

# DESIGN IDEAS

EDITED BY TARLTON FLEMING

## Wien-bridge filters enhance tone control

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Most audio tone controls affect midband gain, and they often create booming or hissing sounds when activated. You can avoid these problems by using a dual Wien-bridge filter to provide independent control of the treble and bass frequencies.

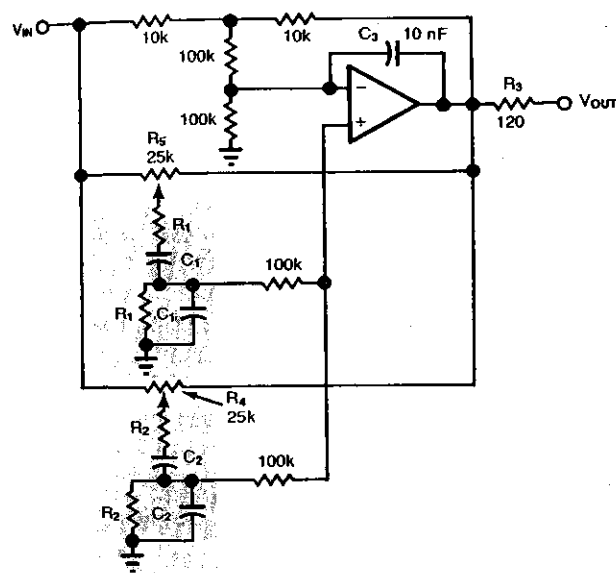


Fig 1—This audio filter's two Wien-bridge networks provide  $\pm 9$  dB of tone control for treble and bass frequencies.

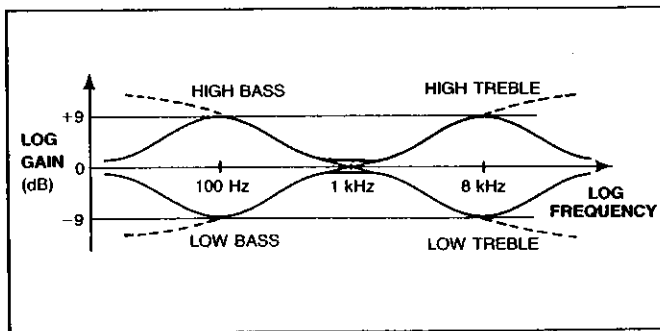


Fig 2—The frequency response of the dual-filter tone control (Fig 1) shows little effect at 1 kHz but  $\pm 9$ -dB variation in the treble and bass regions. For comparison, the dashed lines show the response of a Boxandall tone control.

Experiments with equalizers indicate that the optimum center frequencies are about 100 Hz and 8 kHz. Using the relation  $f = (2\pi RC)^{-1}$ , set the Fig 1 values accordingly:

$$100 \text{ Hz: } R_1 = 15 \text{ k}\Omega; C_1 = 0.1 \mu\text{F}$$

$$8 \text{ kHz: } R_2 = 16 \text{ k}\Omega; C_2 = 1.3 \text{ nF.}$$

$R_3$  and  $C_3$  provide stability. You obtain a  $\pm 9$ -dB variation of treble and bass by adjusting the potentiometers  $R_4$  and  $R_5$ , respectively. The filter's frequency response is shown in Fig 2.

(Ed Note: The LF356 BiFET op amp is a good choice for this application: It provides low  $I_B$ , low noise, and a good slew rate.)

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## Use dual op amp in an instrumentation amp

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Although monolithic instrumentation amplifiers (IAs) are more cost effective than their discrete and modular predecessors, the limited variety of monolithic IAs restricts their use. You can widen your IA options, however, by deriving the differential response of an

instrumentation amplifier from a dual op amp as shown in Fig 1. The circuit uses FET-input op amps to provide lower noise and lower input bias currents than monolithic IAs can offer.

In Fig 1, feedback networks for the two op amps are interconnected to establish  $IC_{1B}$  as an inverting amplifier in the feedback path of  $IC_{1A}$ . Each amplifier provides an external signal input with the high impedance ex-