ISCE

The Institute of Sound and Communications Engineers

Engineering Note 36

Headphone 'peakers'

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What is a 'peaker'?

People with hearing impairment often find that they can hear things better using headphones. However, the headphones don't incorporate the compensation in the hearing aid for the person's loss of sensitivity to some frequencies. It is possible to add this feature, approximately and to a limited extent, with a simple device, requiring no battery, that is inserted between the source of the audio signals (portable music player, computer etc.) and the headphones.

An ordinary treble tone control set to 'boost' doesn't work well at all. As you can see from Figure 1, it gives a quite different frequency response to that which is required to compensate for typical moderate hearing loss.

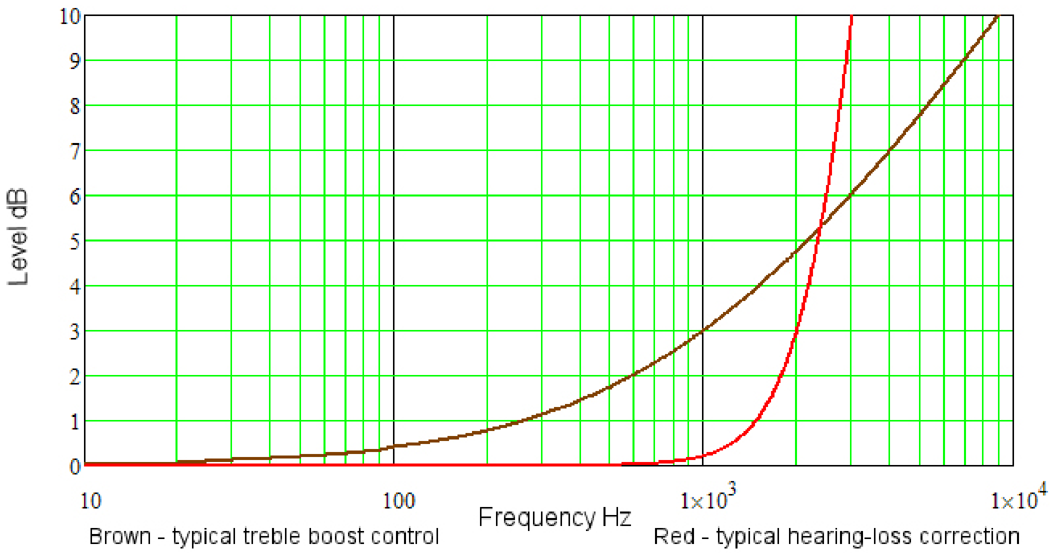

Figure 1 Difference between a treble boost characteristic and a hearing loss correction characteristic

You probably won't make your fortune by selling these devices as commercial products, but you may well make some hard-of-hearing people very grateful. If you do try selling, I would appreciate a credit for the design.

Something is rarely available for nothing , and this is no exception. The low-frequency sounds are reduced in volume, but this can usually be overcome by increasing the volume level at the source. This may not work if low-sensitivity headphones are used, as are required by European safety regulations.

There are two sorts of peaker, which we may call 'series type' and 'T-type'. Both have advantages and disadvantages. This gives ample scope for experiment.

For practical reasons, the peakers described here are intended to compensate for fairly limited high-frequency loss, which is the most widespread form of hearing impairment. Even so, everybody is different, and some with more severe loss may find these devices tip the balance towards 'comprehension' and away from 'confusion'.

Both types of peaker have an adjustable control, which changes the amount of compensation. For demonstration purposes, this control might have a control knob, but for personal use, a pre-set control, adjustable with a small screwdriver is likely to be preferable, because once set to the optimum position, it should require resetting only infrequently.

The designs described are two-channel, for use with 'stereo' headphones. They can be driven from a monaural or a stereo source without any changes. This means that there is a separate adjustable control for each channel, i.e. each ear, which is necessary since many people have differing impairments in their two ears. However, it is **not** satisfactory to connect the two **outputs** together to feed monaural headphones; that requires changes to the component values in the devices.

The Series Peaker

As shown in Figure 2, this works by putting in series with each headphone a resistance (adjustable) and substantially cancelling its attenuating (volume reduction) effect by connecting a series tuned circuit in parallel with it. The shape of the peaking curve with frequency doesn't change as the adjustable resistance is varied, but the level (loudness) of low-frequency sound does change, so the volume level of the source of the audio may need to be adjusted to compensate.

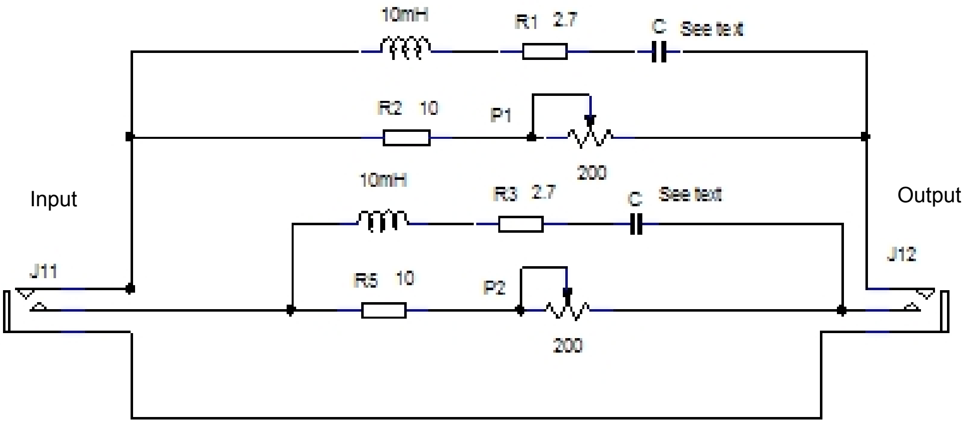

Figure 2 Schematic of the series peaker

The 10 mH coils are RS part number 675-5333 and have a DC resistance of 7.3 Ω. If you use coils with a different DC resistance, adjust the value of R1 and R3 from 2.7 Ω so that the total resistance is 10 Ω in each case. The capacitors can be polyester types. The value can be selected to set the peak frequency, as shown in Figure 3.

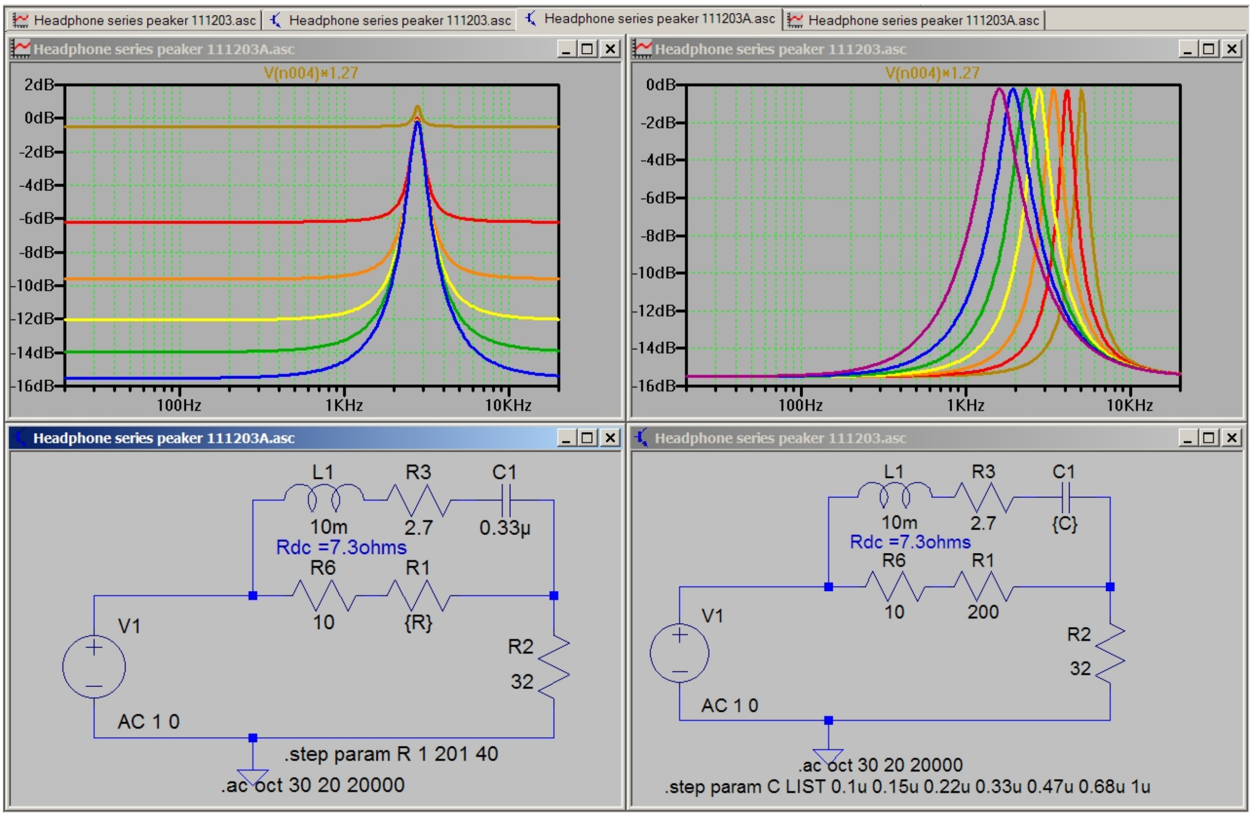

Figure 3 Frequency response curves of the series peaker and LTspice schematics

The upper left diagram shows the effect of varying the adjustable resistor in changing the level of low-frequency sounds while keeping the level of the peak constant, while the upper right diagram show the effect of different values of the capacitors C in changing the peak frequency. The curve for 0.1 µF in the upper right diagram is the brown one and the others follow in order.

You can see that the rise in level on the low-frequency side of the peak is quite sharp, so it can help a bit with quite steep-sloped hearing loss, but the **amount** of compensation is limited to about 16 dB.

These diagrams are based on the device being driven from a source of very low internal impedance. Different, but still useful, effects, are produced if the source has an internal impedance even as large as 33 Ω.

The T-type peaker

Figure 4 shows the schematic of the T-type peaker. It's called 'T-type' because the resistors R1 and R5, the parallel resonant circuit and the headphone impedance form a T-attenuator, with minimum attenuation at the resonance frequency.

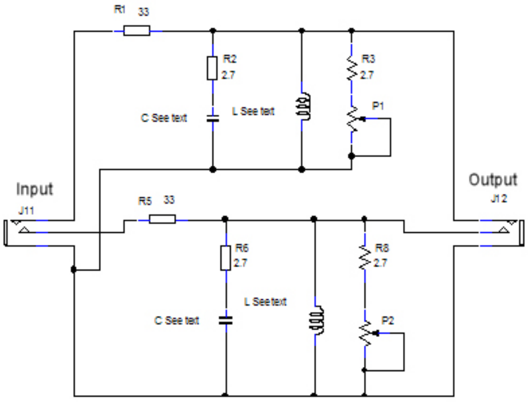

Figure 4 Schematic of the T-type peaker

As for the series peaker, the adjustable resistor varies the peaking effect, but here the low-frequency level does **not** change with the setting. Figure 5 shows the effects of the adjustment and the peak frequency options.

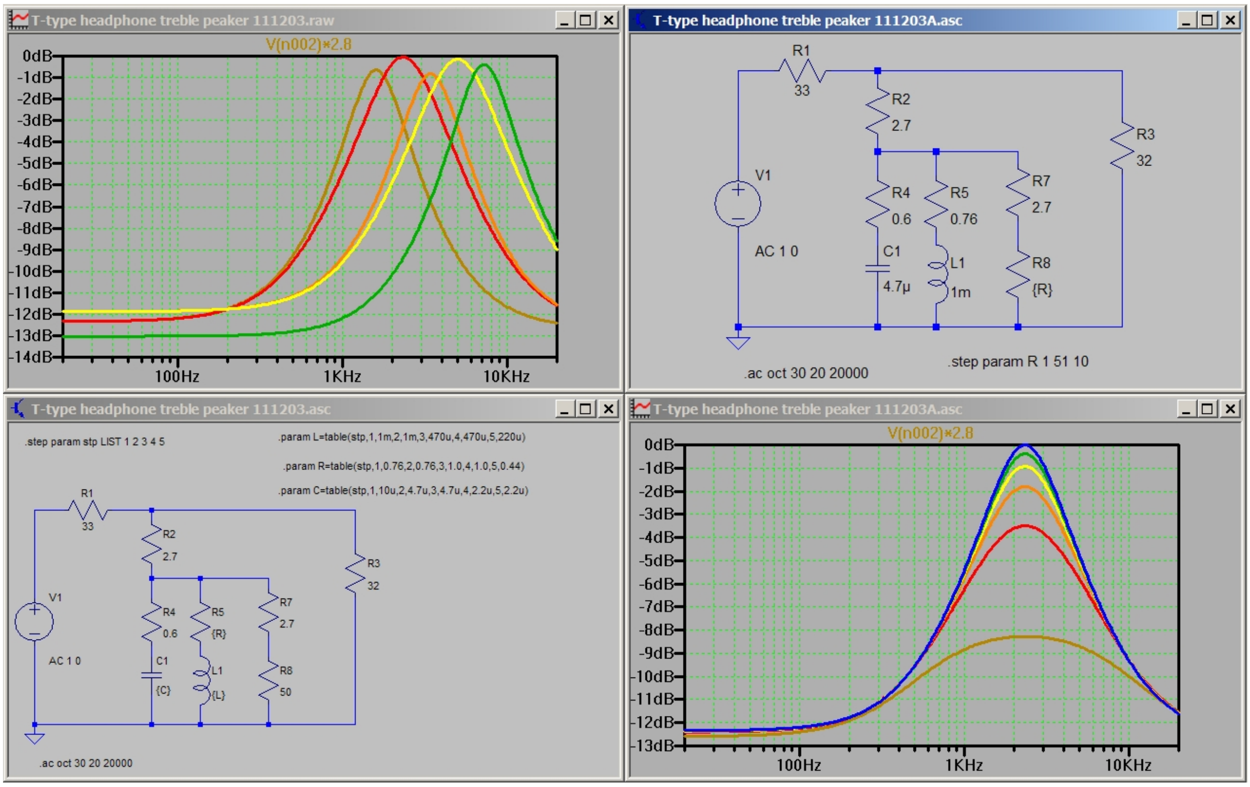

Figure 5 Frequency response curves of the T-type peaker and LTspice schematics

In this case, we have to change both coil and capacitor values to obtain reasonably-shaped frequency response curves with different peak frequencies. In the upper left diagram, the brown curve is for the combination 1 mH and 10 µF, and the others follow in order. Electrolytic capacitors are not suitable for this device, not because there is no polarizing voltage but because their internal resistance is often too high. Polyester capacitors would be very large and costly, but luckily we now have remarkably tiny multi-layer ceramic capacitors at acceptable costs. However, there are three types of these, one very costly, one with a very wide tolerance on the capacitance and one that is OK.