Mixed voltage-current drive with a bandpass and a notch filter

As I already wrote on DIYaudio, I doubt if the arguments for current drive apply close to resonance, where the motional parts of the loudspeaker (that is, the back EMF) rather than the voice coil dominate the impedance. Hence, I'm very interested in the results of mixed voltage-current drive.

If you want to only have voltage drive around resonance, it makes sense to use a bandpass filter for the voltage feedback and a notch filter for the transadmittance feedback, rather than a low-pass and high-pass. The bandpass and notch filters would have to be tuned to the resonant frequency of the loudspeaker.

Some quick simulations show that not much is to be gained with this approach, though. To prevent a bumpy response, the quality factor of the bandpass and notch filters has to be much smaller than the quality factor of the loudspeaker under voltage drive. This leads to wide transition bands that are not much smaller than those of simple first-order low- and high-pass filters. The acceptable filter quality factor can be increased somewhat by making the gain in the voltage feedback mode some 30 % smaller than the ratio of the voice coil resistance to the current sensing resistance, but even then, a *Q* of about 0.3 is as high as you can go.

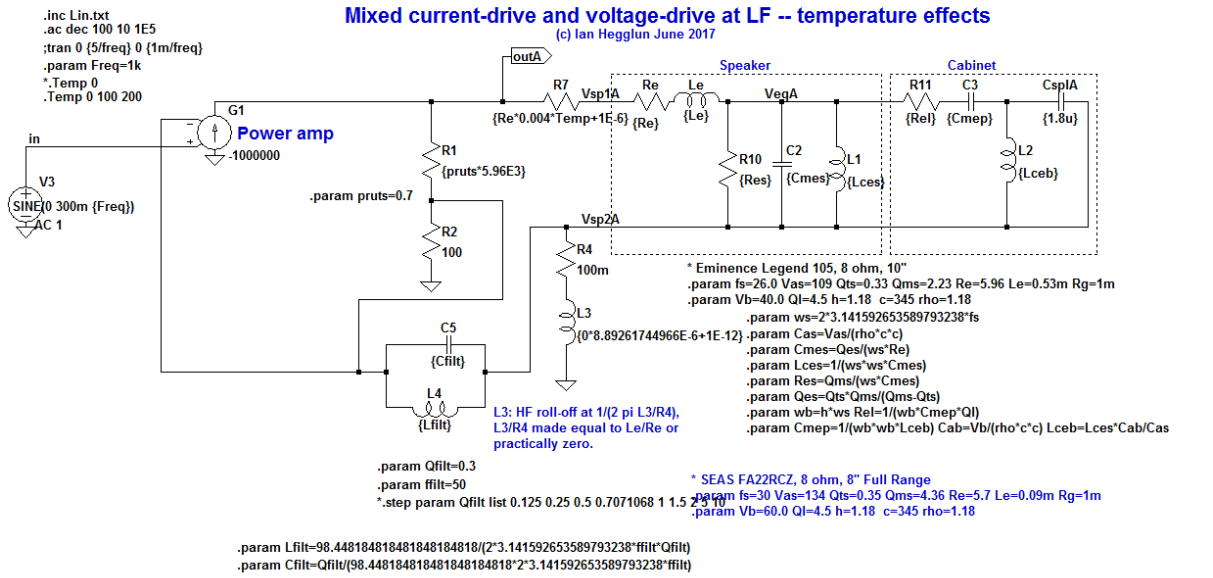

Figure 1 Mixed feedback with bandpass/notch filter

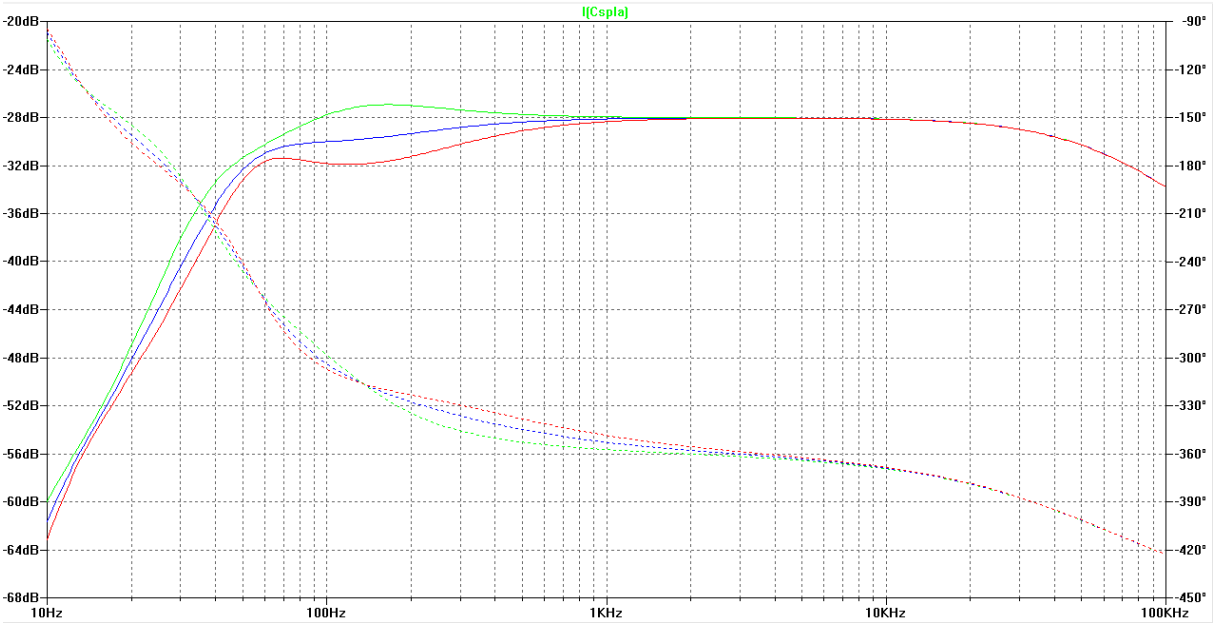

Figure 2 Simulation result of Figure 1, temperature stepped from 0 to 100 and 200 °C

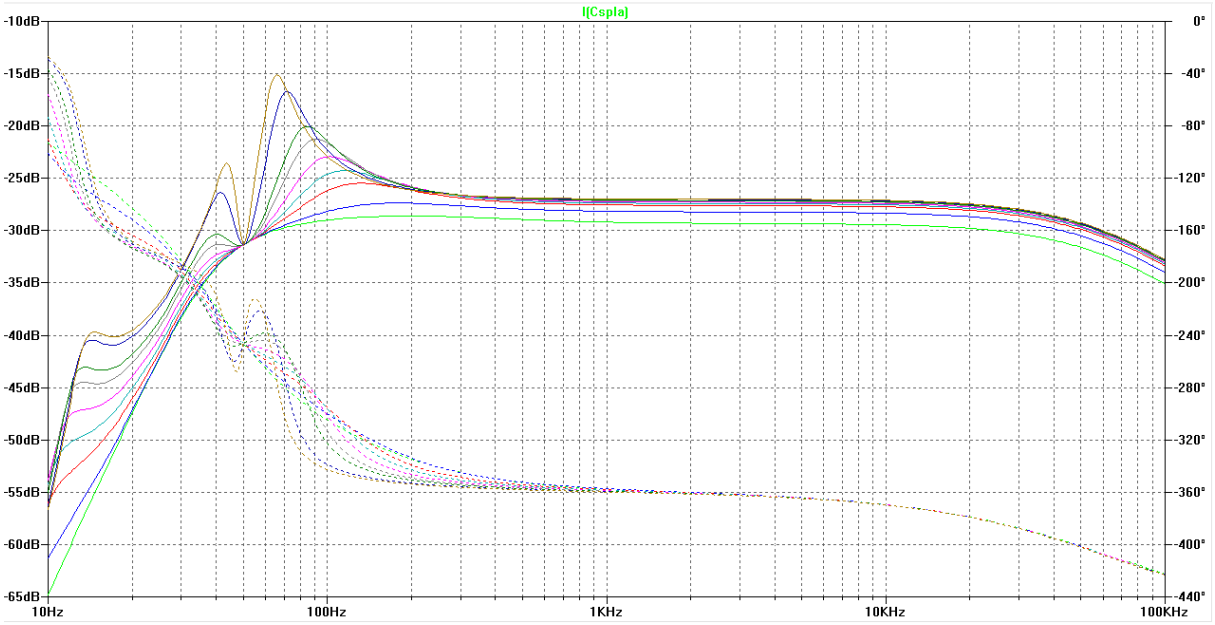

Figure 3 Now at 0 °C, but with the quality factor of the bandpass and notch filter stepped: 0.125, 0.25, 0.5, 0.7071068, 1, 1.5, 2, 5 and 10. The curves do not entirely converge at high frequencies because L3 is switched off; the voice coil inductance makes the voltage across the current sense resistor drop with frequency, so the transadmittance feedback path never gets to completely dominate over the voltage feedback.

The LC filter could be replaced with an active filter or a double-T filter, see Figure 4 and Figure 5.

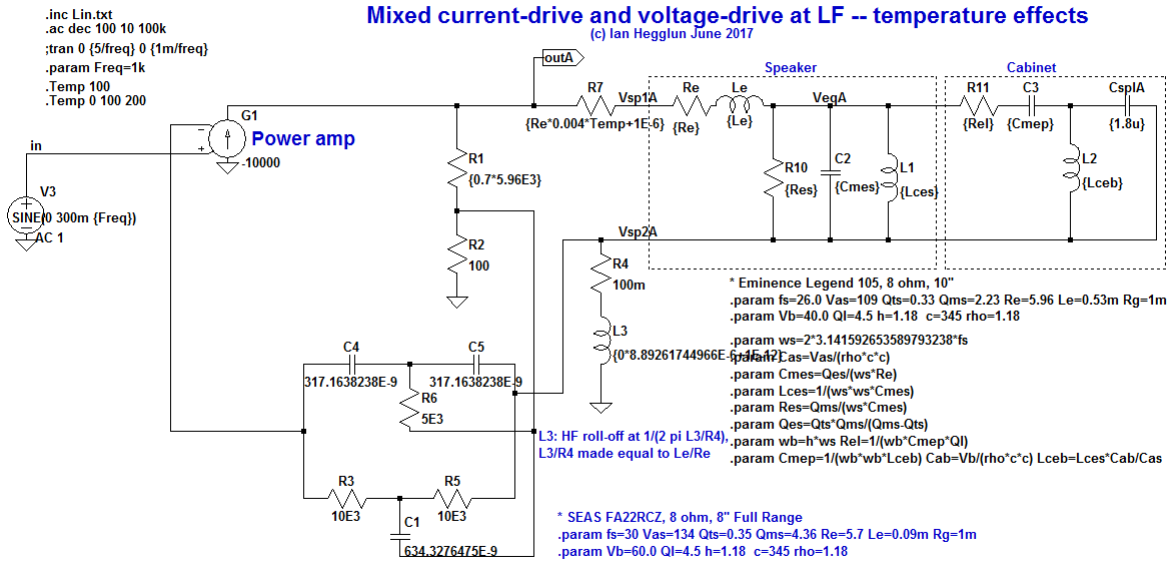

Figure 4 Using a double-T filter rather than an LC filter with impractically high inductance

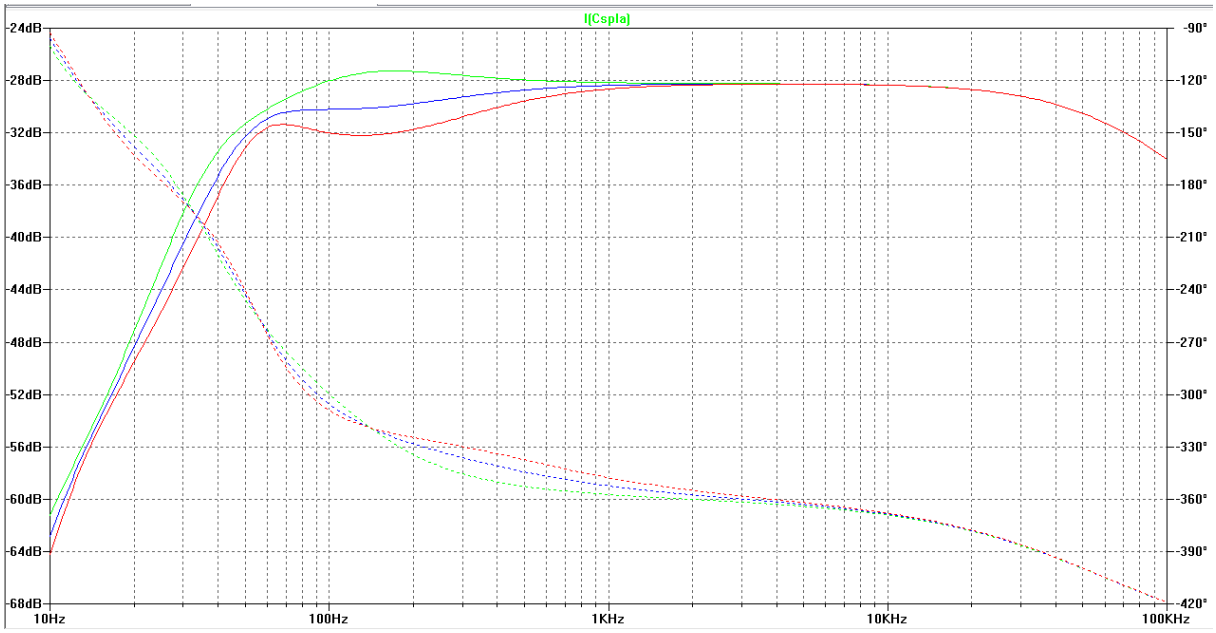

Figure 5 Response at 0, 100 and 200 °C with the circuit of Figure 4 (double-T tuned to 50 Hz, voltage feedback resistor tweaking factor 0.7, roll-off inductor L3 switched off)