Technical paper #4

AXIHORN CP5TB:
HF module for the high definition active loudspeaker system "NIDA Mk1"

Ceslovas Paplauskas

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More closely examine the work of HF Module AXIHORN decided after measuring the distortion of NIDA Mk1 system and compare the results with the FOCAL Nova-Utopia. The Technical letter #3 shows the results of measurements of NIDA Mk1 in the room. It is known that the acoustic parameters of any room affect the measurement result of the loudspeakers, so it was decided to repeat the measurements in open air. Open air measurements at high frequencies not concede in accuracy measurements in an anechoic chamber. One feature of this method - to hold them better at night, when all around quietly.

The measurements were performed using measuring equipment including:

- microphones dbx RTA-M and MK-12 condenser microphone with vacuum tube preamplifier and external polarizing supply;
- audio interface CREATIVE E-MU 0404 USB and computer;
- class-A power amplifier FORTE AUDIO Model 1a;
- SPL meter MASTECH MS6701.

In addition to the main measured object AXIHORN CP5TB, domestic dome tweeters were also measured. Since most of the dome tweeters have similar characteristics, the measurement results of only one such tweeter (VIFA PL27TG35) are presented herein.

To avoid reflections, the tested devices have been raised to the height of 90 cm, and the membranes were turned in the upward direction. The nearest side object that could affect the measurements was not closer than 2.5 meters away. This corresponds to five lengths of the lowest tested sound wave and ensures the accuracy of the required measurements. To maximize the accuracy, most of the measurements were carried out using a method of a stepped-sine signal, when a small (1/48 octave) frequency variation step is chosen. The measurement was carried out in a wider frequency range, but the results were presented in the range from 700 to 20,000 Hz.

Since the accurate measurements using stepped-sine signal takes a long time, for the reduction of extraneous noises, more sensitive condenser microphone with cardioid characteristic was chosen. Microphone vacuum tube amplifier ensures 120 dB dynamic range and small distortions of measurement system. Two distances from AXIHORN mouth to the microphone were chosen: 50 cm and 130 cm. The amplitude of acoustic signal (SPL) was set to 70 dB @ 50 cm. This corresponds to silently listening to the music in a room. The signal was transferred directly to the HF driver.

Since the purpose of the measurements was not absolute parameters, SPL level calibration was not carried out. Distortions (THD) of power amplifier, sound controller as well as microphone's THD were not evaluated. In this case this does not have great influence on the assessment of the results and conclusions.

For a more convenient representation of the data, the results were transferred to the acoustic measurement system "LMS", Linear-X.

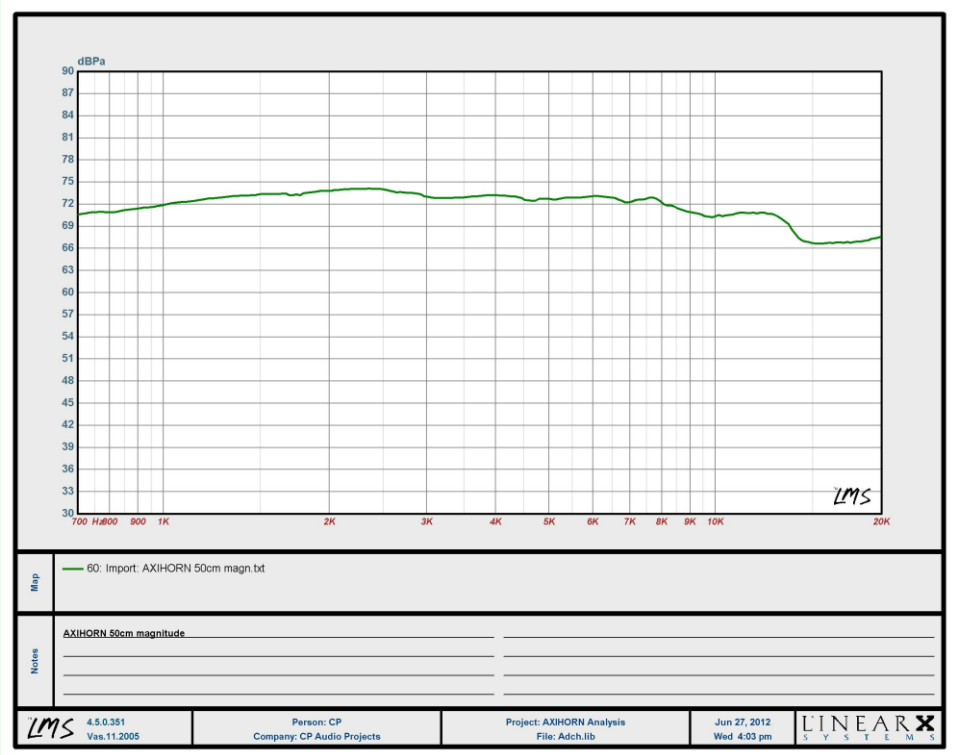

Fig. 1. AXIHORN CP5TB frequency response, measured 50 cm from the horn mouth

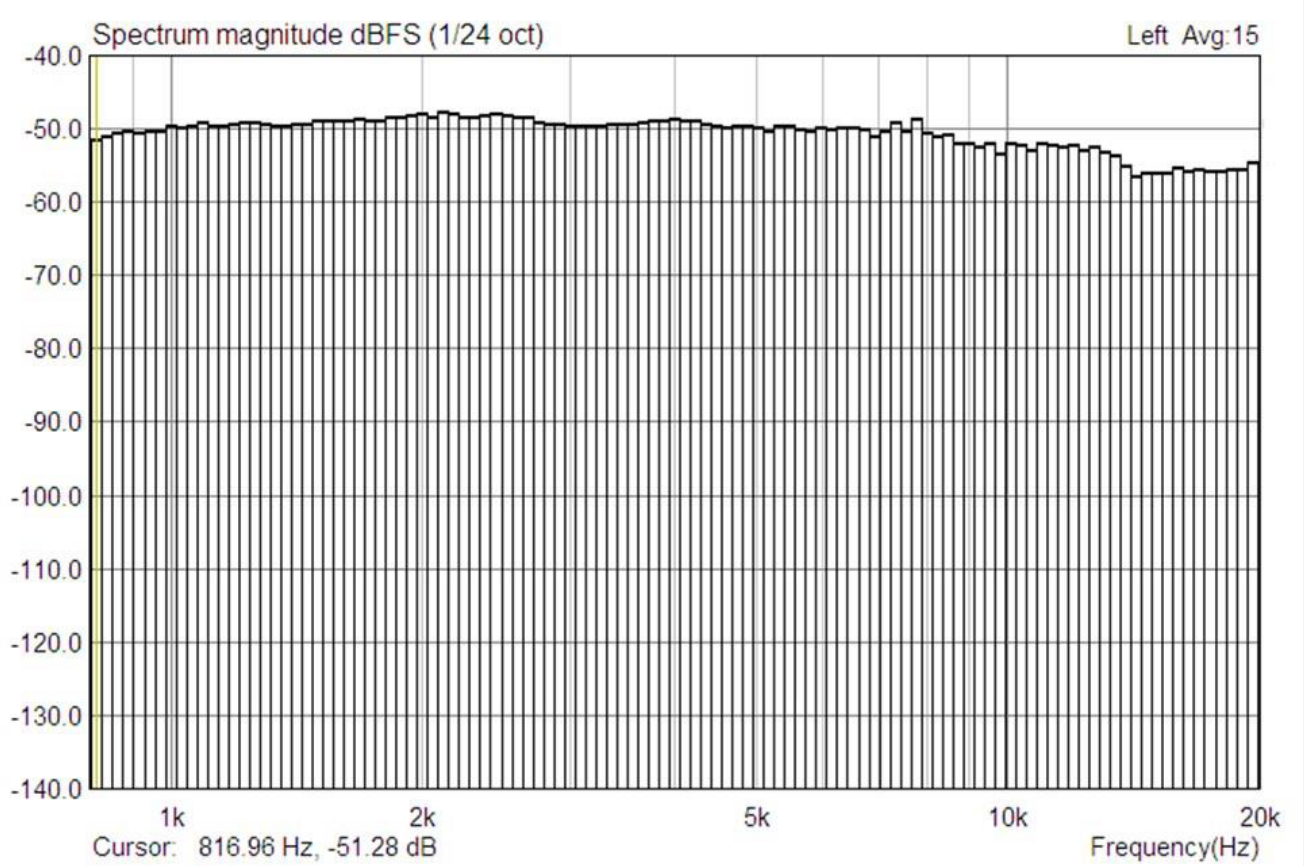

Fig. 2. AXIHORN CP5TB spectrum: pink noise signal, 1/24 oct. resolution

AXIHORN CP5TB is characterised with very smooth frequency response (FR) in the range from 800 Hz to 20 kHz. 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" (see Fig. 3.). A special insert-absorber is used in AXIHORN in order to form proper acoustical frequency response (Fig. 4). This allows avoiding the consequences, which are typical for electronic correction methods.

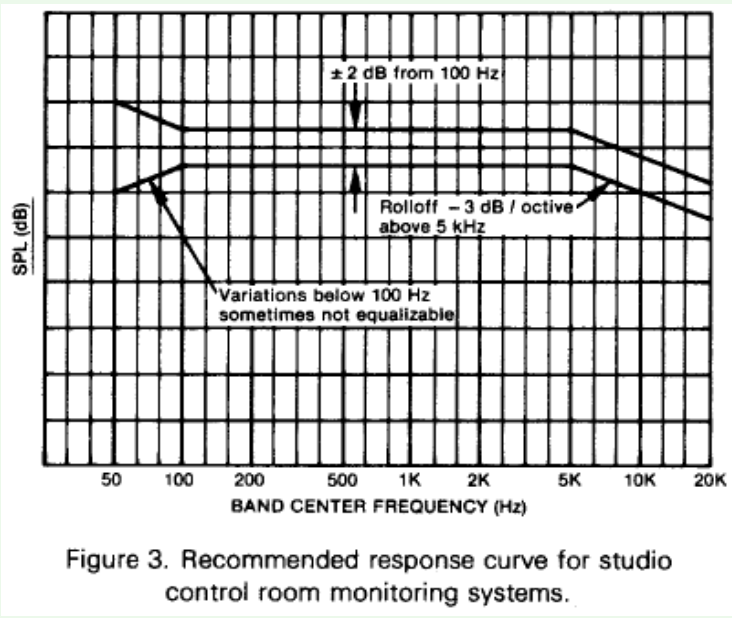

Figure 3. Recommended response curve for studio control room monitoring systems.

Fig. 4. Insert-absorber

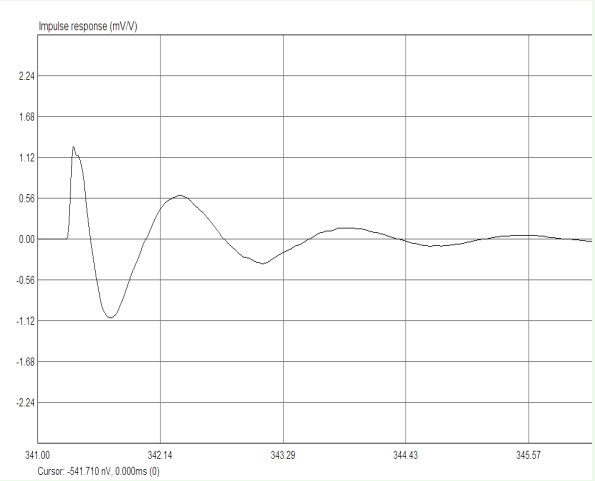

Fig. 5. AXIHORN Step response in 5 ms period

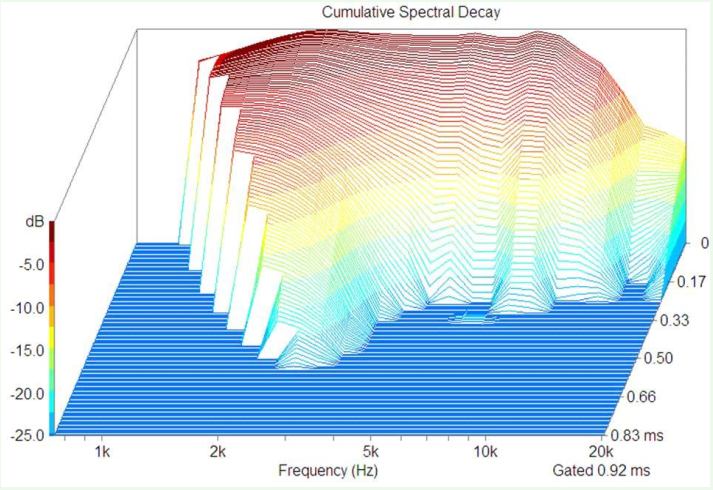

Fig. 6. „Waterfall" or Cumulative spectral decay

As seen from the graphs, AXIHORN CP5TB transition processes settle quickly and end smoothly. "Waterfall" graph indicates that after the pulse impact, the system transition processes end within 0.5 ms.

Graph below presents FR, provided by 1" dome tweeter and AXIHORN.

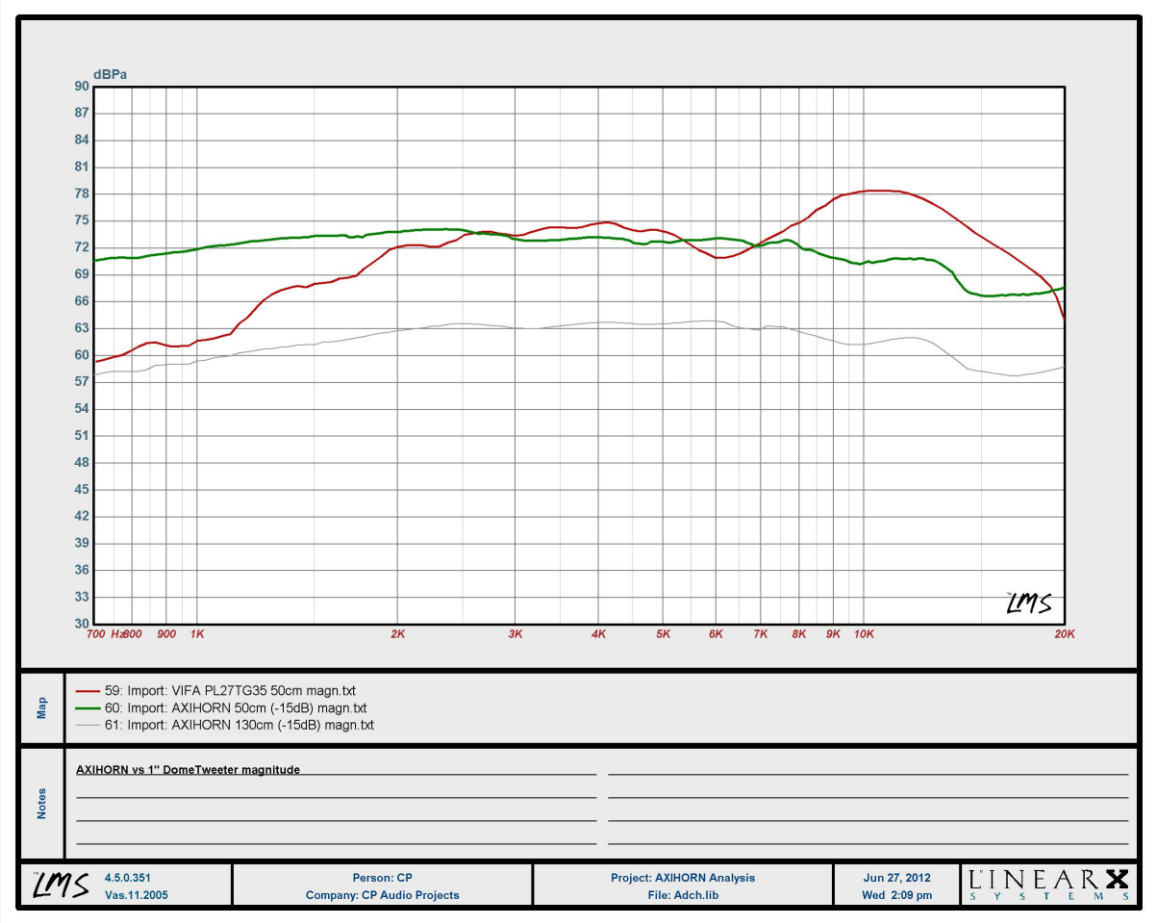

Fig. 7. Frequency responses of 1" VIFA PL27TG35 and AXIHORN CP5TB.
For easier comparison, AXIHORN graphs are vertically lowered by -15 dB.
Green colour represents the AXIHORN CP5TB, red - VIFA PL27TG35.
Grey colour - AXIHORN CP5TB when the microphone is in the distance of 1.3 m.

We see that in the higher distance the FR of the AXIHORN system changes insignificantly. When compared with 1" dome speakers, horn system has a significantly more uniform FR and this uniformity only slightly depends on the distance.

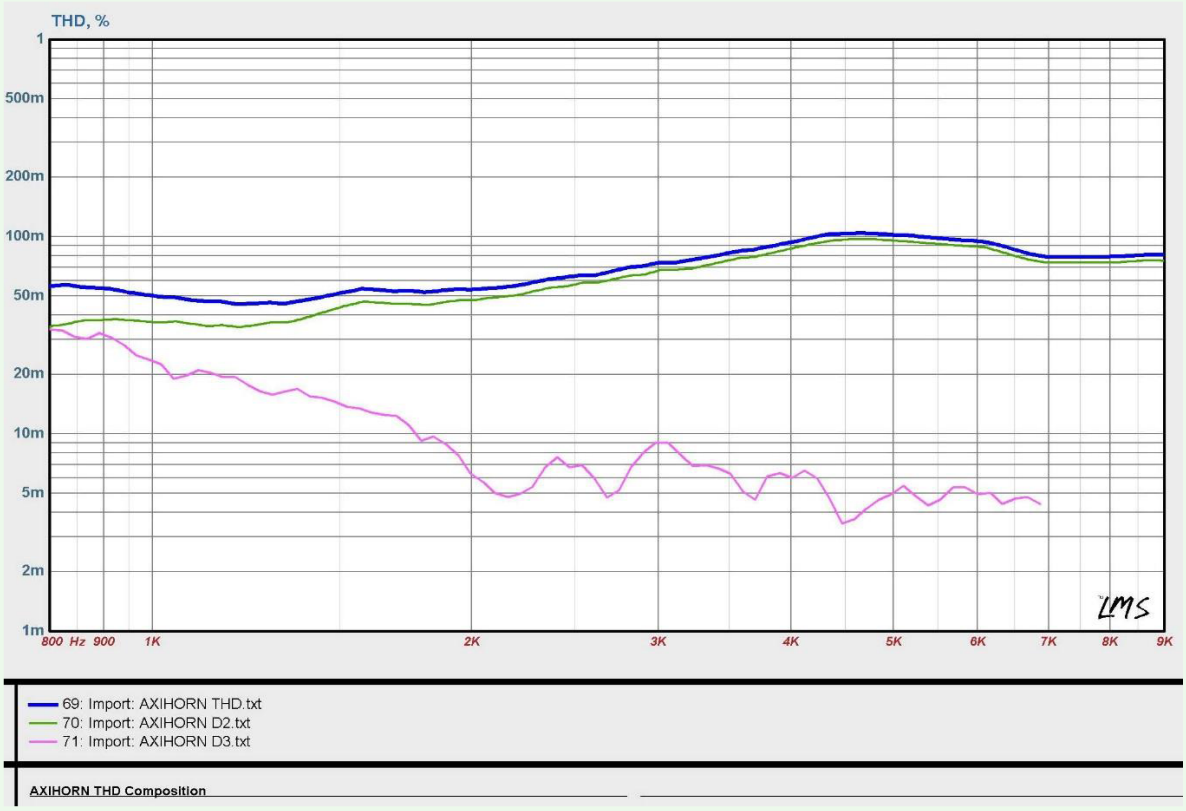

Fig. 8. AXIHORN CP5TB THD (blue) and distortion components: D2 – green, D3 – violet

In the most sensitive area of hearing AXIHORN CP5TB THD is very low (0,05 - 0,08%). It is important that in the THD spectrum, even (D2) harmonic prevail.

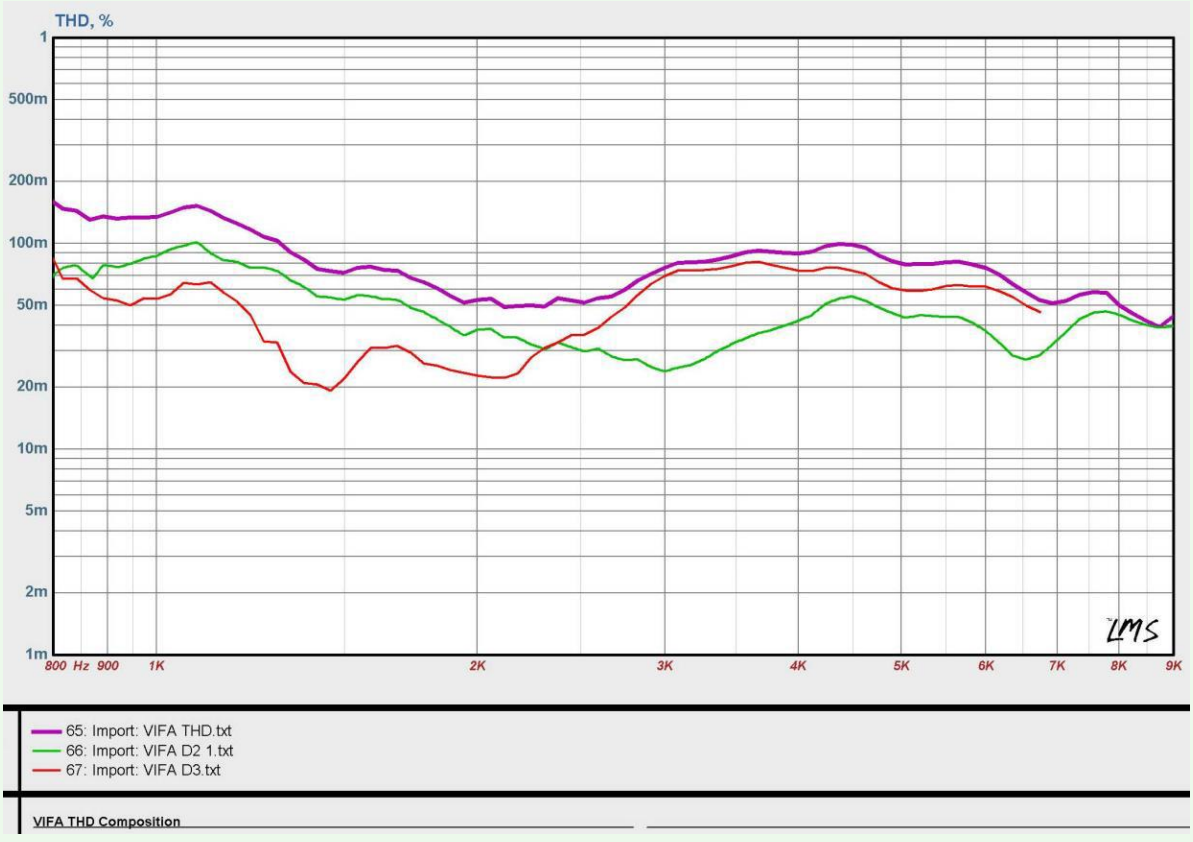

Fig. 9. VIFA PL27TG35 THD (violet) and distortion components: D2 – green, D3 – red

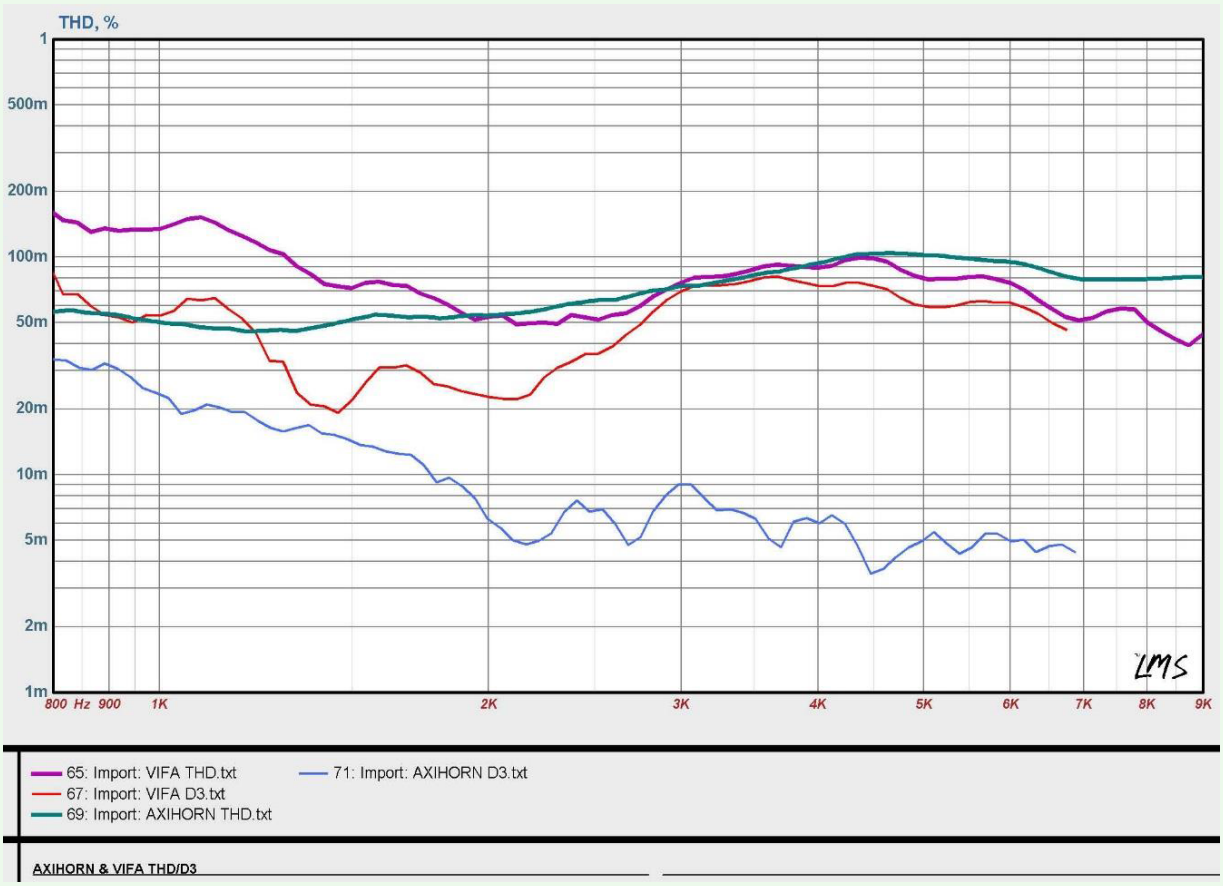

Fig. 10. AXIHORN CP5TB and VIFA PL27TG35 distortion measurements.
THD: AXIHORN – green, VIFA – violet.
Third-harmonic distortion D3: AXIHORN – blue, VIFA - red

1" dome speaker has a significantly larger odd (D3) distortions. Compared with even, the odd harmonics are less tolerated by human ear.

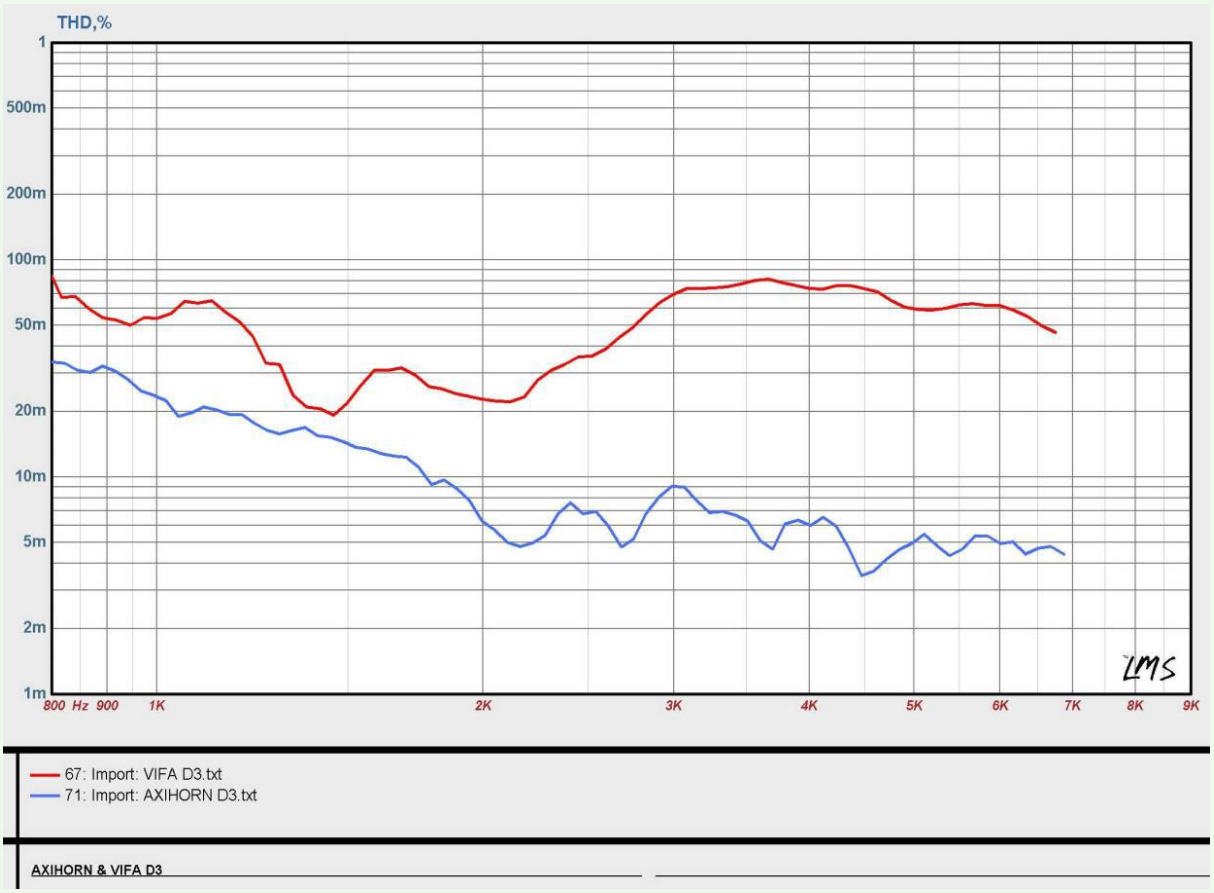

Fig. 11. D3 amplitude: AXIHORN – blue, VIFA PL27TG35 - red

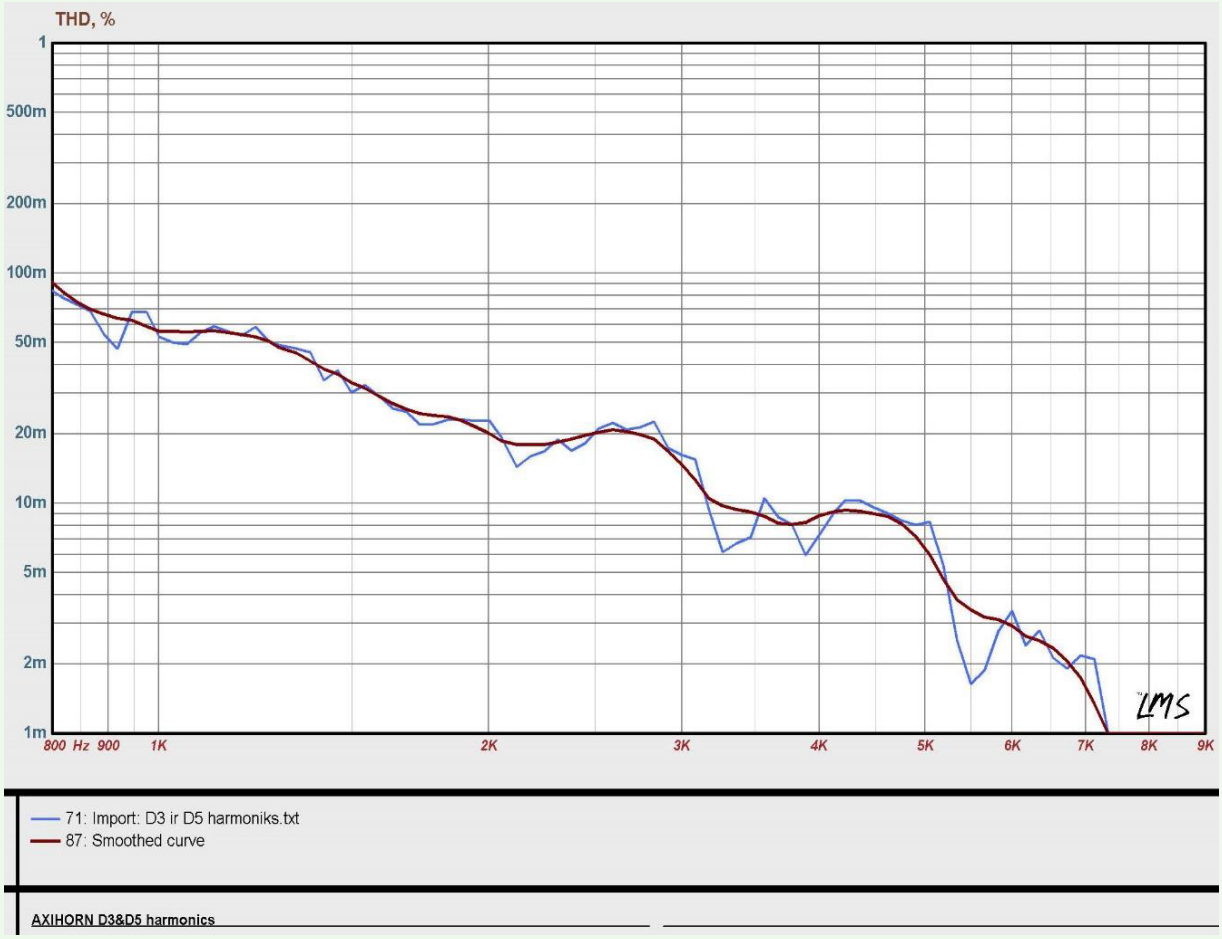

Fig. 12. AXIHORN CP5TB: the sum of odd-harmonics D3 and D5 (claret – approximated graph)

THD does not exceed 0,1% throughout the entire AXIHORN operating range, whereas the amplitude of the signal is 70 dB @ 50 cm. The average THD is even less - about 0.02% in the operating range.

Distortion measurements show that the AXIHORN THD composition predominantly has even harmonics and the dome tweeters – odd harmonics. In the most sensitive hearing frequency band, the levels of these harassing harmonics in AXIHORN are smaller by around 10 times. Similar results were received when comparing the measurements of active loudspeaker system NIDA Mk1 with passive domestic system FOCAL Nova – Utopia.

It is important that the sensitivity of the AXIHORN system is 110 dB/W/m, and the sensitivity of the 1" dome speakers is around 100 times lower (around 90 dB/W/m). When the sensitive system works with maximum power, the driver of the horn system is loaded insignificantly: the maximum load for AXIHORN HF compression type driver is only 7 Watts, when the output for the low frequency module reaches 200 W. Therefore upon reaching the maximum SPL of the system, THD of the NIDA Mk1 system remain very small.

Fig. 13. Devices prepared for measuring

Fig. 14. Preparation for measurement of AXIHORN module

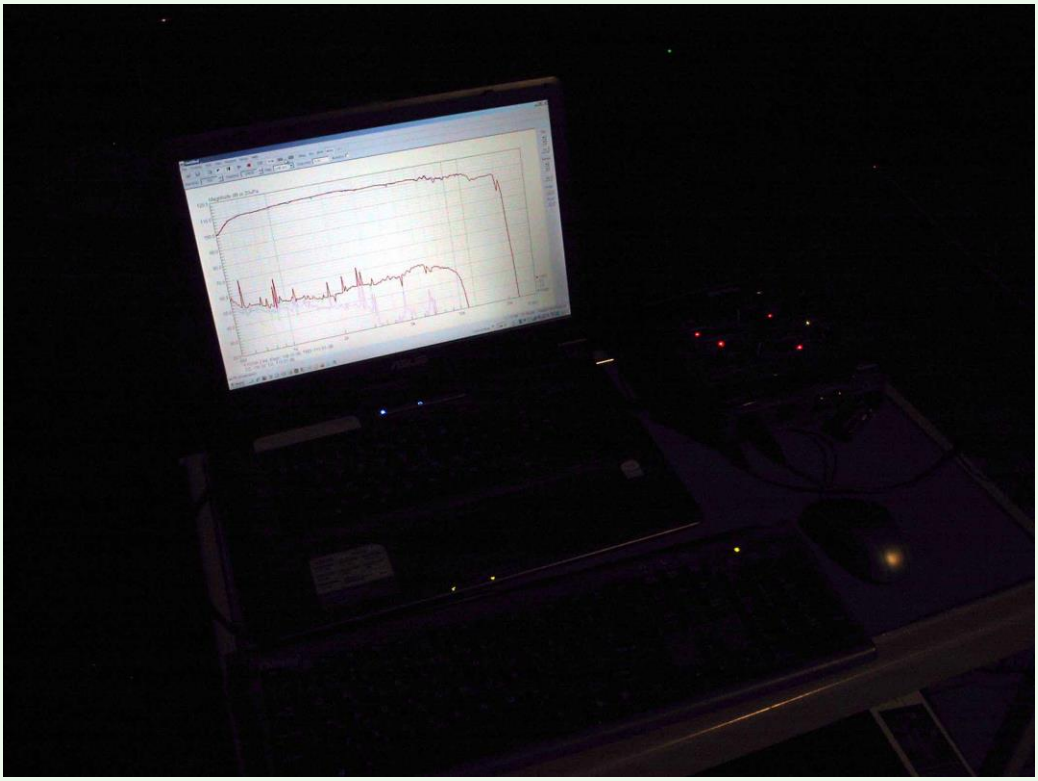

Fig. 15. Measurements were performed at night. The monitor screen shows the results of FR and THD measurement for AXIHORN module in the frequency range of 500 Hz–24 kHz

Conclusions:

1. AXIHORN module has odd harmonics of very low level and these distortions are significantly smaller than the distortions in domestic systems with HF dome drivers.
2. The measurements were performed on a low SPL (70 dBC) level. When listening to the music on higher SPL level, the differences in quality between the high sensitivity horn speakers and low sensitivity dome speakers appear even more.
3. Horn loudspeaker systems are able to play high dynamic modern music tracks most accurately.