Editor's Desk

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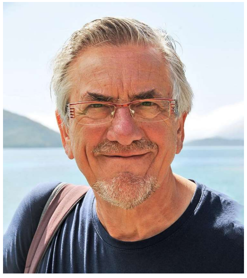


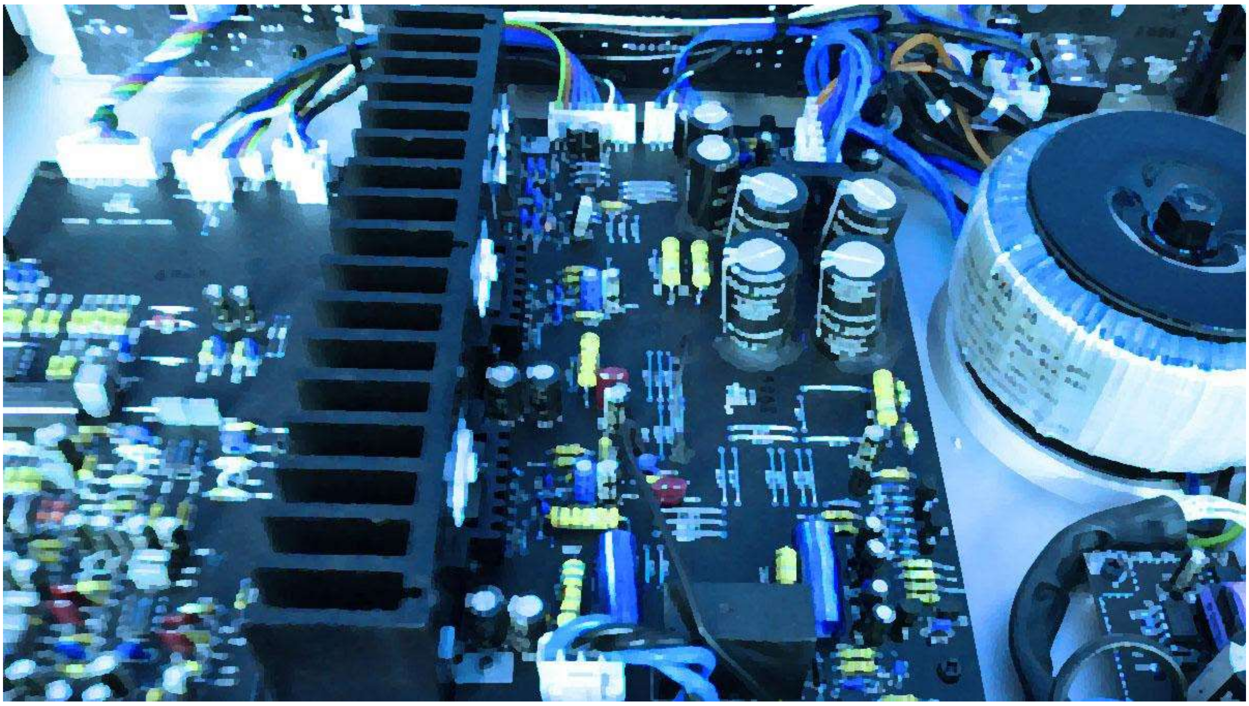
Audio Myths

Why Narrow Bandwidth May Be Better

Although feedback theory for electronic circuits has been established for over a century, it is still a subject for discussion. This short essay is an attempt to shed some light on one of those recurring controversies.

The subject came up at the recent Audio Engineering Society (AES) convention in Helsinki, Finland. Audio amplifiers are basically integrators or, if you will, low-pass filters. That means that at some frequency, their open-loop gain starts to fall off. With that, the loop gain available for feedback also starts to fall off, leading to a diminishing of the curative effects of feedback: distortion starts to rise, gain accuracy starts to drop, output impedance starts to go up, etcetera.

There are roughly two schools of thought: You start with an extremely high open-loop gain that rolls off at a relatively low frequency, so that you have a lot of excess gain for feedback over the audio band (narrow band open loop). Or you start with a moderate loop gain that stays flat up to say the upper audio frequency of 20kHz, then rolls off (wideband open loop).



One effect of the open-loop gain roll off is that the (differential) input voltage to the amplifier, for a given output voltage, must rise with frequency. This increase in input signal level generally increases distortion as more of the nonlinear gain of the amplifier is exercized. In the narrow band case, as the feedback starts to roll off early, the input level also starts to rise early, at a much lower frequency, than in the wideband case. The premise of the discussion was that this is a "double whammy" as, in the narrow band case, the distortion due to higher input levels would rise faster than expected as the amplifier input nonlinearity itself rises with input signal level. This effect, if indeed true, might influence the choice for one or the other open loop bandwidth case as mentioned above.

The purpose of this essay is to try to untangle this and provide a fair comparison between the two cases as far as distortion is concerned.

Figure 1 shows an instance of the two cases, while Figure 2 shows the two open-loop curves, graphed with R3 and R6 from Figure 1 removed. To ensure a level playing field, I have set the gains and roll off in each case so both have around 37dB open-loop gain at 20kHz (Fc of the wideband case) and a closed-loop gain with resistors R3 and R6 as shown, of 26dB.

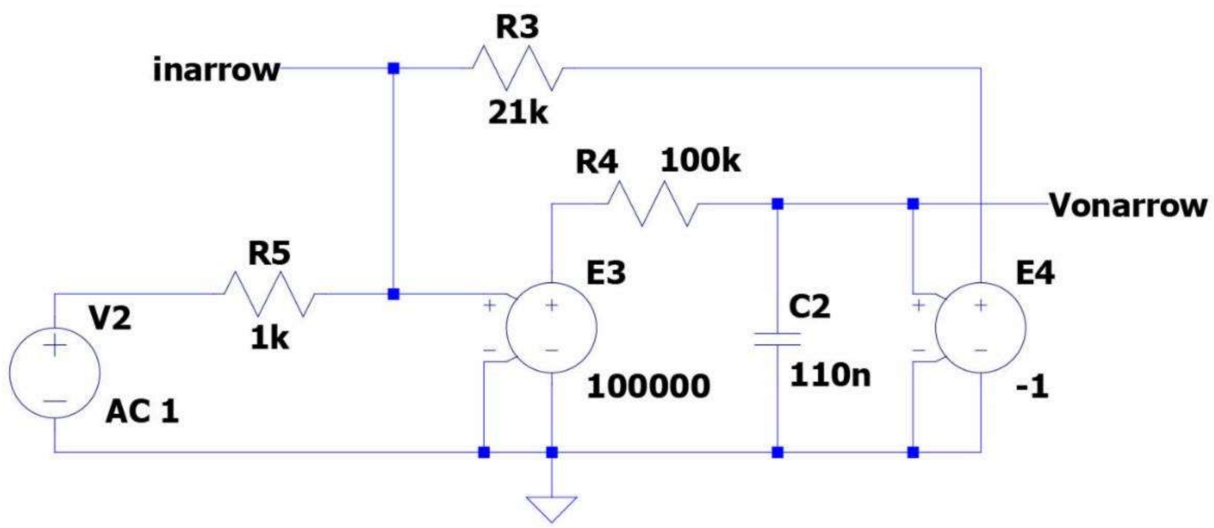


Figure 1a: High open-loop gain, narrow open-loop bandwidth amplifier.

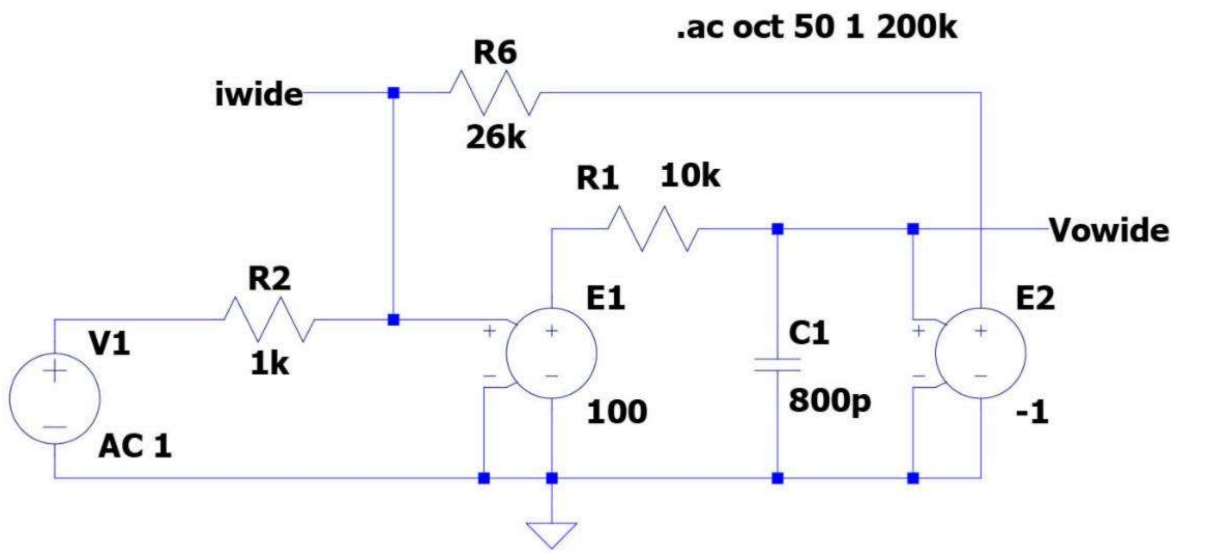


Figure 1b: Low open-loop gain, wide open-loop bandwidth amplifier.

In Figure 2, both circuits show a first-order roll-off of 6dB/octave; one has a flat response up to that 20kHz point, while the other has a very high loop gain at 20Hz of circa 100dB, again rolling off to 37dB at 20kHz. We also assume a required closed-loop gain of 26dB, leaving 11dB for feedback at 20kHz.

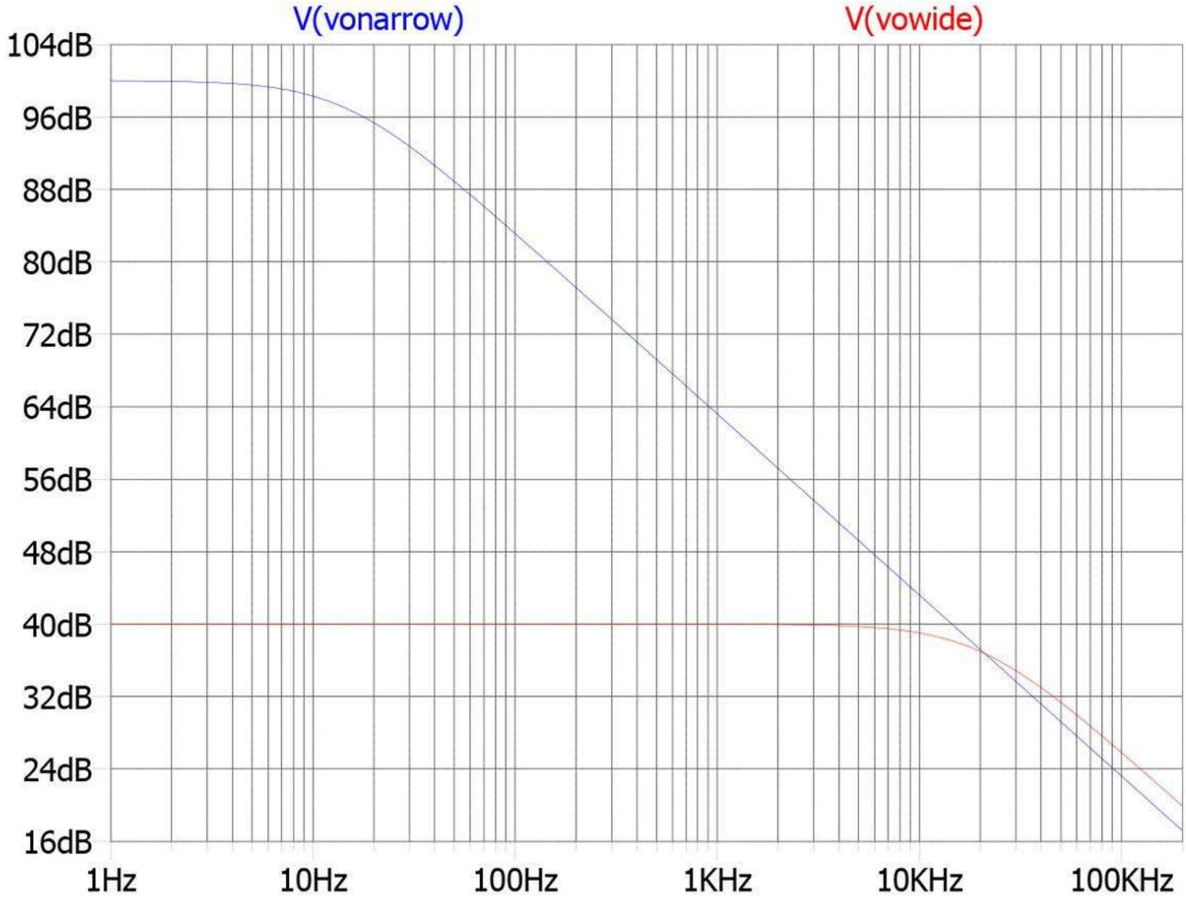


Figure 2: Open-loop responses of the Figure 1 circuits.

Figure 3 shows the closed-loop responses, and thanks to the feedback, these are roughly the same.[1]

Next, we will plot the input voltage of the amplifier in the two cases, for an output signal level of 20Vrms. For the wideband case, that input voltage needs to be 200mVrms, up to the 20kHz roll off frequency.

For the narrowband case, below 20Hz, the input voltage for the same 20Vrms output will only be about 200µVrms and will rise with frequency until it also reaches 200mVrms at 20kHz. The two plots are shown in Figure 4.

The input voltage in the narrow band case at no point rises above that of the wideband case. Therefore, the narrowband case does not cause higher distortion than the wideband case by exercising a larger range of the input non-linearity. There is no advantage in using a wider open-loop bandwidth in this context. If there is a “double whammy” effect, the victim is the wideband case, as it has consistently higher input voltages. The input voltage is as high in the whole audio band as it is at 20kHz, while in the narrowband case, the input level is always lower in the audio band, up to 20kHz where it is the same for both.

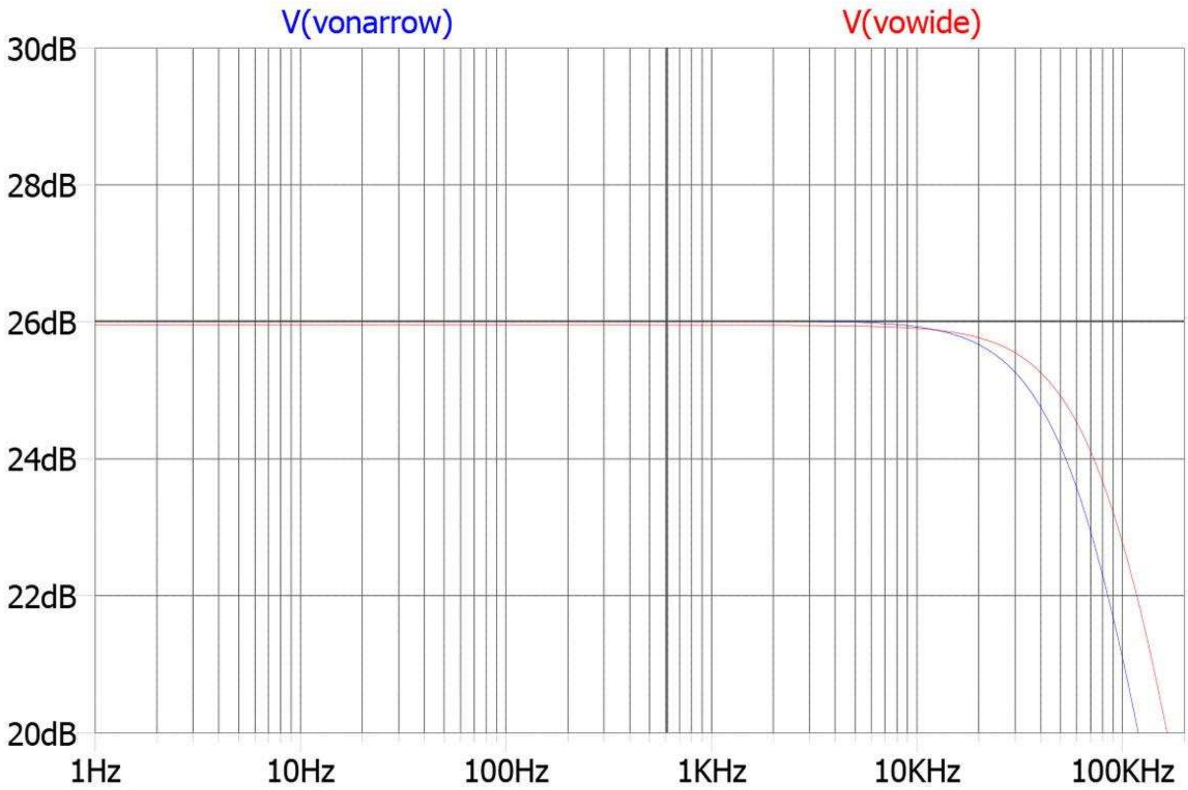


Figure 3: Closed-loop responses of the Figure 1 circuits.

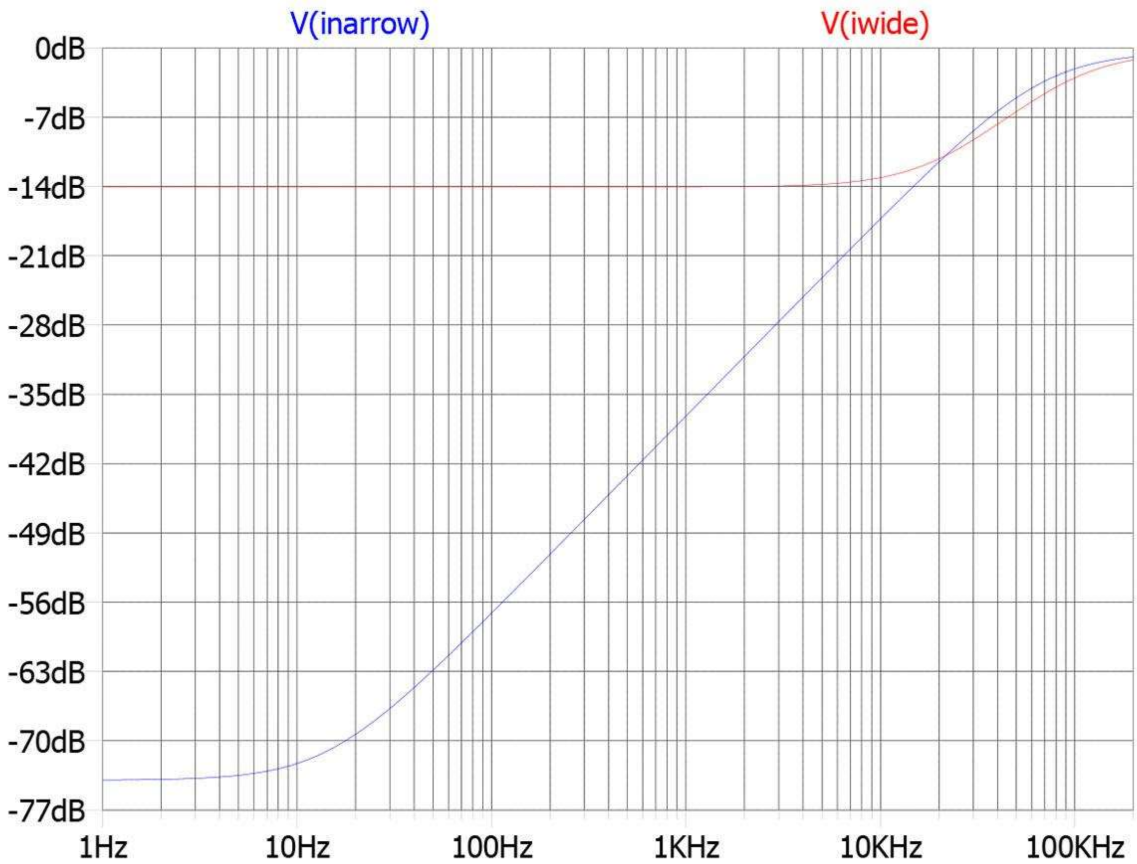


Figure 4: Input signal levels for equal output levels for the wideband case (top) and narrow band case.

The second point is that due to the higher feedback loop gain for the narrow band case it will have more distortion reduction in the audio band than the wideband case.

The conclusion must be that for highest distortion reduction in the audio band, a narrow open-loop very high gain frequency response that starts to roll off at a relatively low frequency is to be preferred over a lower gain flat open loop response, if both have the same open-loop gain at 20kHz. All other things being equal of course, which they might not;

there may be other reasons to choose one or the other configuration. But based on the premise stated at the beginning, the choice would clearly be the narrow band case.

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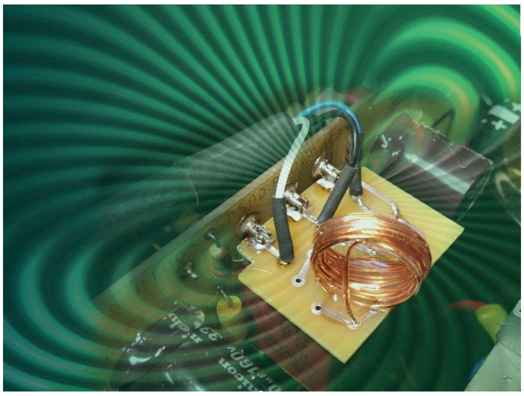
1) At 20kHz, the narrow band case is already at its flat portion, while the wideband case just started to roll off so there are some minor differences, which are also visible in Figure 4. However, these do not change the conclusions.

Audio Electronics

Tips & Tricks: Buzz Abatement in Audio Amplifiers

By Chris Lewis and Dimitri Danyuk



The topology and the distribution of the wiring, partitioning between low power and high power circuits, grounding scheme, types of cables, protection techniques, and safety are important factors that must be considered to minimize the interference effects in audio amplifiers. Complete immunity is hard to attain and there are multiple possible obstacles to ideal layout, wiring, grounding, and shielding techniques implementation. This "tips and tricks" audio electronics article provides several details about inductive coupling effects in audio amplifiers and the simple way to minimize them. Valuable lessons from two great experts in audio power amplifier system design. This article was originally published in *audioXpress*, July 2019. **Read the Full Article Now Available Here**

Voice Coil Focus

A Fresh Take on Green Audio 2023

By Mike Klasco

Good intentions for sustainability, circularity, or simply reducing your carbon footprint in the development or manufacturing stages not always produces the intended results. Mike Klasco reminds us how things are not always as simple as we would like, and that having good intentions and throwing empty claims might work on paper, but not actually work in the real world. And there's nothing better than reading this valuable article to avoid some typical pitfalls, and learn how to actually go about with being green and sorting a sustainable strategy for audio products. This article was originally published in *Voice Coil*, March 2023. **Read the Full Article Now Available Here**