Quality Audio Can Exist

The Key is the Signal Path

By
Dan Foley
President, Association of Loudspeaker Manufacturing & Acoustics (ALMA) International

ALMA International's goal for 2018 is to promote the importance of sound engineers having a deeper understanding of every aspect of the audio signal path and its impact on audio quality.

The opportunity for the average consumer to experience higher-quality audio in 2017 has never been better. Despite previous assertions that the days of high-quality audio were long gone, those being the "good old days" of turntables, separate preamps, power amps, and so forth, audio products that produce high-quality sound are very much in demand.

The sound systems that come standard in vehicles selling for less than $20,000 can rival those of luxury cars from a decade ago. Headphones costing $300 or more are now the norm. Focal, renowned for its audiophile loudspeakers and high-end studio monitors, released two headphone models in 2016, its first ones ever. Despite selling prices in the four-figures, Focal had a several-month backlog shortly after these headphones were introduced.

Audio Signal Paths Have Changed

What is in the past has to do with the audio signal path. For the vast majority of audio products, the audio signal no longer passes through discreet components, such as an equalizer, preamplifier, and power amplifier before it reaches the loudspeaker. Modern audio products have converged these discreet analog components and added digital hardware and signal-processing algorithms. Turntables no longer just convert the undulations in a record groove to a low-level voltage. Integral USB technology enables the music listener to rip vinyl directly to a digital format as it integrates the cartridge PLUS phono preamp, analog-to-digital converter, USB chip set and possibly on-board DSP, into a converged product. Modern powered headphones, at a minimum, incorporate amplifiers that are typically a Class-D design. Noise-cancelling headphones are that much more complicated with integral microphones, DSP and Wi-Fi and/or Bluetooth technology. Sound bars typically include all of these features plus many loudspeaker transducers packaged in a single enclosure so as to achieve a surround-sound experience with no physical surround speakers.

With today's complex products, there are many more parts of the signal path where sound quality can be diminished prior to reaching the plus and minus terminals of a transducer's voice coil. When this does occur, the consumer will often blame the loudspeaker when the root cause has nothing to

do with acoustic/electroacoustic aspects of the products' design.

The Impact

How does this convergence impact the loudspeaker industry, especially for loudspeaker transducer designers? The impact is that loudspeaker designers must be cognizant of how the various parts of the audio signal path, in particular any digital portion, will affect the audio sound quality emanating from his or her design. The following is an example of how the loudspeaker could be falsely blamed for poor sound quality when the root-cause has nothing to do with the transducer.

A few years back, I was attending a Bluetooth Unplugfest where unreleased Bluetooth products are tested to ensure they "play nice" with other Bluetooth products in regard to discovery, pairing, and streaming audio with no (major) quality degradation.

I was testing a second-generation product that was implementing a new Bluetooth voice codec that enabled speech to be sampled at 16 kHz instead of 8 kHz. By extending the speech frequency response by one octave (up to 8 kHz vs. 4 kHz), the person listening to the conversation on this product will hear speech that sounds more natural. I successfully paired this product with the audio analyzer I was using and confirmed the Bluetooth audio sampling rate was indeed at 16 kHz. I streamed some speech files and viewed the response from its amplifier output on a live FFT trace (this product was designed to use external loudspeakers). I immediately noticed that there was very little energy above 4 kHz even though these speech files contained considerable energy above 4 kHz, especially the sibilance portions (e.g., "S" sounds). I then ran a frequency response sweep from 20 Hz to 8 kHz and saw that above 4 kHz, the response rapidly dropped off.

The engineer with whom I was interacting was involved with only the Bluetooth-protocol aspects of the design and did not know what was happening in regard to the audio signal processing. He immediately contacted his audio DSP colleague back at his company. This engineer looked at his DSP code and discovered that the original anti-aliasing filter designed to work with the older 8 kHz sampling-rate codec had never been changed to reflect the 16 kHz sampling rate being used with the more modern Bluetooth voice codec. This negated one of the important aspects of this second-generation product—namely a more natural-sounding conversation when used as a speakerphone.

The typical end-customer would have no idea that the anti-aliasing filter had been set incorrectly and most likely would blame the loudspeaker because "it does not sound good." How often have you heard that customer comment and that's all the information you have to help you find the root-cause of the poor sound quality?

AISE 2018

The theme for the ALMA International Symposium & Expo (AISE) 2018 is "The Revolution of the Signal Chain" and the example I provided is one of many where audio engineers, not just transducer engineers, need to have a deeper understanding of every aspect of audio signal path and its corresponding impact on audio quality.

The transducer engineer needs to be aware of how every part of the signal chain can impact a loudspeaker's performance. But this also applies to the engineers designing amplifier chips and developing DSP algorithms. Just because some type of "cool" signal processing can be achieved in a DSP chip does not mean it's the elegant engineering solution to achieving better audio quality. Choosing the appropriate transducer in the first place and/or a better acoustic design may be the actual elegant

solution. If the people making the decisions on loudspeakers are not educated as to a particular electrodynamic transducer's limitations regarding sound reproduction, then poor choices can be, and often are, made. The transducer engineer is then left with cleaning up a mess of which he or she was never even aware.

The days of having a multi-decade career designing one part of an audio system and throwing one's design over the proverbial wall are long over. Today's engineers designing an audio system, or any of its components, needs to have at least a basic understanding of the complex interactions of each part of the entire audio signal path. This requires a willingness to learn about technologies for which one may not been formally trained.

Attending meetings put on by professional technical organizations is a great way to learn about emerging technologies as well as expanding one's network of technical contacts. For those of you associated with a company that has a many engineering disciplines, do not hesitate to approach your colleagues who have expertise in areas other than your own. In my three-plus decades involved in the technical side of audio, whenever I approached another engineer with a sincere willingness to learn more about his or her world, he or she was always very happy to further educate me. In return, I often was able to provide them some "golden nuggets" of knowledge applicable to their work. What initially started as a teacher/student relationship often became friendships that have lasted many years and been strengthened by our mutual passion for the audio industry. ***LIS***

About Author

Dan Foley has been in the audio test and measurement industry for more than 35 years and has a broad background in analog and digital audio test, acoustics, electro-acoustics, telecom audio, as well as vibration measurement and analysis. He was recently elected President of the Association of Loudspeaker Manufacturing & Acoustics (ALMA) International, is a member of Audio Engineering Society (AES) and the Institute for Electronics and Electrical Engineers (IEEE), and has many close ties to the audio industry, having worked for the likes of Bose, Listen, and Brüel & Kjær. Dan has developed and taught seminars regarding digital signal processing techniques used in acoustic, vibration and audio test, and measurement applications. He currently serves on the IEEE Transmission Access & Optical Systems Committee as well as standards committees of AES. Dan is also an Adjunct Faculty Member at Worcester Polytechnic Institute where he is developing a curriculum in audio product design engineering.