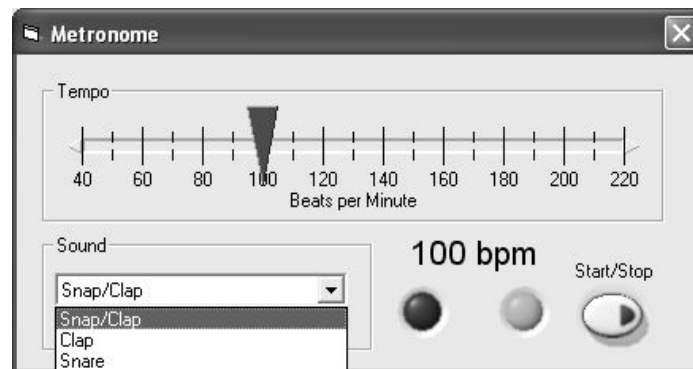
If a note is sharp and needs to be flattened, placing tape over the hole below the note the piper is fingering will flatten the note.

If the note is flat and needs to be sharpened, the reed can be sunk into the reed seat until the note is at the correct pitch, and then the other notes (which will have sharpened as well) can be flattened via tape. OR: It is not uncommon for experienced pipers to CAREFULLY carve out the holes of their chanter in order to raise the pitch of a specific note. If you have never done this before, please consult a local Open piper, a local Pipe Major, or a local Pipe Maker for instruction on how this should be done. If a piper is not a steady blower, this type of modification should never be performed.

**NOTE ON CARVING UP YOUR CHANTER:** Pipe makers are very clever folks who have sized and placed the holes on your chanter in very exacting locations. However, blowing pressure, temperature, humidity, reed maker, etc. are also critical variables to getting the chanter in tune. While pulling out a Dremel tool, deburring tool, or a knife should never be your first method of sharpening a note, the careful customization of your chanter can make playing and staying in tune much easier.

### **Metronome:**

The tuner software also comes with an accurate metronome.

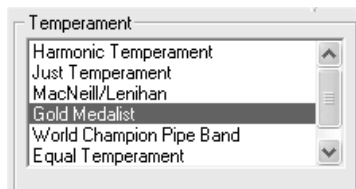


The tempo can be selected from 40 to 220 beats per minute. The sound the metronome produces can be selected from the 'Sound' drop-down list. To start the metronome, simply click the 'start' button. Pressing it again will stop the metronome.

## **SECTION 4 : UNDERSTANDING TEMPERAMENTS**

The scales played on the modern Great Highland Bagpipe differ from the scales used by most Western instruments. Bagpipe notes are named low G, low A, B, C, D, E, F, high G, and high A. These notes and scales do not match modern Western instruments due to slight differences in pitch and temperament. The pitch bagpipes are tuned to has been steadily rising over the years. The actual frequency of A above middle-C is 440 Hz (cycles per second). The frequency that pipers now tune low A to has risen to between 470 and 480 Hz (over a half step above A-440). This has to be taken into account when attempting to tune the bagpipes to play with other instruments. The bagpipe can produce scales that closely approximate the Mixolydian, Ionian, and Aolian modes. Many Western instruments today use "equal temperament" where each semitone or half-step of the scale is equidistant and exactly 100 cents apart. Bagpipes evolved to play unique scales with **unequal ratios** between each pitch. These ratios are slightly different from those used in Western modes. All of this makes it very difficult for bagpipes to play in tune with instruments that use equal temperament. Today, bagpipes are usually tuned very close to "just temperament". Other common temperaments include the "Seumas MacNeill temperament" and "Harmonic temperament", each with slightly different interval ratios between certain pitches.

The tuner also comes with two preset temperaments that were constructed by doing advanced pitch analysis on leading soloists and pipe bands. These two presets are labeled 'World Champion Pipe Band' and 'Gold Medalist'. It is interesting to note that the tuning of these temperaments is slightly different. This is due to the fact the top bands today regularly play harmonies that require some slight compromise in note tuning in order to maximize the impact of the close harmonies the bands use.



In the past, tuning the bagpipes to a desired temperament required lots of guesswork or the use of complex tuning tables that required transposition of each pitch, then tuning each note an exact number of cents sharp or flat of each equally tempered note on the tuner. The Pitch Pipe Tuner's simple interface allows anyone to easily and exactly tune the bagpipes to any desired temperament without any guesswork or complicated tables. Users can select one of several preset temperaments or create their own temperament settings. This makes it easy to set up the pipes to play with other instruments no matter what temperament the other instruments use.

## Understanding and creating Temperaments:

The following section is from E. MacPherson's very good research paper at:

<http://www-personal.umich.edu/~emacpher/pipes/acoustics/pipescale.html>

We were going to write our own description, but Ewan's is so clear!

*From the time of Pythagoras, it has been known that two notes sounding together are heard as a consonance (a smooth, pleasant combination) when the ratio of their frequencies is a fraction with small integers in the numerator and denominator. In such a situation the two notes have many harmonics in common, which reduces the roughness of the combination. A simple example is the octave (from low A to high A) in which the frequency ratio is 2:1 and every harmonic of the upper note coincides with a harmonic of the lower one. A ratio of 5:4 gives a major 3<sup>rd</sup> (A to C#), and a perfect 5<sup>th</sup> (A to E) has a ratio of 3:2. In solo pipe music the frequency ratio we are concerned with is always that between the chanter and the drones. Since the drone notes are "A" (one or two octaves below the chanter's low A) we can just define the frequency of each note on the chanter by the ratio of its frequency to that of low A. Thus for example, low A will have a ratio of 1:1, and high A will have a ratio of 2:1.*

*Not all of the frequency ratios on the chanter are universally agreed-upon, and tuning styles, like the overall pitch, have changed with time. Some notes (the As, C, and E for example) are very easy to set relative to the drones, with clearly audible "beating" when out of tune, but others are less straightforward. In particular there are several schools of thought on the tuning of D and high G. In the non-piping world, the simplest and purest tuning scheme known for a Mixolydian scale is a type of Just Intonation (which simply means a scale using whole-number frequency ratios) in which D is tuned to a frequency ratio of 4:3 above low A, and the high G is tuned to a ratio of 16:9. However, in 1954, J. Lenihan and Seumas MacNeill published a study of the tuning of 18 pipe chanters in which they concluded that Ds were tuned to 27:20, and the high G to 9:5. These values are sharper than the simple Just values, although since they are whole-number ratios they are, strictly speaking, just. A scale formed in this way has unique and interesting melodic properties, particularly when one considers the various pentatonic scales which can be derived from it (Piping Times, October 1997).*

*Analyses of recent recordings by well-known soloists from North America and the U.K. show that tuning practice has changed in the last 4 decades. Ds vary from piper to piper, but are generally tuned very close to the Just D (a 4:3 ratio with low A) rather than the significantly sharper 27:20 ratio. High Gs are also tuned much flatter, apparently at a ratio of 7:4, which might be termed the "Harmonic" high G since in this case the note's harmonics coincide exactly with every 7<sup>th</sup> harmonic of the bass drone. Low Gs are frequently exactly an octave lower at 7:8. In practice, the tuning of high A almost always departs from a true octave relationship with the drones, and is typically tuned 10 to 30 cents flat. Recordings*

*of John D. Burgess provide good example of this effect. It is perhaps done in order to make the high A more audible against the drones or to guard against the reed sharpening up during a performance, but is probably best regarded as a matter of convention or taste. Certainly the ear of the pipe music aficionado becomes used to the flat high A to such an extent that a "true", octave high A can sound overly sharp and shrill.*

End MacPherson



## SECTION 5 : CREATING AND SHARING TEMPERAMENT FILES

To create or adjust the temperament setting for your tuner, select the 'Temperament' menu item on the main interface display.

Temperament Configuration																																																											
<div> <div> Harmonic Temperament Just Temperament MacNeill/Lenihan Gold Medalist World Champion Pipe Band Equal Temperament Concert Bb </div> <div> <div>Properties</div> <div> Temperament Name: Harmonic Temperament  Temperament Author: Pitch Pipe Products  Filename: _Harmonic_Temperament.ptf </div> <div> <div>Pitch</div> <div> Reference Pitch: 475  Enforce Pitch Override: <input type="radio"/> Yes <input checked="" type="radio"/> No </div> </div> </div> <div> <div>New Delete</div> <table> <tr> <td>Ratios</td> <td>Hi A</td> <td>Hi G</td> <td>F</td> <td>E</td> <td>D</td> <td>C</td> <td>B</td> <td>Lo A</td> <td>Lo G</td> </tr> <tr> <td>Beta</td> <td>2</td> <td>7</td> <td>5</td> <td>3</td> <td>4</td> <td>5</td> <td>9</td> <td>1</td> <td>7</td> </tr> <tr> <td>Alpha</td> <td>1</td> <td>4</td> <td>3</td> <td>2</td> <td>3</td> <td>4</td> <td>8</td> <td>1</td> <td>8</td> </tr> <tr> <td>Cents from Tonic</td> <td>1200</td> <td>968.825</td> <td>884.358</td> <td>701.955</td> <td>498.044</td> <td>386.313</td> <td>203.910</td> <td>0</td> <td>-231.174</td> </tr> <tr> <td>Hertz Value</td> <td>950</td> <td>831.25</td> <td>791.666</td> <td>712.5</td> <td>633.333</td> <td>593.75</td> <td>534.375</td> <td>475</td> <td>415.625</td> </tr> </table> </div> </div>										Ratios	Hi A	Hi G	F	E	D	C	B	Lo A	Lo G	Beta	2	7	5	3	4	5	9	1	7	Alpha	1	4	3	2	3	4	8	1	8	Cents from Tonic	1200	968.825	884.358	701.955	498.044	386.313	203.910	0	-231.174	Hertz Value	950	831.25	791.666	712.5	633.333	593.75	534.375	475	415.625
Ratios	Hi A	Hi G	F	E	D	C	B	Lo A	Lo G																																																		
Beta	2	7	5	3	4	5	9	1	7																																																		
Alpha	1	4	3	2	3	4	8	1	8																																																		
Cents from Tonic	1200	968.825	884.358	701.955	498.044	386.313	203.910	0	-231.174																																																		
Hertz Value	950	831.25	791.666	712.5	633.333	593.75	534.375	475	415.625																																																		

The difference between two notes can be described in relative term by a coefficient, or in absolute term using cents.

$$cents = \frac{(1200) \left( \log_{10} \left[ \frac{\beta_f}{\alpha_f} \right] \right)}{\log_{10}(2)}$$

Example:

Low A = 475 Hz.

Harmonic Temperament System for tuning D:

$$Pitch = 475 \frac{4}{3} = 633.34Hz$$

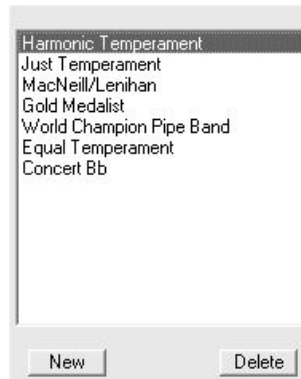
$$cents = \left| \frac{(1200) \left( \log_{10} \left[ \frac{4}{3} \right] \right)}{\log_{10}(2)} \right| = 498.04$$

MacNeill/Lenihan Temperament System for tuning D:

$$Pitch = 475 \frac{27}{20} = 641.25Hz$$

$$cents = \left| \frac{(1200) \left( \log_{10} \left[ \frac{27}{20} \right] \right)}{\log_{10}(2)} \right| = 519.55$$

To create a new temperament file, Select the 'New' button on the left of the 'Temperament Configuration' window.



The system will prompt you for a temperament name. After you have entered a name, the system will create a Pitch Pipe Temperament File (.PTF) in the '\Temperament\_Files' directory on your computer.

You may adjust the temperament and author's name of any temperament file by adjusting the value in the text boxes and clicking on 'Apply'.

The Pitch settings for each temperament allow the user to set the reference pitch that is displayed, as well as if the system should prompt the user to the reference

pitch or not. Note: The reference pitch that is stored with the temperament file will not override the pitch a user has set on his/her system. Only if the 'Enforce Pitch Override' is set will the user be prompted to accept the new reference pitch. For example, a soloist will not care what the stored pitch is for a temperament file, as he/she will set the system reference pitch prior to tuning. But a Pipe Major that is using the tuner will want to ensure that the members of the band do use his reference pitch, and thus he would want to send out a PTF that has the 'Enforce **Pitch Override**' enabled.

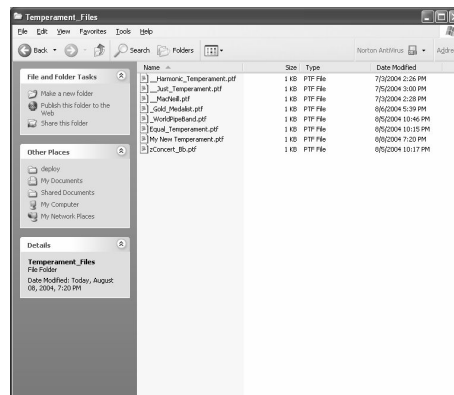
The Alpha and Beta that comprise the coefficient can be adjusted for a temperament by entering in a new number or click on the up/down arrows to adjust each value by .01.

Ratios									
Note:	Hi A	Hi G	F	E	D	C	B	Lo A	Lo G
Beta	2	9	5	3	27	5	9	1	8
Alpha	1	5	3	2	20	4	8	1	9
Cents from Tonic	1200	1017.59	884.358	701.955	519.551	386.313	203.910	0	-203.910
Hertz Value	950	855	791.666	712.5	641.25	593.75	534.375	475	422.222

Clicking 'Apply' commits the changes to the temperament file. Clicking 'Close' closes the 'Temperament Configuration' window.

### To Distribute Pitch Pipe Temperament Files (PTF):

You may send others temperament files you have created by sending them the file and instructing them to copy it into the directory labeled 'Temperament\_Files' under the directory folder where the application was installed.



### Using Temperament files others have sent you:

To use a temperament file that someone has sent you via email, diskette, web download, etc., simply copy the file into the directory labeled

'Temperament\_Files' under the directory folder where the application was installed.

Thank you for your interest in the Pitch Pipe Bagpipe Tuner. If you have additional questions, or comments on how this user's guide to be made better, please let us know!

Visit us on the web!

<http://www.pitchpipetuner.com>