PC Sound Card as an Audio Measuring Device

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Abstract - Possibilities and quality of modern PC sound cards are increasing. New sound cards offer 24-bit quantization and higher sampling frequencies, which in some cases are going up to 196 kHz. In theory this makes them comparable with professional audio measuring devices. Praxis is somewhat different because of some characteristic problems that occur in PC environment. Noise is the largest problem, which affects dynamic range of a sound card, especially those in computer cases. Sound cards, which connect through USB port, are somewhat less affected with this problem. Other problems include generation of signals with small distortion, small voltage range and similar. This article makes a comparison of the professional audio measuring device and three sound cards. All were used to make standard measurements on audio devices and their results were compared and analyzed.

I. INTRODUCTION

What makes a good audio measuring device? At first, its electrical and audio characteristics should be better than audio device, which is measured. If one measures CD player with 16-bit quantization, it should use measuring device with higher quantization, for example 24-bit. Frequency range of CD players is 20 kHz, so measuring device, which is used to measure a CD player must have larger working frequency range than CD player. Modern sound cards satisfy these basic requirements, and therefore can be used as measuring device. But question arises to what extent? We will try to answer this question in this article.

The largest problem with PC sound cards is noise. Although, large efforts are made to decrease noise in PC cases, this is still the big problem. Large numbers of ventilators used for cooling, numerous moving parts (hard discs, DVD and CD players) are all big electric noise generators and sources. Switching supplies, with their high frequencies are also noise generators. All of them influence quality of a sound card placed in computer case. USB sound cards have fewer problems with noise, but are limited in other way, because of smaller bandwidth of USB interface. Smaller data transfer bandwidth limits the highest sampling frequency and number of simultaneous audio channels.

We compared three sound cards with measuring device AudioPrecision System Two. This device is considered as a reference for measurements on various audio devices, and includes all standardized measurements. The first sound card was internal, cheep model with 16-bit quantization and maximal sampling frequency of 48 kHz. The second was USB model with 16-bit quantization and the same sampling frequency. The third was multichannel soundcard with balanced inputs and outputs, 24-bit quantization and 96 kHz sampling frequency. Electrical part of this sound card is connected with PC through IEEE1394 port, which ensures enough bandwidth.

II. SOUND CARD MEASUREMENTS

Before measurements with sound cards, we made measurements of sound cards. In this way we could compare their electrical characteristics to the same characteristics of professional measuring device. Sound cards can be measured in three basic ways.

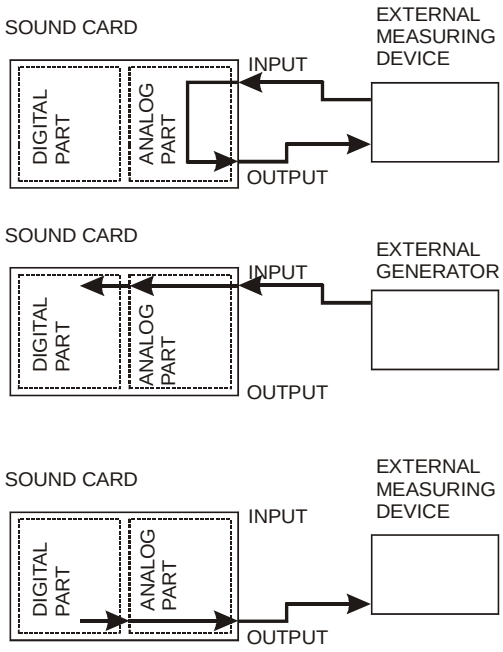

Figure 1: Three methods for measurements of sound card's characteristics.

One way is to measure only analog part, where external generator is used, and test signal is passed through only analog part of a sound card. In this way one can measure and analyze electrical and audio characteristics of the input and output of a sound card. Signal does not reach the digital part, where signal processing takes place. This analog part mainly influences on distortion and noise generation, and dynamics. The second method uses external source of test signals, and computer acts as measuring device. In this way one can analyze only the

input of a sound card, its sensibility and voltage range. Sampling frequency of a A/D converter determines upper frequency limit. The third method uses sound card's generator as the source of test signal, and external measuring device. In this way one can test output characteristics of a sound card, how well signal are generated, signal to noise ratio, etc.

Figure 1 shows schematics of all three methods. The first method gives overview of both input and output of a sound card. The second gives overview of input, and the third of output. If sound card is used as an audio measuring device than both input and output must be considered.

In order to measure common audio devices, sound card should be able to measure frequencies to at least 20 kHz. Figure 2 shows measured frequency characteristics of three used sound cards. As can be seen modern sound cards satisfy first condition. Their frequency characteristics are flat form 10 Hz do 20 kHz or more. Upper frequency limit is determined by sampling frequency. According to Nyquist, sampling frequency must be at least two times higher than maximal frequency of audio signal. Sound cards with sampling frequency of 96 kHz, are not rare anymore, so their frequency range can be extended to 48 kHz, which is higher than audible range.

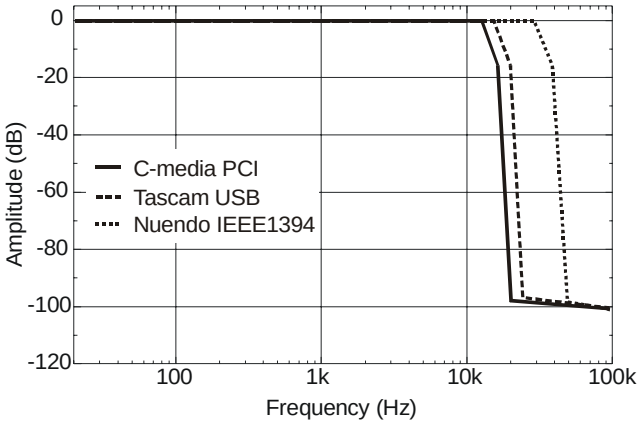

Figure 2. Frequency characteristics of three used sound cards.

Second condition is low level of distortion during measurements and during generation of test signals. To measure distortion level of modern audio devices, distortion generated by a sound card must be as low as possible. In a world, where audio amplifiers have harmonic distortion lower than 0,01%, it is very hard to construct sound card that has better characteristics than this. Figure 3 shows harmonic distortion measurements versus output level on used sound cards. Instead of distortion percentage, level of distortion harmonics was measured. This method gives better overview of distortion level at low voltage levels. It can be seen that professional sound card has the best characteristics.

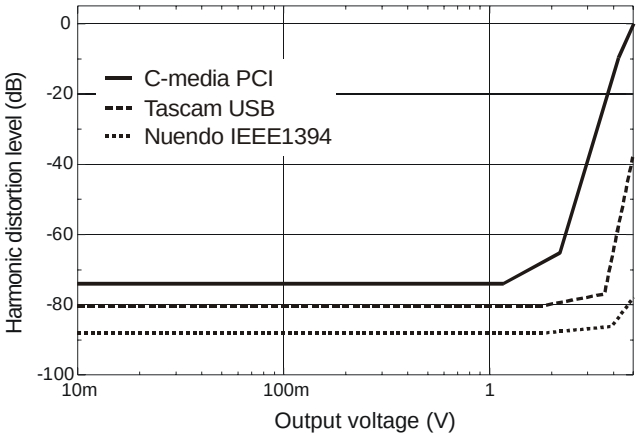

Figure 3. Harmonic distortion level versus output voltage of three used sound cards.

The biggest problem with sound cards is dynamics. Higher level of noise and increasing distortion at higher outputs limits dynamic range. In order to measure modern audio devices, sound cards must have dynamic range of 100 dB or more, which is hard to achieve. Table 1 shows results of dynamic range measurements of used sound cards. Only one sound card satisfies condition for dynamic range.

Table 1

Results of dynamic range measurements of used sound cards.

	C-media PCI	Tascam USB	Nuendo IEEE1394
Measured dynamic range (THD<1%)	68 dB	89 dB	102 dB

III. MEASUREMENTS ON AN AMPLIFIER

In order to compare three sound cards with professional measuring device, we made some basic measurements on a power amplifier. Amplifier used, is stereo amplifier with rated power of 300 W on 8 Ω load.

Sound cards served both as the generator and measuring device. Their output was connected to the input of the amplifier, and output of the amplifier to the input of the sound cards. Voltage divider is used to protect input of the sound cards, because of their smaller voltage range. Test signals were generated using Matlab and measurements and analysis were made in Matlab. Measured signals were recorded in WAV format and transferred into Matlab, where they have been analyzed.

All measurements were made according to valid IEC standards concerning audio measurements.

Figures 4, 5, 6 and table 2 show results of measurements. Figure 4 shows results of measurements of frequency characteristics for rated power output. It can be seen that all three sound cards gave the same results, which correspond to the measurement results of the professional measuring device.

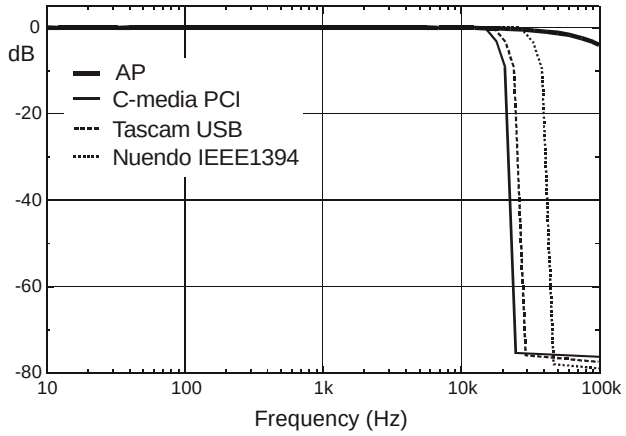

Figure 4. Amplifier's frequency response measured with professional AP measuring device and three sound cards.

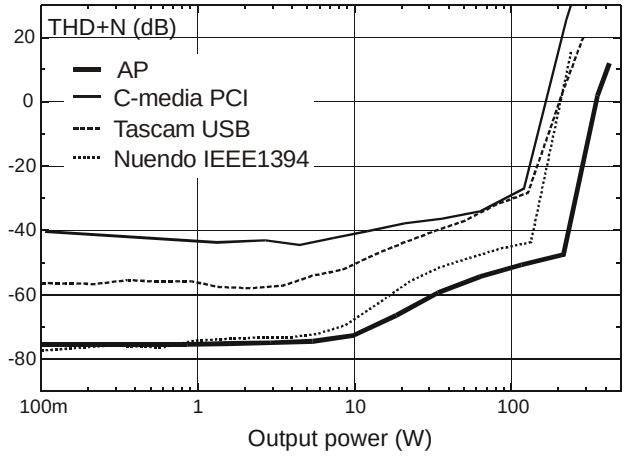

Figure 5. THD+N value measured on the amplifier with professional AP measuring device and three sound cards.

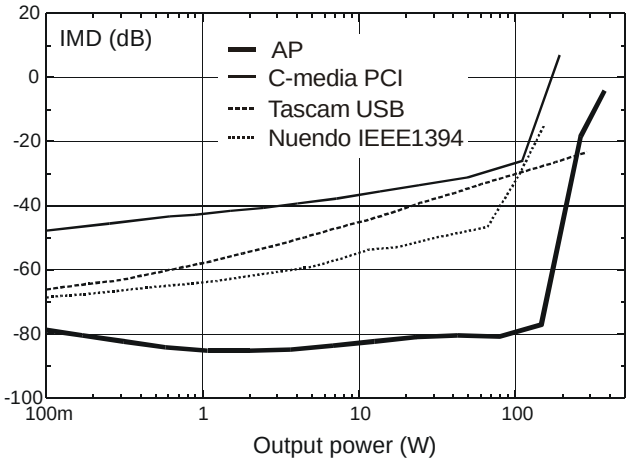

Figure 6. IMD value measured on the amplifier with professional AP measuring device and three sound cards.

Figures 5 and 6 show results of measurements of harmonic and intermodulation distortion. In this case differences are more obvious. Results show that only professional sound card Nuendo could be compared to the professional AP measuring device. Differences are even bigger when dynamic range is measured. Higher noise level can significantly influence signal to noise ratio and dynamic range measurements.

Table 2
Results from the measurements of amplifier's dynamics with professional AP measuring device and three sound cards.

	AP	C-media PCI	Tascam USB	Nuendo IEEE1394
Measured dynamic range of the amplifier (THD<1%)	108 dB	90 dB	82 dB	76 dB

IV. CONCLUSION

Results show that sound cards can be partially used as an audio measuring device. Their analog inputs and outputs still cannot be compared to the inputs and outputs of a professional measuring device. Although, some sound cards come close to them. The main problems are noise level, distortion and dynamic range. Computer case is not suitable place for a sound card, which is used for audio measurements, because of numerous noise sources. Better results can be achieved with external sound cards, such as USB or IEEE1394 models. Generally speaking, sound card must have at least 100 dB dynamic range, low distortion level, below 0,1% of harmonic distortion for both input and output circuits. For most modern sound cards frequency range is not a problem.

From obtained results, most of sound cards can be used as an audio measuring device for nonprofessional purposes and if device to be measured has worse characteristics than the sound card. Only professional external sound cards satisfy most of the conditions.

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