The equal-loudness contours

Twenty years ago, at a High End show I visited, I met a designer that played his equipment at ridiculously low volumes. When I asked him why he does this, he replied that well-designed amplifiers shine at low volumes. Let us explain the significance of the equal-loudness contours and see if he was right or wrong.

The equal-loudness contours arose from research done in the 1930s by Harvey Fletcher and Wilden Munson. The International Organization for Standardization (ISO) revised the Fletcher-Munson curves and issued ISO 226. The numbers above the curves is the subjective loudness expressed in phons. On the x-axis we have the frequency of the tone and on the y-axis the sound pressure level expressed in dB. The sound pressure level is an objective way of measuring the sound intensity; a microphone is used for this purpose. The contours are constructed in such a way so that the subjective loudness coincides with the objective sound pressure level at the frequency of 1 kHz. At other frequencies those two may differ. From the equal-loudness curves we can determine the subjective loudness of a tone. To understand how this works let's pick for example the 60 phon contour. Moving along the curve to the left we reach the frequency of 50 Hz where we see that the sound pressure level on the y-axis is 90 dB. This means that a 50 Hz tone at 90 dB is perceived as having a loudness of 60 phon, i.e. 30 dB less. On the same contour moving to the extreme right, reaching the frequency of 20 kHz, we note that the sound pressure level is about 85 dB. A 20 kHz tone reproduced at a level of 85 dB is subjectively perceived as having a loudness of 60 phon. At what level should a 1 kHz tone be reproduced so that it sounds equally loud to the 85 dB 20kHz tone? You guessed it. It should be played at 60 dB, 25 dB lower than the 20 kHz tone and 30 dB lower than the 50 Hz tone.

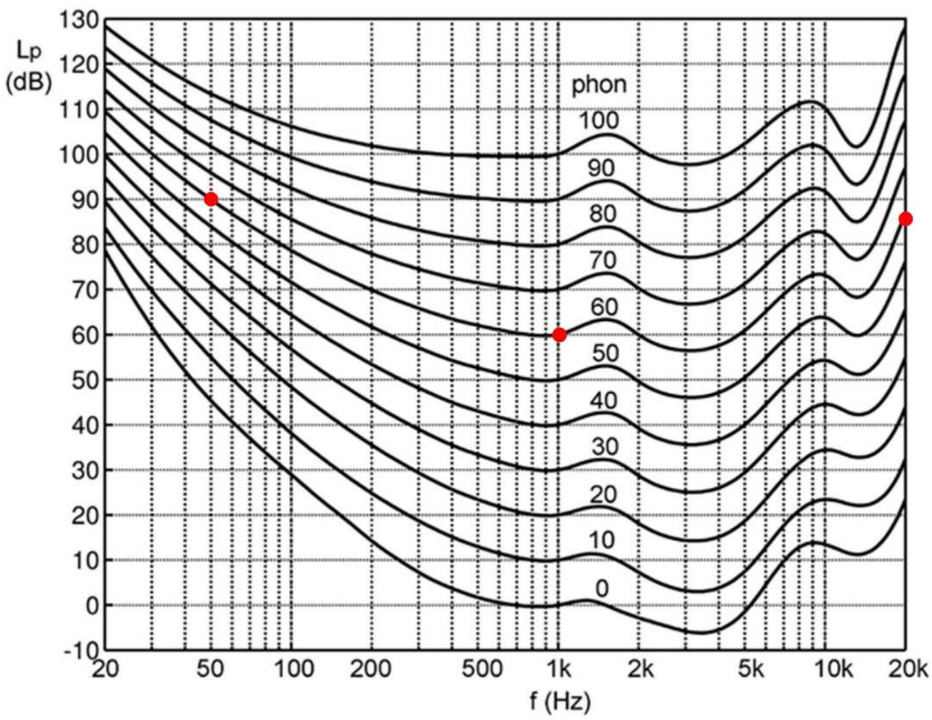

Figure 1. The equal-loudness contours

In simple terms, this means that our hearing does not hear all sounds equally well; it is relatively selective in the range of frequencies between 500 Hz and 5 kHz. Lows and highs cannot be heard unless we pump up the volume. Most of us know that already. There exists a narrow range of frequencies between 2 kHz to 5 kHz where the curves bend downwards. This means that for these frequencies in order to sound equally loud to the 1 kHz reference tone they should be played at a lower volume. Our hearing is most sensitive in this range of frequencies, which is approximately the speech spectrum. Now comes the important part.

Notice that as the loudness increases the contours tend to flatten out. In other words, our hearing becomes less frequency selective and the ear's frequency response becomes flatter. This is good. This is exactly what we want. Therefore, if we want to hear the bass and treble well, we just have to increase the volume. It is as simple as that. No matter how low our speakers can get down in frequency, we're not going to hear it if there isn't enough volume. The only limitation is the complaints the neighbors will make and the fact that long hours of listening with levels above 90 dB can damage our hearing.

In conclusion, listening at low volumes puts our hearing at a disadvantage. We simply cannot hear well very low or very high frequencies at low volumes. It goes without saying that the critical evaluation of any audio reproducing device should be done under the right conditions. The next time you come across someone playing at a low volume, politely ask him or her to turn up the volume.

For Echo Diastasis

Spyros Loutridis