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AUTOMATIC MEASURING SYSTEM FOR ACOUSTICAL DEVICES CALIBRATION IN THE FREE-FIELD

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In connection with the introduction of the new standard PN-EN 61672-2:2005 concerning pattern evaluation tests of sound level meters, which requires performing very large number of measurements to determine the frequency and directional responses, the necessity of developing the new, fully automatic, test system arose. The hitherto applied measuring system was replaced with the automatic one, based on the computer software *PomAk*. While testing the new method several calibrations of microphones and sound level meters were made. The results were fully satisfying both in their accuracy and in the shortening of the operation time.

The capabilities of the software, the calibration results and their verifications are presented in the paper.

Key words: sound level meters, free-field investigation, frequency responses, directional responses.

1. Introduction

Within investigations in the free-field the frequency and directional responses of devices are estimated. Before the introduction of the new Standard PN-EN 61672-2:2005 the tests performed in the Vibroacoustic Laboratory (Calibration Laboratory AP 022) were done in a way presented in papers [1] and [2]. New requirements increased significantly the number of measured frequencies and the applied hitherto methodology became too much time consuming. Thus, the necessity of replacing the then-existing measuring set-up (a turntable level recorder controlled) with an automatic computer-controlled system was identified. The new set-up should meet the requirements of the new standard in a relatively short time while simultaneously retaining the adequate accuracy of measurements.

This new method is based on the same measuring equipment but the application of the new software *PomAk* from the Svantek Company is utilised. Calibration methods remain the same, however the technique of performing tests has been changed.

2. Calibration method

In the Vibroacoustics Laboratory the frequency characteristics are determined by comparing the response of the device under test with the response of the reference microphone to the same sound signal, in the same measuring set-up and in the same environmental conditions. The measurement is done in such a way that the reference microphone is placed in turn in the given measuring point, the response measured and then the reference microphone is substituted by the device under test (substitution method). Directional responses are estimated by recording responses of the device under test, which rotates on the turntable. Calibration is being done by a sinusoidal acoustic signal of selected frequencies and a constant amplitude (of the reference meter level).

Layout of the measuring systems for the determination of the frequency and directional responses is presented in Fig. 1.

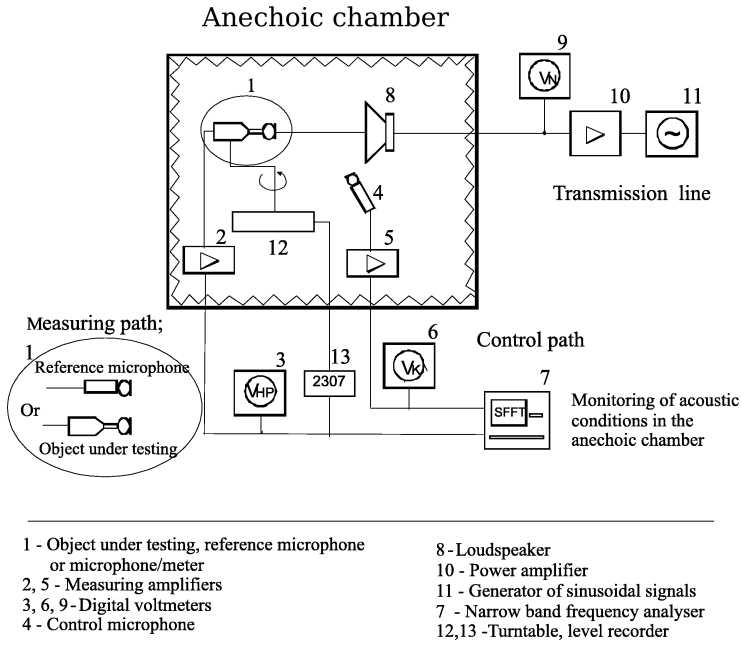

Fig. 1. Layout of the measuring set-up for the determination of the frequency and directional responses – prior to the application of the automatic test system.

The same measuring system is used for the determination of both kinds of responses. A device under test is placed on the special stand fixed to the turntable, which is immobilized during the frequency response measurements.

The measuring system presented in Fig. 1 was replaced by the computer-controlled set-up, the conceptual diagram of which is given in Fig. 2.

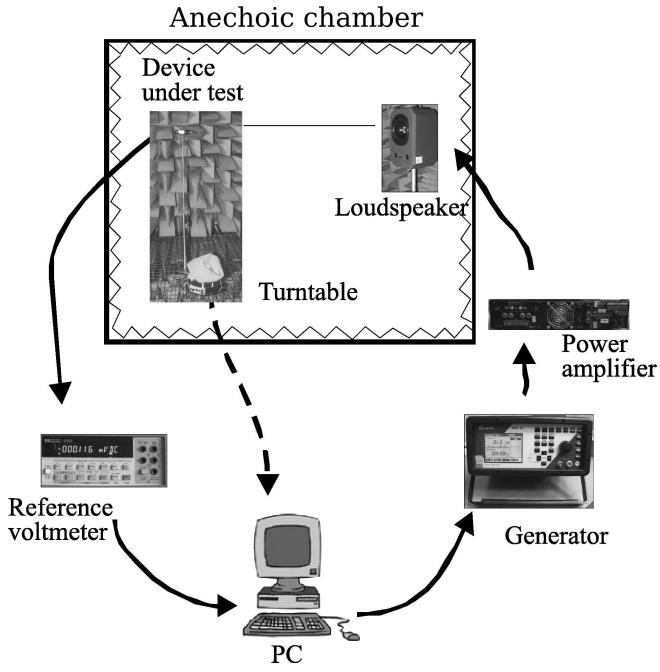

Fig. 2. Conceptual diagram of the computer aided measuring system for the determination of frequency and directional responses.

Automatic tuning of the generated measuring frequencies and automatic readout of responses of the device under testing are currently performed. The synchronization of the measurement with the positioning of the device versus the acoustic wave angle of incidence – during the determination of the directional responses – is being done by means of an optical tachometer. The turntable (after being switched-on) performs rotations in a uniform motion. The tachometer detects the moment when the turntable passes point 0° (the reference direction) and releases a measurement. The characteristics measurement for one selected frequency takes two full turns of the table. During the first turn the generator is switched to the new frequency and the stabilisation of the signal generated by the loudspeaker occurs, during the second turn the actual measurement of the signal is performed.

3. Description of the *PomAk* program

The computer software *PomAk* (Acoustic Measurements) is the tool allowing measurements of frequency and directional responses of various acoustic instruments (e.g. microphones, sound level meters, loudspeakers) in the free-field. Since the system is

intended not only for pattern evaluation tests, but also for performing other tests (e.g. at the stage of designing devices), the program allows for different measuring options and for defining own configurations of measuring sessions (apart from the default configuration conforming to the standard requirements [3]).

Measuring configuration contains, among others: ranges and stages of measuring, tolerances and uncertainties, various options of performing the measurement (delays, number of averaging points). There is the possibility of declaring in the *PomAk* software six frequency ranges within the band from 250 Hz to 22 kHz – in accordance with the requirements of standards PN-EN ISO 266 and PN-EN ISO 61260. Each range has a determined minimal and maximal frequency as well as the "step" (interval between measuring frequencies), after which a change of frequency occurs. Frequency intervals for each range can be chosen from five logarithmic indices of bandwidth: *1/1, 1/3, 1/6, 1/12, 1/24 of octave* and one linear: *other (linear)*. At defining frequency bands either the decimal or binary octave quotient can be chosen. Numerous options of displaying and copying the obtained results allow not only for the full documentation of the results but also for their instant estimation versus the selected reference characteristics and for undertaking immediate decisions concerning further tests. As an example: selecting the display mode: *device under test-reference* we obtain the subtraction of the DUT response from the reference response (e.g. from the reference microphone).

Exemplary windows appearing when the frequency and directivity responses are tested are presented in Fig. 3 and Fig. 4, correspondingly.

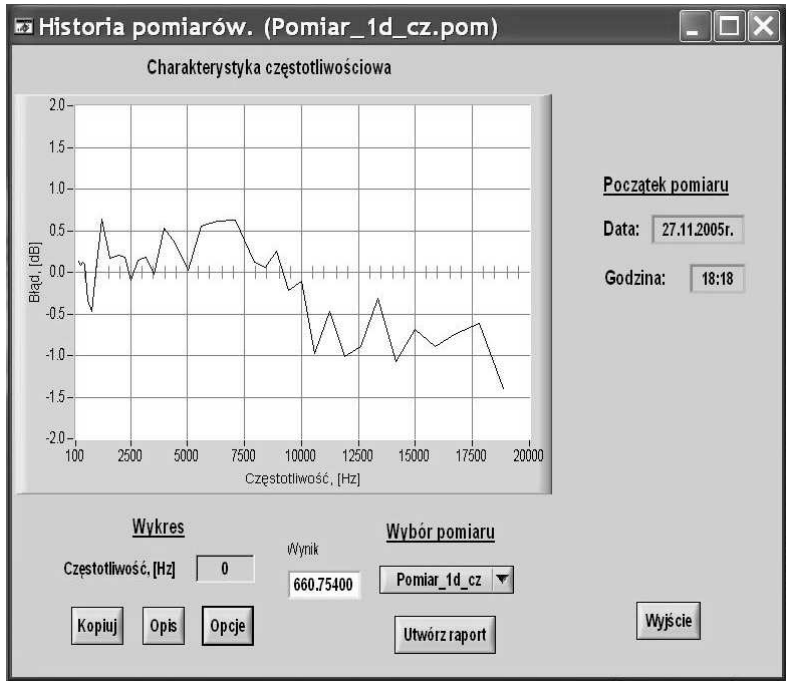

Fig. 3. Window of the frequency response measurement.

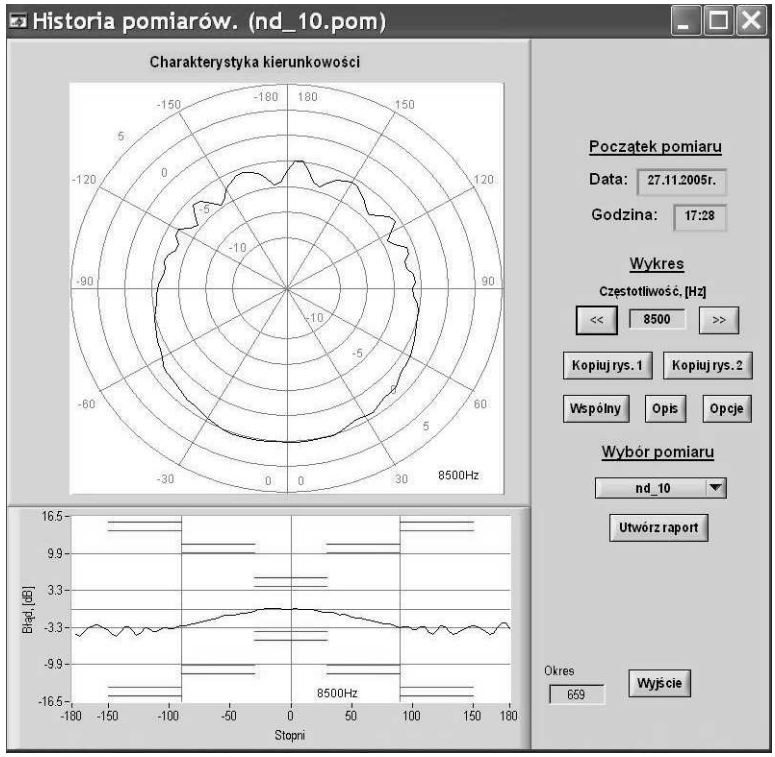

Fig. 4. Window of the directional response measurement.

Capabilities of the software related to easiness of performing measurements and their analyses, recording the results, searching and viewing files as well as generating measurement reports cause, that the system constitutes an excellent research tool. It enables performing large number of tests and their fast analysis.

In addition the *PomAk* is the user-friendly software. The program guides the user providing him with directions and answers, informs on the ways of diagnosing test interruptions and on the measures of eliminating defects. It has the detailed Instruction Manual. This fact should be emphasised here, since the documentation of specific measuring systems and programs, which are not commonly used, is usually very limited and scarce what causes a lot of problems during calibration.

4. Validation of the measuring system and verification of the results

Validation of the measuring method was mainly based on comparison of the results obtained at testing the reference devices, which characteristics are well defined by the recognised laboratories, with the results obtained at the set-up at “manual” operation (Fig. 1), followed by checking the repeatability and reproduction of measurements. An example of comparison of the results obtained on both measuring stands is presented in Fig. 5.

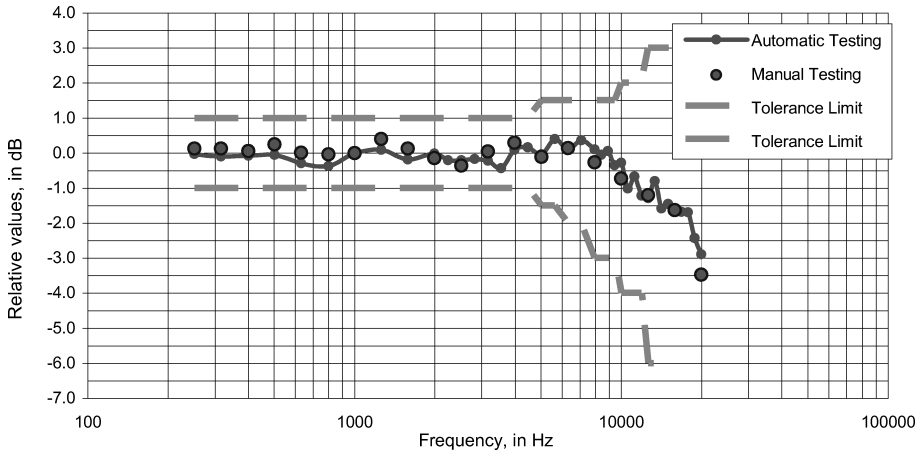

Fig. 5. Example of the results of the frequency responses of the sound level meter type 2231 B & K Company, obtained at the "manual" and automatic testing.

Automated manual operations (setting generated frequencies, readout of results) allowed increasing the accuracy of results and shortening the time of measuring. Presently the time of measuring of one frequency response equals approximately 8 minutes, and one directional response approximately 2.4 minutes (full investigation of 30 directional responses – approximately 72 minutes), which enables performing higher number of tests.

5. Conclusions

The solution of automatic testing of acoustical devices meeting the requirements of the new standard concerning pattern evaluation tests of sound level meters – PN-EN 61672-2:2005 [3] is presented in the paper.

In order to verify the obtained results several comparative measurements were performed. Their results were quite satisfactory.

The presently used measuring system (automatic and fully developed – when taking into account the accuracy of measurements) constitutes very useful tool not only at the stage of calibration but also at the designing of acoustical devices.

Acknowledgment

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References

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