High Resolution Testing with 45CC

By Morten Wille

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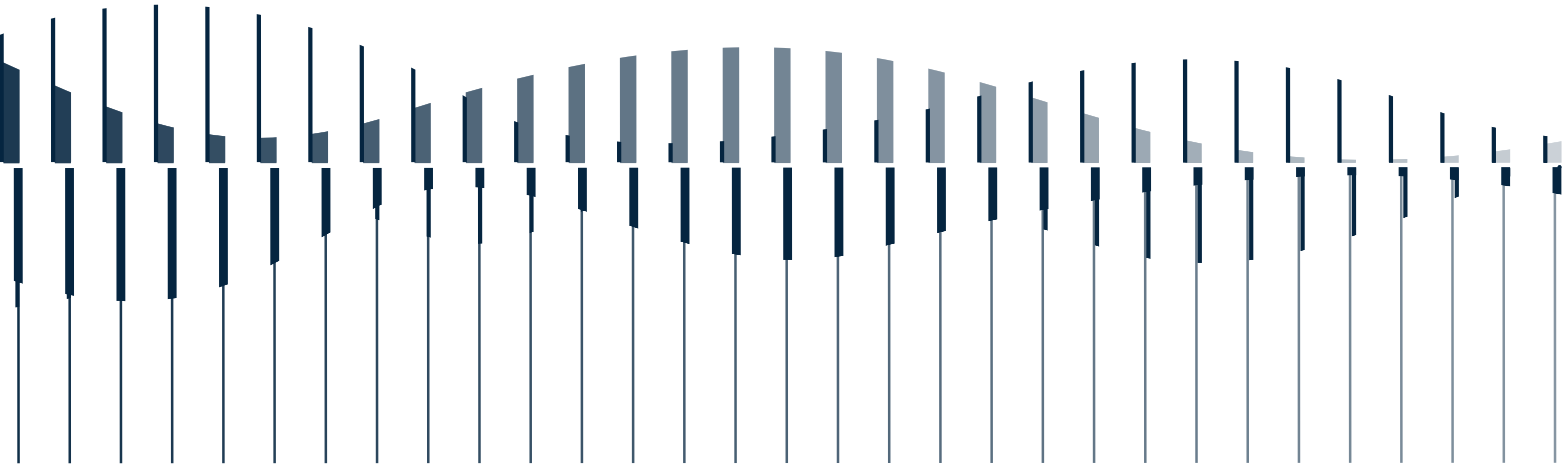

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GRAS Sound & vibration

High Resolution Headphone Testing with 45CC

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This technical note discusses how headphone geometry and even very small differences in positioning influence the repeatability and frequency response that can be obtained when testing at frequencies above 20 kHz.

45CC Configured with 1/4” Microphones

The GRAS 45CC with ¼” microphones offer the possibility to do measurements at frequencies above 20 kHz. The 40BD/40BP ¼” microphones have a flat frequency response from 4 Hz to 70 kHz. In combination with the headphone positioning system of the 45CC, this opens the possibility of doing repeatable measurements at high frequencies.

Although the ¼” microphones offer high frequency capabilities, the geometry of the headphone itself will greatly influence the frequency response. At frequencies above 20 kHz, even minute differences in position and geometry will affect the measured frequency response.

The optimal solution here would of course be to have a model of the human ear that can be used beyond 16 kHz, which is the limitation today according to IEC 60318-4. The problem in making such a coupler is that no two human ears are alike and especially at high frequencies, even small differences in geometry like ear canal length and shape will fundamentally change the frequency response at high frequencies. This actually means that the signal transferred to the human brain is different for each human being, but the brain compensates for that so we can still discuss how thing sound. Another challenge that hasn’t been solved yet is how to do feasible measurements inside an actual human ear at frequencies >16kHz.

Another method could simply be to measure the high frequency response in free-field, meaning place the measurement microphone in front of the headphone in the same position as the ear entrance point (EEP). Using the free field measurement method will of course not give usable result for frequencies below approximately 1000 Hz where conditions are not free-field since the acoustic load on the diaphragm does not match the load in a small volume.

Figure 1 below shows a comparison of three different measurements on the same pair of headphones. The purple curve shows a 45CC equipped with a ½" microphone limited to 20kHz, the orange curve shows a ¼" microphone which extends the frequency range to 70kHz, and the blue curve a free field measurement using the same ¼" microphone as in the flat plate 45CC measurement (orange curve). As can be seen, the three measurements coincide well in the frequency range from approximately 1 kHz to 20 kHz. The ½" and ¼" are perfectly aligned up to 30 kHz. Above 30 kHz, the drop in sensitivity of the ½" microphone is apparent.

Because geometry of the headphone plays a huge role for the actual frequency response it is not possible to make a simple transfer function that can be applied on other headphones.

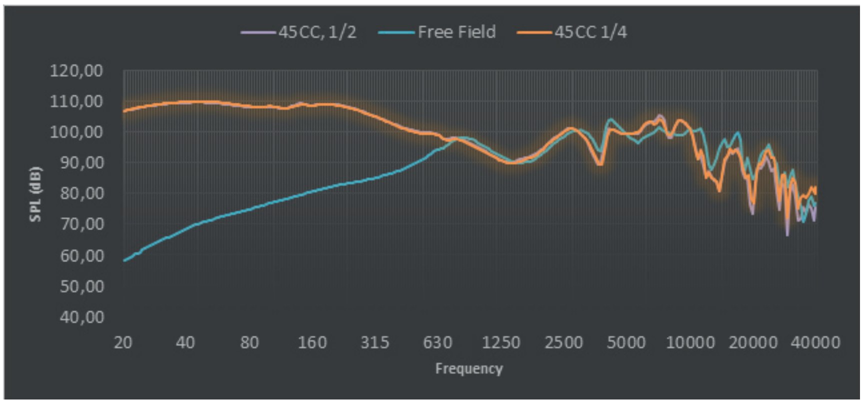

Figure 1
Frequency response with ½" and ¼" microphones mounted in 45CC compared with a free-field measurement with the same ¼" microphone.

Conclusion

Measurements made with a 45CC configured with 1/4" microphones provide valid and actionable information about the headphone's performance, and 45CC is therefore a useful development and QC tool because it allows for repeatable measurements at high frequencies.

However, when interpreting measurement results it is important to keep the influence of geometry and positioning in mind. Also, it does not approximate a model of the human ear and therefore correlation to subjective listening experience has to be established by other means.