

## What is the best high frequency response for earphones? (Extending the Harman Curve)

By Cristina Downey and Tom Miller- Knowles

Sean Olive and team did a fantastic job developing the Harman recommended curve for earphone response. This curve has been widely adopted by the earphone industry. However, they admittedly didn't really study response above 10 kHz, citing technical limitations of the gear at the time. Knowles has taken up the challenge of discovering what listeners really prefer for that last octave of music, using methods similar to Sean's along with improved equipment. The results are surprisingly brighter than the Harman curve. We will describe how we developed a new recommended headphone curve, and how we overcame the challenges of getting reliable listener results at high frequencies.



By day, **Cristina Downey** is an electroacoustic engineer at Knowles Electronics where she works in R&D for balanced armature devices and on the fringe of perceptual audio. She holds an MS in Acoustics from The Pennsylvania State University, an MFA in Recording Arts & Technologies from Middle Tennessee State University, and a BS in Metallurgical & Materials Engineering from Colorado School of Mines. By night she functions as a freelance recording and mix engineer with fluency & proficiencies spanning the breadth of large format analog consoles and 24-track tape to in-the-box processing and sound synthesis. In between working on technical audio projects, she continues working with select patient artists of various genres with the anticipation of building a studio in the Chicago area within the next 5 years.

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**Tom Miller** is an Engineering Fellow at Knowles Electronics, a title he has earned by succeeding in hanging out there for over a quarter century. Over those years he has helped to create many of Knowles' balanced armature receiver designs and has been granted over a dozen patents. More recently he has been studying how Knowles microphones and receivers affect system level issues, such as the control of wind noise pickup and active noise cancellation. Tom is an AES Fellow, a former Regional Vice President of the AES, and has held every local office except treasurer. Back in a previous century when LP's were king and were sold in places called record stores, Tom obtained a Bachelor's degree in Electrical Engineering from the University of Michigan. Upon graduation, he worked for a dozen years as chief technical engineer of Universal Recording, a major Chicago recording studio in its day. After that, he spent a few years working on signal processing for loudspeakers at International Jensen before moving on to Knowles Electronics. In his spare time he creates electronic music under the name Shadreaux (shameless plug - Bandcamp).

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