CP AUDIO PROJECTS

Technical paper #3

Passive and active sound reproduction systems on example of the «NOVA-Utopia» and «NIDA Mk1»

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„CP AUDIO PROJECTS“,
Kaunas, 2012

Have you ever heard the silence of music playing on Your sound system?

And while listening to the applause, could You differ which one is men's and which one is women's, whether those hands are wet, in which location of the hall is the listener?

Did you experience the tickles in your belly while listening to music at maximum sound, same as we normally feel on the rock - concert?

You've probably realized that I intend to fix your attention towards high sensitivity horn systems, and why a properly design one will allow your speaker to reproduce the widest variety of music recordings with the best possible fidelity.

In this paper I will make an effort to reveal the difference between consumer and professional horn systems by presenting a comparative evaluation of key measurements and acoustic parameters of a highly respected passive system the FOCAL "NOVA-Utopia" and the active horn based system by our Company, the "NIDA Mk1".

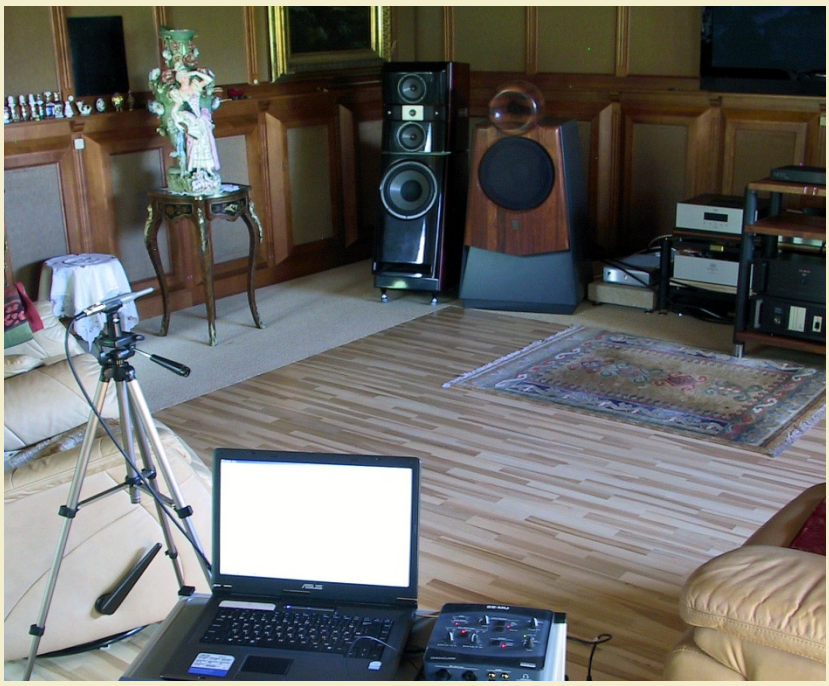
I have long sought an answer to the question of - why do the majority of so called hi-end audio systems sound so poor? I'm not just talking about uneven frequency response, but about the sense that the sound is not pure in the way live music is and that what we are hearing is the distortions inherent in the loudspeaker. Recently I had the opportunity to measure the basic parameters of the Focal NOVA-Utopia in an acoustically good room, and compare the Focal speaker directly with the NIDA Mk1. The measurement results and conclusions drawn are the basis for this paper, the first of several to follow to explore the topic of how to design a system that can transport us to experiencing music at the highest level.

NOVA-Utopia is a high-quality passive home system, and the NIDA Mk1, an active horn system using professional drivers. When listening to any record on the NOVA-Utopia it is not difficult to realize that the loudspeaker does not correctly reproduce the low frequencies with the following notations:

- the level of bass region raised, heard "mumbling", and the first musical octave (20-40 Hz) unable to play at proper intensity and in proper balance with the rest of the musical spectrum
- high frequencies are also raised, but the main thing problem is the sound is lacking in clarity, mainly due to distortions inherent in the design resulting in listen fatigue and a lack of desire to listen at realistic levels (I call this experience - "the common sound of domestic playback systems."

The measurements were performed using high caliber measuring equipment including:

- microphone dbx RTA-M;
- audio interface CREATIVE E-MU 0404 USB and computer;
- SPL meter MASTECH MS6701.



The microphone was established in the central listening position, with the distance from the front of the speaker to the microphone set at 11 ft. The sound pressure level chosen is at a level we commonly listen to soft music at -70 dBC.

Since the aim of taking these measurements were not absolute values of a particular system, the calibration level SPL was not done. Irregularity of frequency response and THD level of the microphone, power amplifiers and sound controller, compared with the acoustic system is making a minor error, so these effects were not considered. In order to verify the conclusions, two-way acoustic system ADS L10 was also measured to confirm the results achieved were not skewed by something other than our focus on the two loudspeakers under consideration for this paper. The results of measurements of this small system are also presented below.

For easier comparison of the results, the data transferred to the Linear-X "LMS" see the chart below.

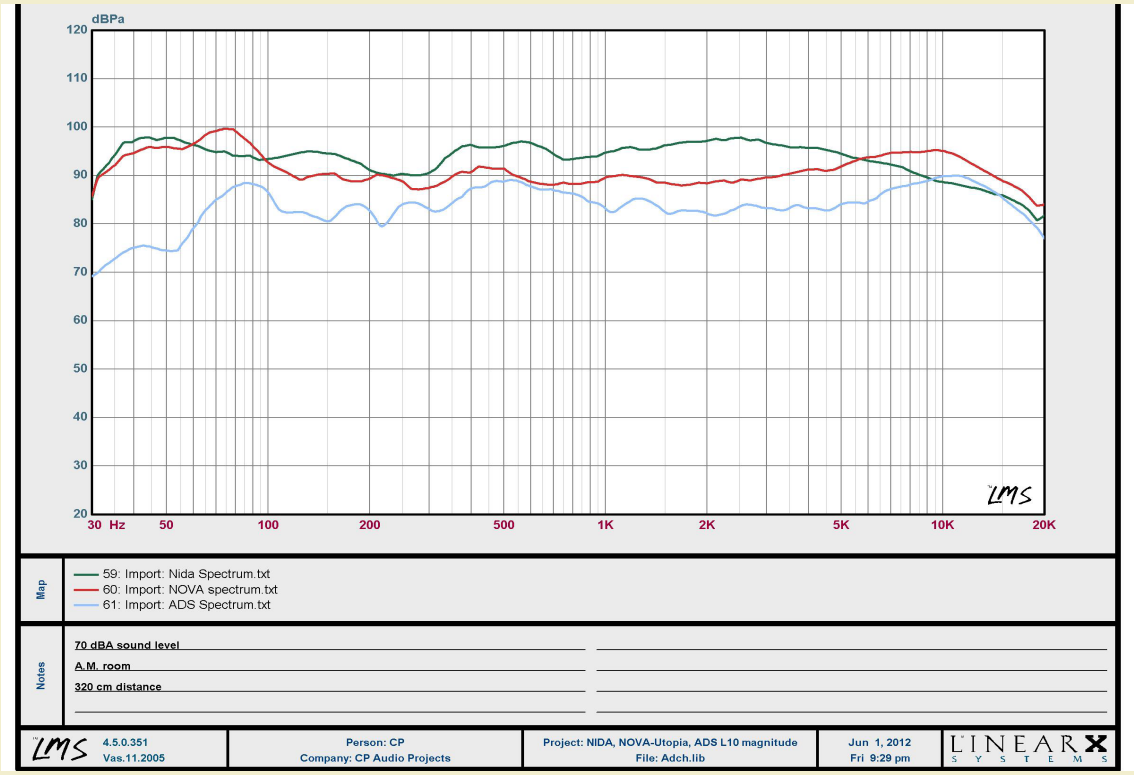


Figure 1. Frequency response of the systems:
NOVA-Utopia - red, NIDA Mk1 - green, ADS L10 - Blue

NOVA-Utopia has the rise of the frequency response (hereinafter - FR) approximately +10 dB at 75 Hz. A similar result is presented in Stereophile. Reproduction of high frequency signal also has a lift +6 dB at 10 kHz. The total irregularity in the frequency band 30 Hz - 15 kHz is 13 dB.

Irregularity of frequency response of NIDA Mk1 is less. The system has a smooth decrease in the FR area of the upper decades of this type, which is recommended for recording studio monitors. For more information about recommendations for monitors you can read the Altec Lansing "Technical Letter No.232A".

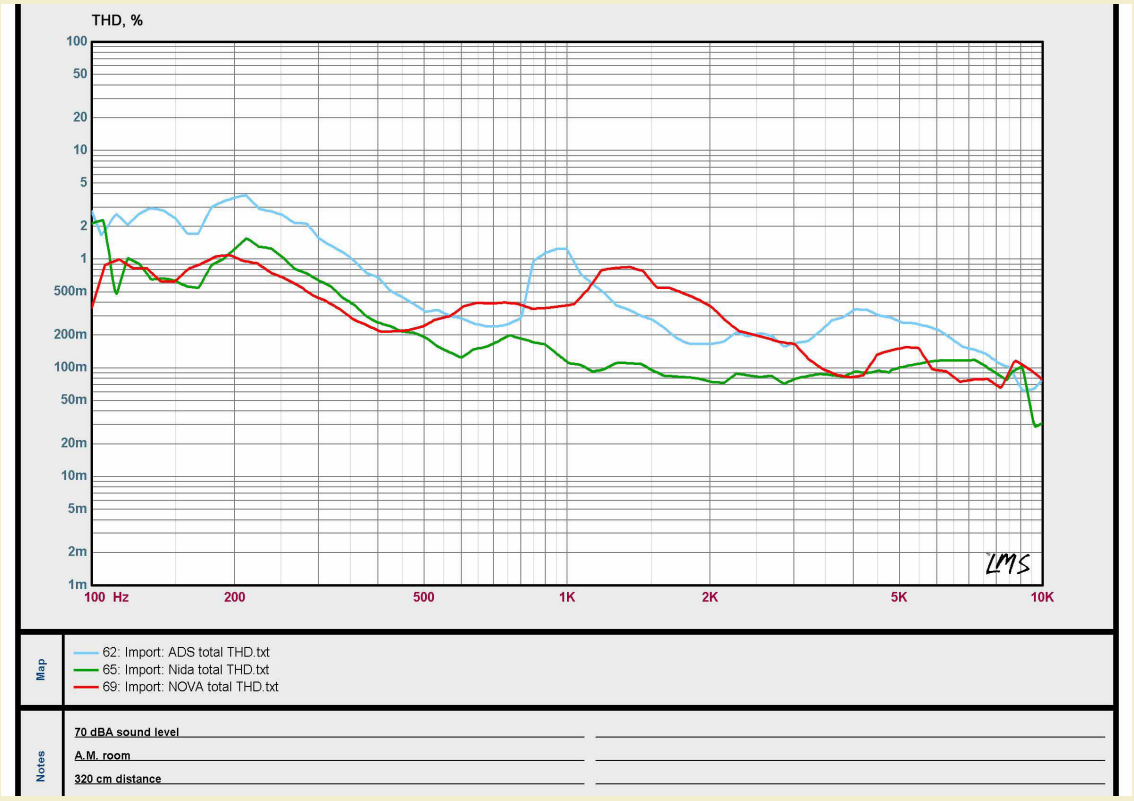


Figure 2. Total harmonic distortion (THD) of systems:
NOVA-Utopia - red, NIDA Mk1 - green, ADS L10 - Blue.

Compared with the NOVA-Utopia, NIDA Mk1 system has a much lower level of THD in the zone of maximum sensitivity of our hearing. By comparison with the large systems, small system ADS L10 has maximum THD.

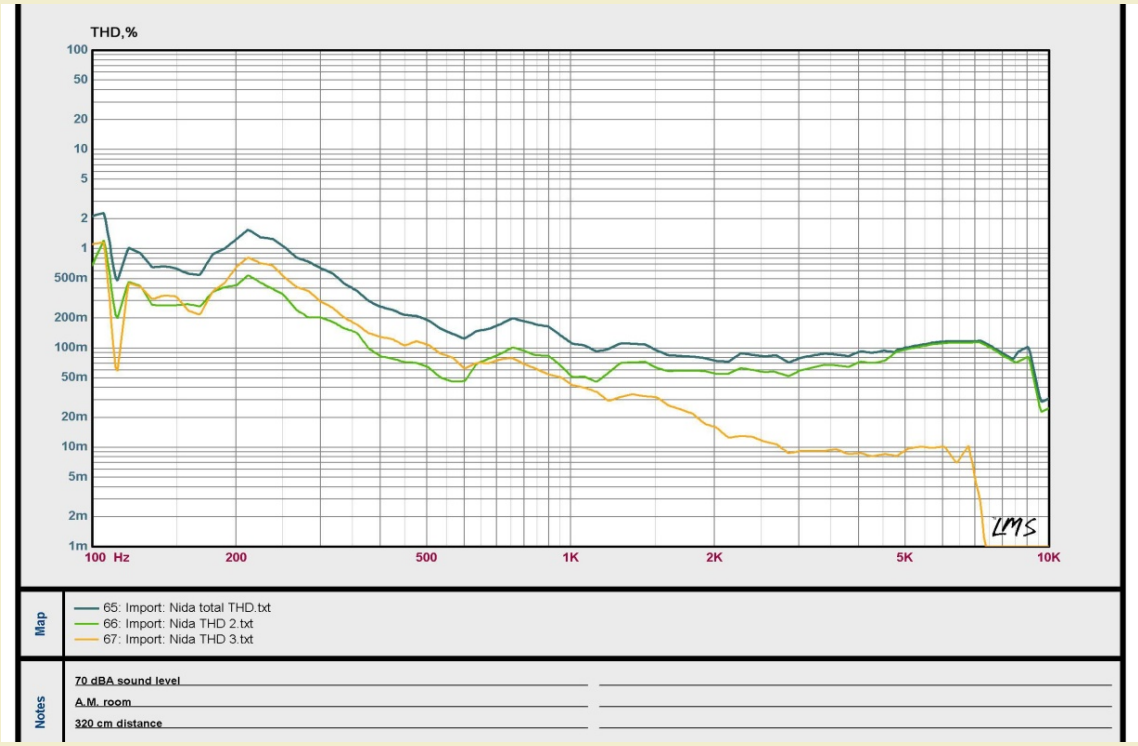


Figure 3. The components of harmonic distortion of NIDA Mk1:
THD - dark blue, the second harmonic of D2 - green, third harmonic D3 – Yellow

Measurements show that the THD of the system NIDA Mk1 basically determined by the level of the second harmonic D2. On the other hand, in the range of maximum degree of sensitivity for our hearing, the level of third harmonic D3 of NIDA Mk1 is very low (~0.01%). It is known that even harmonics are symmetric, perceived by our ears better than the odd (asymmetric). Without going into details of psychoacoustics we can say that the second harmonic is not perceived as a distortion, but as an additional music signal, which is an octave higher. Another consideration is that odd harmonics contribute to sound with unnatural color and harshness.

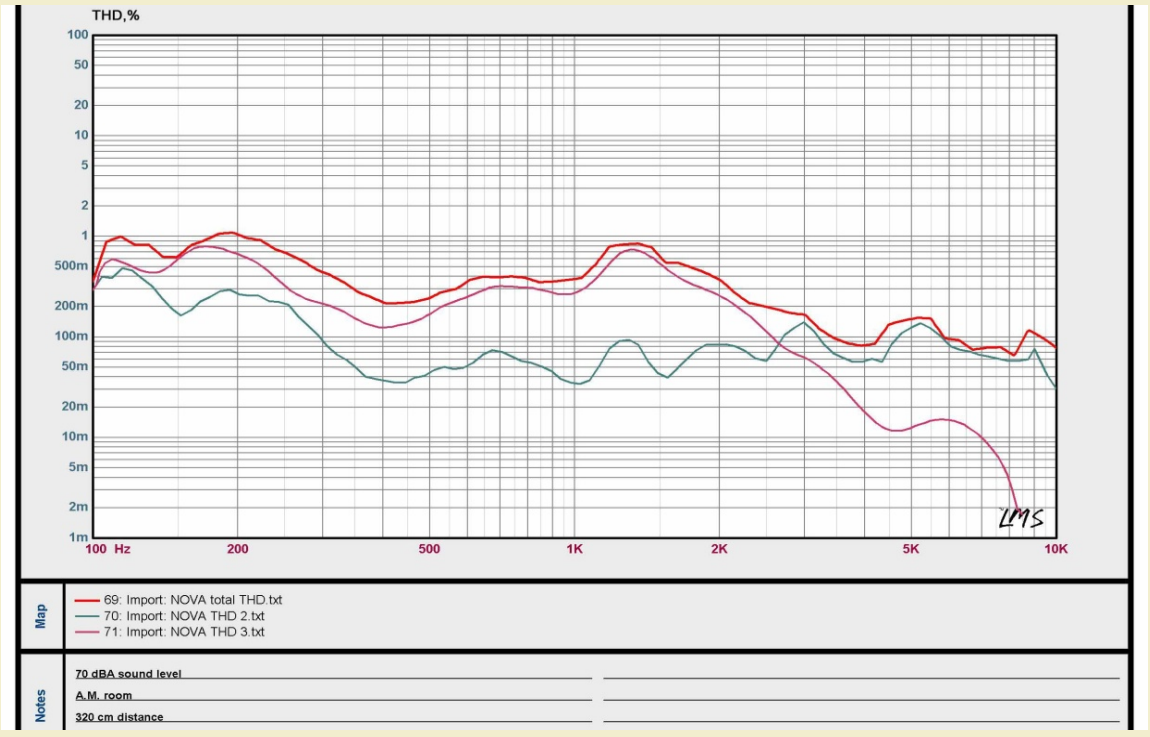


Figure 4. The components of the nonlinear distortion of NOVA - Utopia:
THD - red, the second harmonic D2 – purple, third harmonic D3 - a dark green

Here we have another situation where the overall level of distortion THD is mainly determined by the level of the third harmonic D3.

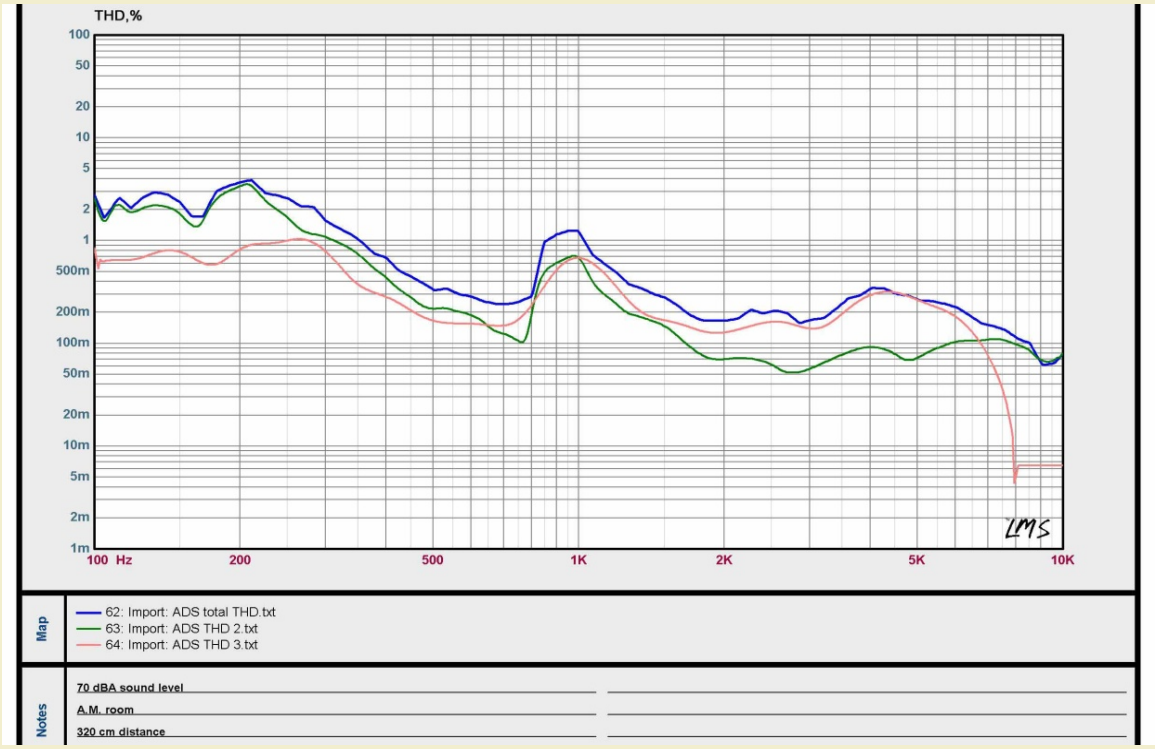


Figure 5. The components of the nonlinear distortions for the system ADS L10:
THD - blue, the second harmonic D2 - green, third harmonic D3 – pink

As in the case of NOVA - Utopia, the major share the distortions of ADS L10 is also the third harmonic D3.

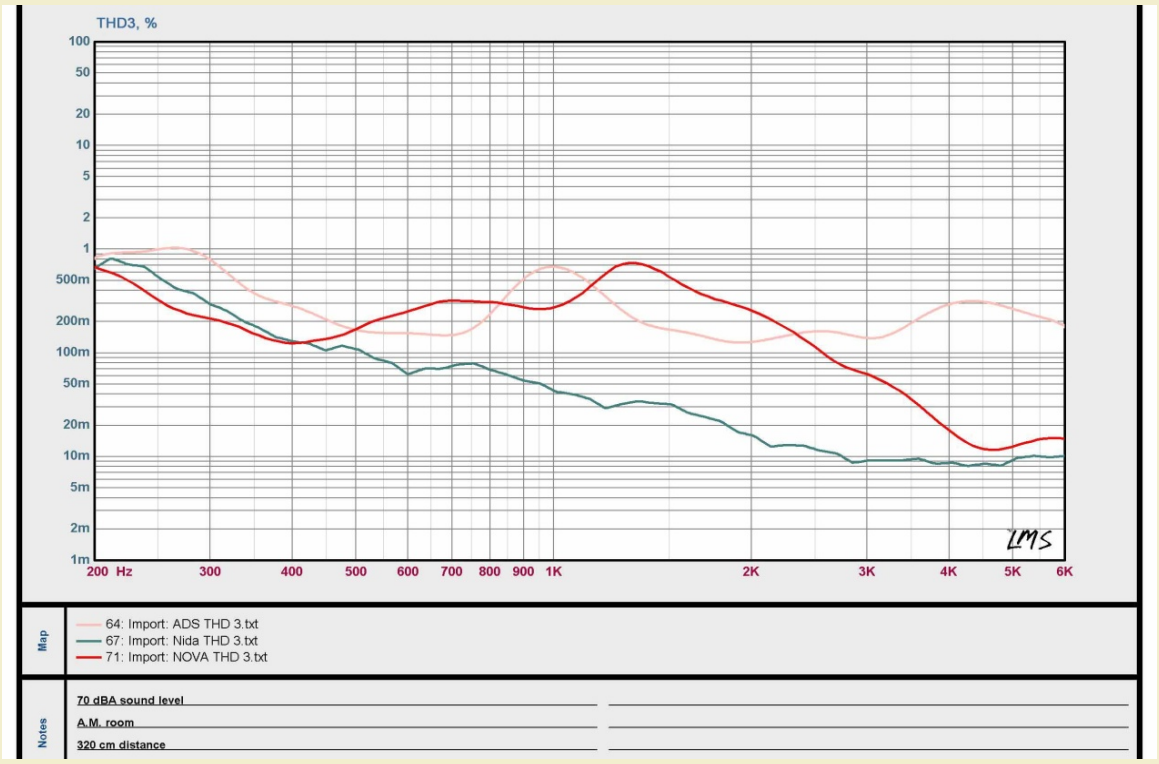
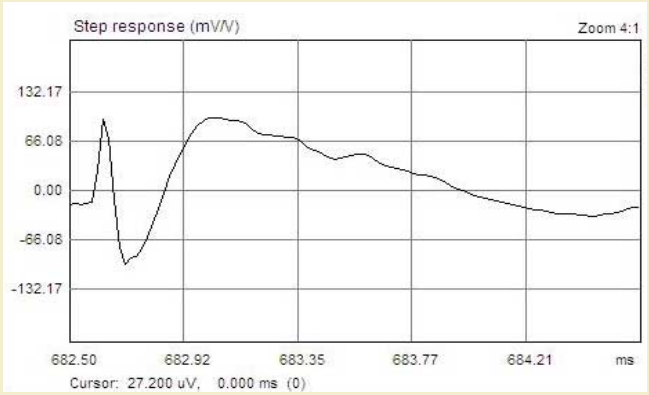


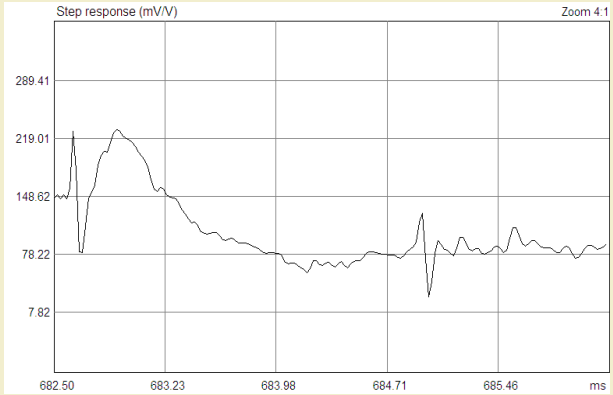
Figure 6. Value of the third harmonic D3 for all systems:
NIDA Mk1 - green, NOVA-Utopia - red, ADS L10 - pink

Compared with other systems, the NIDA Mk1 has the lowest level of odd harmonics of D3.

In addition to nonlinear distortion, each speaker also emits acoustic distortion. To evaluate this type of distortion, we use the impact of the pulse front (Step Response) and "blow" the system by the broadband spectrum (“Water-fall” or Cumulative Spectral Decay).

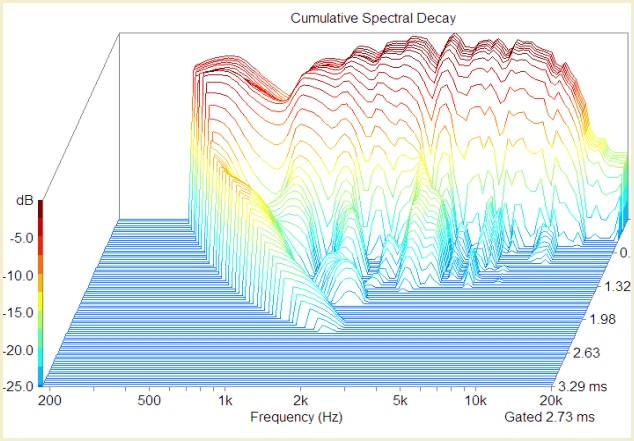


NIDA Mk1

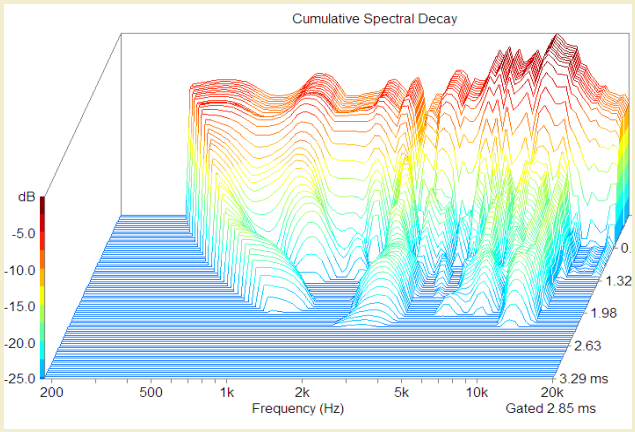


NOVA-Utopia

Figure 7. Step Response of both systems after the impact of the pulse in period of 3 ms



NIDA Mk1



NOVA-Utopia

Figure 8. Waterfall charts show how quickly the process ends in each of the systems after the action of broadband spectrum

In comparison with NOVA - Utopia Step Response of system NIDA Mk1 is smoother, and Waterfall spectral emission is completed faster. This shows that the speakers and the body of NIDA Mk1 emit less parasitic acoustic distortion.

In fact, the system NIDA Mk1 «calm down" after 1.5 ms, and at high frequencies, these processes subside to the level of -25 dB for 1 ms. For system NOVA - Utopia, these distortions are continuing longer (about 2 ms).

It should be noted that the results of these measurements in a particular case, are affect by the acoustic properties of the room.

Now we can answer the question - why the system NIDA Mk1 play musical recordings in better quality?

The main advantages of high sensitivity systems can be described as follows:

- high sensitivity drivers work in a linear mode, which allows to reproduce music with a very small level of compression;
- the spectrum of distortion is dominated by the even (symmetric) harmonics, because of that there is less impact on quality of music playback;
- the level of the odd (asymmetric) harmonics of these systems is much lower and has a monotonically decreasing character;
- ultra high sensitivity compression driver with a diaphragm made of pure beryllium and round wooden horn gives the minimum distortion in the range of the upper octaves of music;
- in active systems there is no passive filters, so the signal from the output of power amplifier goes directly to the speaker drivers. This helps to avoid additional distortion.

Studio reference horn monitors KINOSHITA, MEYER SOUND or WESTLAKE AUDIO may serve as evidence of the mentioned advantages.

Conclusions:

1. Passive sound reproduction systems generally produce higher levels of odd harmonic distortion components. As we noted earlier, the ear perceives this distortion as unnatural and lacking in overall faithfulness to the sound of live music. The result is fatigue, and the inability to relax into your music, especially over the course of longer listening sessions.

2. A properly designed, high sensitivity, actively amplified horn system is able to reproduce music recordings with minimal distortion and an almost total lack of compression. Such systems are able to provide the highest quality playback of today's music recordings.

3. When music is played at higher volume levels, the difference between high sensitivity horn systems and less sensitive domestic systems becomes even more apparent.

References and links:

1. „Testing loudspeakers", Joseph D'Appolito. ISBN: 1-882580-17-6
2. „Loudspeakers For Music Recording and Reproduction", Philip Newell and Keith Holland. ISBN-13: 978-0-240-52014-8
3. „Equalization Techniques and Practices", Ted Uzzle. Altec Lansing Engineering Notes, "Technical Letter No.232A"
4. KINOSHITA RM-series far-field studio monitors
5. MEYER SOUND Linear control room monitor X10

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