# Sound in Multimedia Systems

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**Abstract** – *The Personal Computers are nowadays complex multimedia system. In the real everyday usage the sound card, or audio device, became the very important part of the system. It is used to record and reproduce the sound, whether the music is listened, the film is shown, or someone is talking with another party through the Internet, and so on. The most of modern PC motherboards already have audiodevice included on the board, but if someone wants to have better sound quality, then external soundcards/audiodevices are used. It is possible to connect them through the slots on the board, like PCI interface, or via external ports, like USB. In this article the measuring methods, measuring results and their comparison are shown.*

**Key words** – *Sound in Personal Computer, Soundcard, Audio Device, Digital Sound*

## 1. INTRODUCTION

The phrase Personal Computer Audio Device is used to identify the portion of PC hardware used for acquiring, storing, and rendering audio program material using the sophisticated data handling facilities built into the PC. Such systems started out in the early days of PCs as simple "sound cards".

The technology has evolved over more than two decades to the point where contemporary PC sound systems are typically 16 to 24 bit resolution, often include surround sound, and exhibit performance levels on a par with high quality home audio systems. Small speakers have been replaced with full-range speaker systems, some even with sub-woofers, resembling those supplied with home stereo systems. In many cases, the PC audio device is connected to an external sound system.

A typical PC audio device has representative collection of inputs. Any particular system may have more or fewer inputs and outputs. Line In and Line Out are present on virtually all systems with the exception of some notebook computers that have only a microphone input with no line input. Some sound cards include small power amplifiers and therefore have speaker outputs, although most systems generally provide only line level outputs and rely on powered speakers. It is not uncommon today to find 5.1 surround sound outputs as well— rear channel line outputs, center channel outputs and a sub-woofer output.

The user control of the audio system is typically by means of a "mixer panel", a series of software slider controls that control the gain of various parts of the circuit.

Signal levels and signal handling capability are subjects of high importance to an audio engineer. Any audio system designer must pay careful attention to signal levels throughout the signal path and signal handling capacity of the respective circuitry if good performance is to be attained. This requires attention to clipping or "full scale" level, noise floor, and nominal program level. Any evaluation and testing process must also recognize these issues.

## 2. MEASUREMENT STANDARDS

There are several standards and commercial practices that define how tests of PC audio devices should be performed. AES6id specifically addresses testing PC audio devices. AES17 covers digital audio measurements in general and measurements of A-to-D and D-to-A converters in particular.

Intel Corporation and Microsoft Corporation have produced a series of measurement practices to define testing procedures for all hardware used in a PC, including a chapter devoted to testing audio systems. The Microsoft Windows Hardware Quality Labs (WHQL) administers compliance testing based on these documents. The latest document as of this writing is PC2001.

In a well-designed PC audio device, the converters should be the weakest link in the chain. If the supporting analog circuitry is designed with good engineering practice, its performance will exceed the performance of the converter. Unfortunately, this is not always the case. There are examples of PC audio devices with excellent high-resolution converters that do not deliver the full performance of the converters because of design flaws in the analog input or output circuitry. To be able to fully characterize a high performance PC audio device, a true Dual Domain analyzer must be used. This means that the analog signal generation must be done by an analog generator, not a D-to-A based generator. Otherwise, it is hard to tell which converter is dominating the measurement—the test instrument generator D-to-A or the PC audio device A-to-D.

## 3. MEASURING PATHS

To characterize a PC audio device, there are actually five variants of these two paths that should be tested [1]. Note that not all paths are accessible on all PC Audio devices.

### 3.1. PC to DA (Playback path)

This is a measurement of the D-to-A and analog output circuitry. It uses a digitally generated test signal, typically a .wav file and provides an analog output signal at line out.
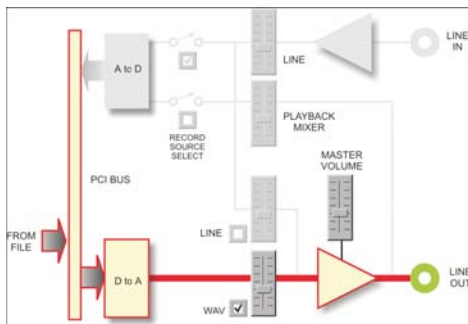


**Fig. 1.** PC to DA Path

### 3.2. Analog loop-through path

This path measures only the analog circuitry without going through any converters. The mixer controls are set to allow line in (or mic in) to connect to line out.
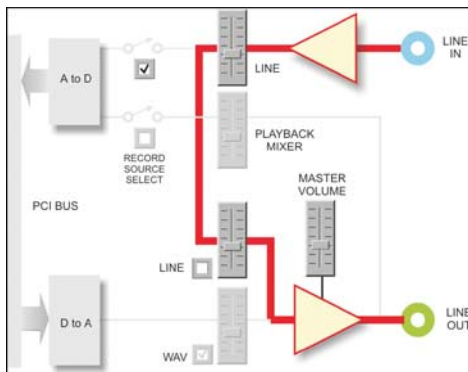


**Fig. 2.** A-A Through Path (mixer)

### 3.3. AD to PC (Record path):

This is a measurement of the A-to-D and analog input circuitry. It uses an analog signal and generates a digital test signal, typically a .wav file.

### 3.4. AD to PC to DA

Analog measurement of Record/Play loop. This is a digital loop through connection that includes all of the elements. The analog test signal is sent to line

in, flows through the A-to-D to the PCI bus, is recorded on the hard drive, and then played back through the D-to-A and out the analog line out. Alternatively, in full duplex systems, the digital output of the A to D is directly "looped through" to the digital input of the D to A.
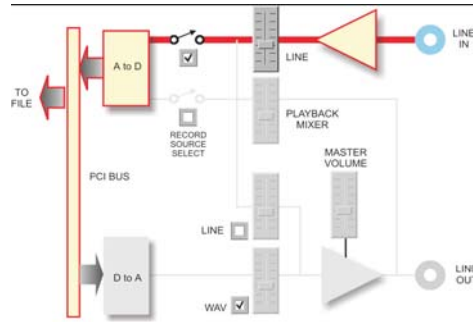


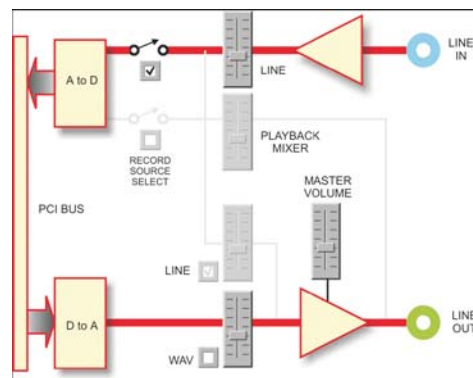**Fig. 3.** AD to PC (Record) Path



**Fig. 4.** AD to PC to DA Path

### 3.5. AD to PC to DA

PC to DA to AD to PC: Digital measurement of Record/Play loop. This is a loop through but measured on the digital side. A digital test signal, typically a wav file, is played through the D-to-A, the line out is connected to the line in, and the signal is digitized again by the A-to-D and sent to the PCI bus where it is analyzed. This requires a system able to handle simultaneous record/play such as possible on a full duplex system.
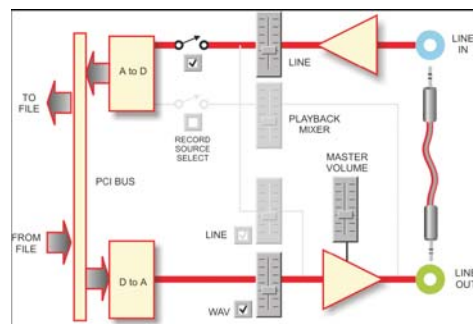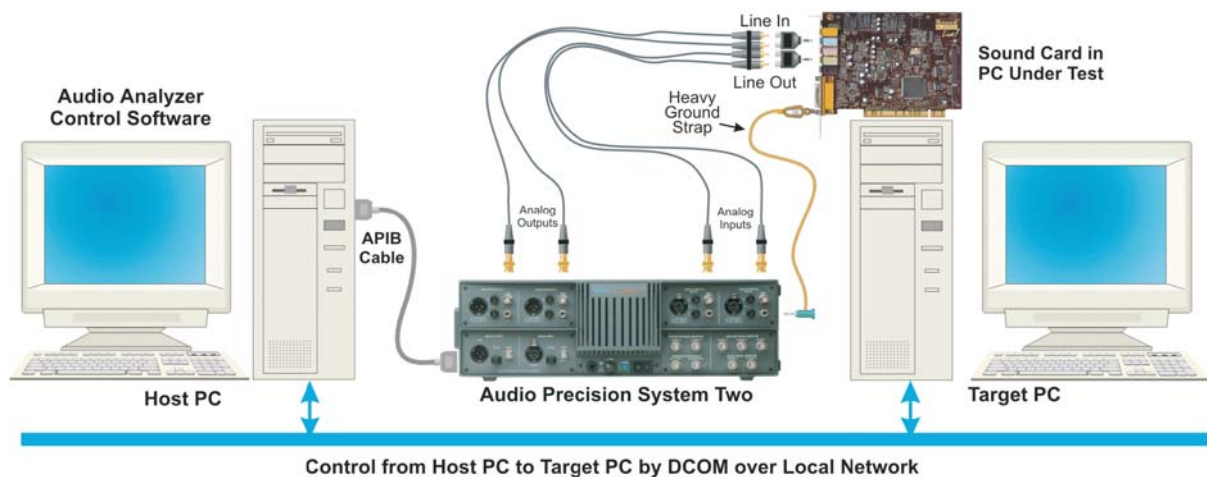


**Fig. 5.** PC to DA to AD to PC

**Fig. 6.** Test setup

## 4. MEASURING RESULTS

During our test, three different sound cards were measured on the same test PC, and the measured results were compared. The measurements were made through A-A path.

Those cards are:
a.) Realtek ALC 662 6-channel High definition Audio Codec, integrated on motherboard ASUS P5KPL-VM
b.) Creative Labs Audigy SE on PCI bus
c.) Tascam US-144 on USB port

The measurements were made with AudioPrecision System Two measuring equipment, according to the test setup shown on the Fig. 6.

### 4.1. Frequency response

The frequency response was measured for the whole audio bandwith, and it was flat through, on + 3dBr for Realtek ALC 662, +2 dBr for Creative Labs Audigy SE and +16 dBr for Tascam U144.
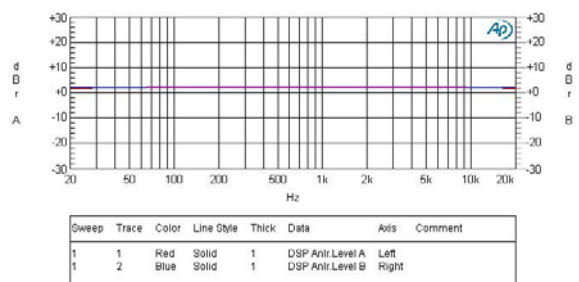Some of the results and comments are shown hereafter.



**Fig. 7.** Frequency response for CL Audigy SE

### 4.2. Distortion THD+N

The THD+N distortions were measured 4 times for each card. The frequency range was 20 Hz to 20 kHz, but the input signal level was changed in 4 different levels: 50 mV, 100 mV, 200 mV and 400 mV [2]. The measurement were made separately for each channel on all three cards.
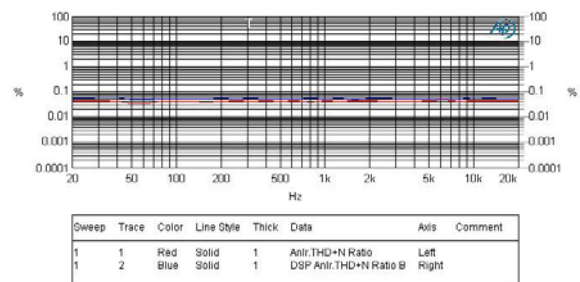Some of the results and comments are shown hereafter.
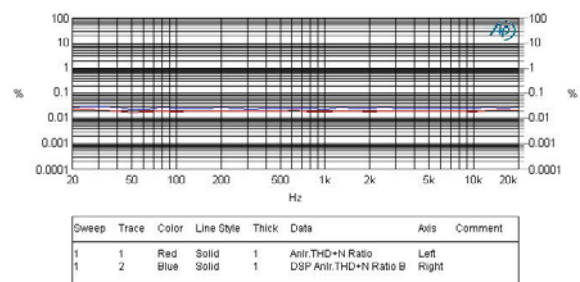


**Fig. 8.** THD+N, Realtek ALC 662, 100 mV
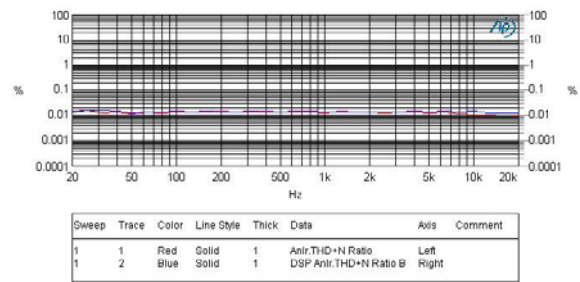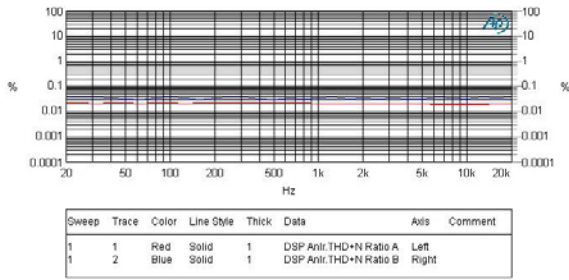


**Fig. 9.** THD+N, Realtek ALC 662, 200 mV



**Fig. 10.** THD+N, Realtek ALC 662, 400 mV

**Fig. 11.** THD+N, CL Audigy SE, 200 mV

For example, if we compare the results on Fig. 9. and Fig. 11, we can see that THD for CL Audigy is 0.021-0.04% (L/R), compared to 0.02-0.025% on Realtek (L/R), what means that difference between left and right channel are bigger on CL Audigy then on Realtek.

### 4.3. S/N ratio

The results of S/N ratio are as follows:

Realtek ALC 662
Ch A: 80.61 dB below 5 dBV ref. level (THD+N 1%), input level 453 mVrms (10 Hz – 22 kHz).
Ch B: 78.88 dB below 4.62 dBV ref. level (THD+N 1.04%), input level 459 mVrms (10 Hz – 22 kHz).

CL Audigy SE
Ch A: 86.71 dB below 1.44 dBV ref. level (THD+N 1.01%), input level 895 mVrms (10 Hz – 22 kHz).
Ch B: 82.43 dB below 1.48 dBV ref. level (THD+N 1.03%), input level 893 mVrms (10 Hz – 22 kHz).
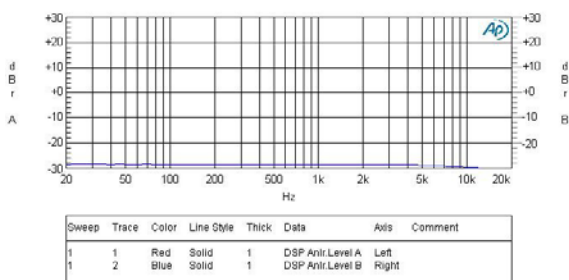
Tascam US-144

Ch A: 91.8 dB below 11.87 dBV ref. level (THD+N 1.004%), input level 2.29 Vrms (10 Hz – 22 kHz).
Ch B: 91.5 dB below 11.89 dBV ref. level (THD+N 1.003%), input level 2.096 Vrms (10 Hz – 22 kHz).

### 4.4. Crosstalk

During the Crosstalk measuring on the one channel the signal 0 V is connected to A channel, and 400 mV to the B channel. After that the signal connection were changed, meaning that 400 mV signal is connected to A channel and 0 V to B channel.
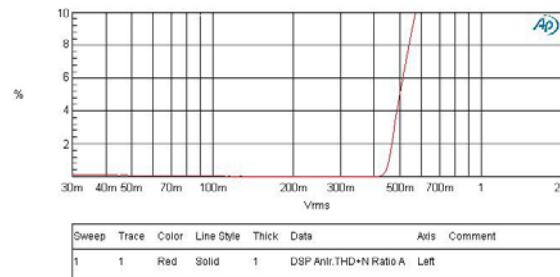


**Fig. 12.** Xtalk RL, Tascam US-144

### 4.5. THD vs. Amplitude

The measurements of THD vs. Amplitude were made for all systems, but in this paper only the results for left ch. of CL Audigy SE and Realtek ALC 662 are shown. As we can see, THD can grow up to 6-10% for different input level on different cards.
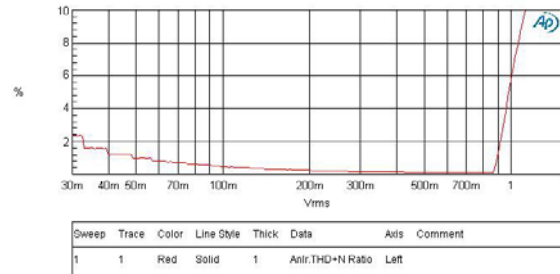


**Fig. 13.** THD vs. Ampl., CL Audigi SE, Ch. L.



**Fig. 14.** THD vs. Ampl., Realtek ALC 662, Ch. L.

### 5. CONCLUSION

While the technology of PC audio devices enables parity with conventional high quality audio systems, it is not without its potential problems. The PC must share its resources with many other tasks and applications. The electronic environment is inherently hostile and noisy compared to conventional audio components, which are packaged to optimize the rejection of interference sources and other contributors to signal degradation.
Our test and measuring confirmed this state.

### REFERENCES

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