

## WaveStats

### Contents

WaveStats is supplied as a zip file, wavstats.zip. When unzipped it should contain:

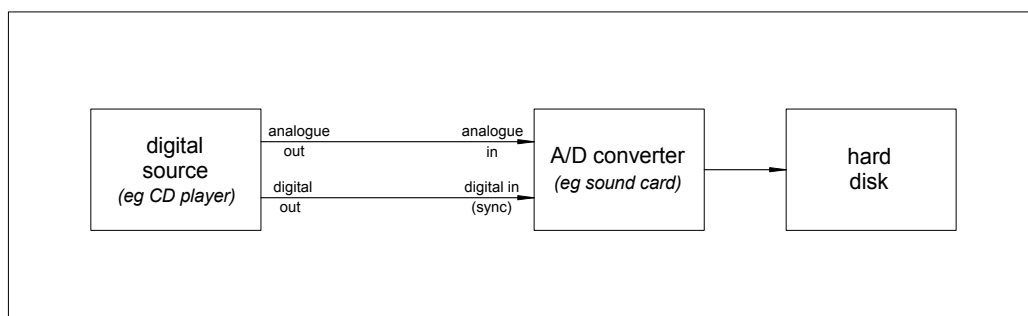
WaveStats.exe  
Leader16\_44.wav  
Leader16\_48.wav  
Leader16\_96.wav  
Leader24\_44.wav  
Leader24\_48.wav  
Leader24\_96.wav  
CT\_Pro.dll

and this information file.

### Description

Wave Stats performs statistical analysis on two sets of nominally identical Wave files to determine the mean and standard deviation of each equivalent sample. It then uses these values to compare the two sets of files to determine and quantify statistically significant differences between them. It is principally intended for the comparison of sets of recordings taken from hi-fi components before and after accessories such as isolation platforms/feet, CD mats or aftermarket mains cables are applied. It is not suitable for determining the effect of any accessory that may be expected to affect amplitude versus frequency and/or phase versus frequency response, so it generally should not be used, for example, to test the effect of loudspeaker or interconnect cables.

In order for the sets of files to be accurately compared the signal source must be digital (eg a CD player) and must have a digital output. The A/D converter used for the recording must be capable of being slaved from the embedded clock in the source's digital output so that successive recordings are made with tight and repeatable synchronisation. An example setup is shown in the diagram below.



*Example test setup*

Any number of audio components may be included within the test system, provided that the digital source provides both the audio signal feed to the system and A/D synchronisation. For example, recordings could be made from the output of a power amplifier, suitably attenuated.

For WaveStats to align the successive test recordings and provide correction for any gain drift (which it applies automatically) the test excerpt must be preceded by a short 'leader' that contains

an alignment impulse and toneburst. This leader is supplied herewith as various Leader\*\_\*.wav files for different combinations of bit depth (first digit) and sampling rate (second digit). For example, Leader 24\_96.wav is for source files of 24-bit resolution at 96kHz sampling rate. The appropriate leader should be copied and pasted, using an audio editor, to the front of both channels of the Wave file containing the chosen test excerpt. This extended file can then be burnt to CD or DVD if you intend to use a CD or DVD player as the signal source. If you are to use a number of different test excerpts then the leader must be pasted to the beginning of each of them.

## **System requirements**

WaveStats should run under any Windows 32-bit operating system, from Windows 95 onwards. It has been tested on Windows 95, Windows ME and Windows NT4.

To run, WaveStats requires that the supplied CT\_Pro.dll be installed in the same directory as the executable. This file contains the runtime files of Perfect Sync Inc's Console Tools Pro (<http://perfectsync.com>) which provides enhanced control over the console window's appearance and function.

The WaveStats console window is sized for use with screen resolutions of 1024×768 or greater. If you attempt to use it with lower screen resolution you will have to navigate the console window via scroll bars.

WaveStats is inherently a fast-running program. Its speed in practice is determined principally by disc reading/writing and memory operations, particularly when processing large Wave files. If there is intensive hard disk activity as WaveStats reads the files this indicates that your computer is having to use virtual (hard disk) memory. Operation will be significantly faster if all the memory operations can be achieved within RAM. To facilitate this you may need to close other applications. If virtual memory is required even when WaveStats alone is running, a RAM upgrade will be needed for your computer to run it faster.

## **Operation**

The Wave files identified for analysis must be mono and have either 16- or 24-bit resolution. In the latter case the Wave file must be a 24-bit packed integer type.

WaveStats first asks you to identify the folder in which the first set of Wave files (the reference files) are contained. You must enter the complete path for the directory, eg c:\wave files. It then asks you for the core filename of the reference files. If, for instance, you have saved the first set of files as (c:\wave files\ symphony 1\_1, symphony 1\_2, symphony 1\_3, etc, you would enter 'symphony 1'. (Directory and file names are not case-sensitive.) Once the core filename has been entered WaveStats reports the number of Wave files that meet this description.

WaveStats then asks you to specify a threshold value with which to identify the alignment impulse in each file. An appropriate value should be determined by examining one of the files using an audio editor. If you recorded with 24-bit resolution and the first sample associated with the alignment impulse has an amplitude of 4,100,000, for example, then a threshold value of 3,000,000 would be appropriate.

WaveStats then asks for the number of samples over which you wish the analysis to be conducted. This figure should be less than the overall length of the file, as measured from the end of the leader section (ie 0.4 seconds after the alignment impulse). Be careful not to specify a number that will cause WaveStats to attempt to read beyond any of the files it is asked to analyse otherwise a system error will be reported and WaveStats will crash.

Before analysing the identified reference files, WaveStats lastly asks you to specify whether the statistical comparison between this set of files and the second set, specified later, should be at the 95 or 99 per cent confidence level (using the Student T-test).

WaveStats now reads the specified reference files. If the program crashes at this point it is almost certainly because it has attempted to read beyond the end of one of them. Check that the number of samples you wish to analyse over is appropriate and try again. If the program still crashes it may be that one or more of the specified files is shorter than you expect. This can occur if the recordings were made to hard disk using a disk drive that is not AV certified. Such drives can

cause drop-outs to occur in long recordings while they perform thermal recalibration. Make a note of which file WaveStats is reading when it causes the system error and check it.

Once all the reference files have been read they are analysed and WaveStats reports the largest single sample standard deviation and average per sample standard deviation within them. It then asks you to specify the directory and core filename for the second set of (comparison) files. If the directory is the same as for the reference files you can simply press Enter rather than re-type the directory path. WaveStats then reads and analyses the comparison files using the impulse threshold and analysis length specified previously. Again, if WaveStats crashes at this point it has probably attempted to read beyond the end of one of the files.

WaveStats then reports the largest single sample and average per sample standard deviations within the comparison files before comparing the two file sets and reporting the differences between them. These are quantified as the number of samples identified as significantly different, the average per sample difference (only statistically significant differences included) and the accumulated difference over all the samples (again only statistically significant differences included).

These results can be archived, along with filenames of the analysed files and the analysis parameters, by specifying a text file to which to save them. WaveStats will also create and save, if required, Wave files containing mean sample values for the reference and comparison files, and/or a Wave file containing the statistically significant differences between them. Analysis of this difference file can help identify the nature of the disparities between the two sets of files. Note that WaveStats applies TPDF dither at the optimum amplitude of 2LSB pk-pk to all output Wave files.

For a more detailed description of the test methodology and its application please refer to the two articles I wrote about it for *Hi-Fi News*, in the May and June 2003 issues of the magazine.

### **Licence**

This software may be freely distributed provided that it is unaltered and distributed in its entirety, including the supplied DLL, Wave files and this information file. No support or warranty is implied or given but if you encounter any bugs or have suggestions for improvements you are invited to post them via [www.audiosignal.co.uk](http://www.audiosignal.co.uk).

### **Source code**

WaveStats was written using PowerBASIC Console Compiler v3. If you wish to verify the source code you should apply for a text copy of it via [www.audiosignal.co.uk](http://www.audiosignal.co.uk), stating your reasons for wishing to have it. When requesting a copy of the source code you must undertake in writing not to distribute it in any form (eg text file, .bas file or compiled executable).

Keith Howard  
June 2003

### **History**

altered 18 June 2003 – '1LSB pk-pk' corrected to '2LSB pk-pk'