# Improved Headphone Listening

## Build a stereo-crossfeed circuit

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RECENT REVIEWS of stereo headphones and introductions of new models by various manufacturers point towards an increasing interest in headphone listening.

Offering the possibility of listening in complete privacy and at volume levels which might be intolerable otherwise, stereo headphones in addition can provide a fidelity of sound reproduction equal if not superior to the very best loudspeakers, yet at considerably lower cost. When buying a pair of headphones, it should be kept in mind that the published frequency curves are measured with an "artificial ear," a fixture which tries to approximate the geometrics of a true ear, and that the measured curves may differ considerably from the sound pressure that is actually perceived by the listener. So the best advice is to listen to a variety of headphones, just as one would do when selecting loudspeakers.

There are some problems with headphone listening which might not be immediately apparent:

1. Headphones can become very uncomfortable after wearing them for more than a half hour, because they might be too heavy or clamp the ears too strongly.

2. Some headphones, due to their acoustical design, require an airtight seal between the ear and the reproducer in order to avoid low frequency loss. This provides a large amount of isolation between the listener and his surroundings and, while this might be very desirable in a monitoring situation or while listening in a noisy environment, it can also put great strains on a normal family life because the listener, even though present, cannot be talked to.

3. Finally there is a problem due to the unnatural spaciousness of the sound reproduction and the complete separation between channels which does not correspond to our normal listening experience. Thus this "super stereo" effect, while very impressive at first, becomes very tiring after a while.

In summary, four factors are required for satisfying listening with stereo headphones:

1. A flat or at least smooth frequency response;
2. A physically comfortable design of the headphones;
3. An amount of isolation appropriate to the living environment, and
4. A means of reducing the channel separation to a natural level.

The first three requirements can be met by choosing the right headphones, but a little help is hereby offered to bring the recorded sound back to its natural spaciousness, even though the problem has been long recognized and described(*).

Therefore the circuit shown in Fig. 1 was developed for addition to any stereo amplifier, either as a separate unit to be connected to the second speaker terminals of most amplifiers or as a modification of the standard headphone output circuitry.

*Hewlett-Packard Co.

*Larson, Eargle, AUDIO, Nov., 1962; Bauer, JAES, April, 1961, Oct., 1965.

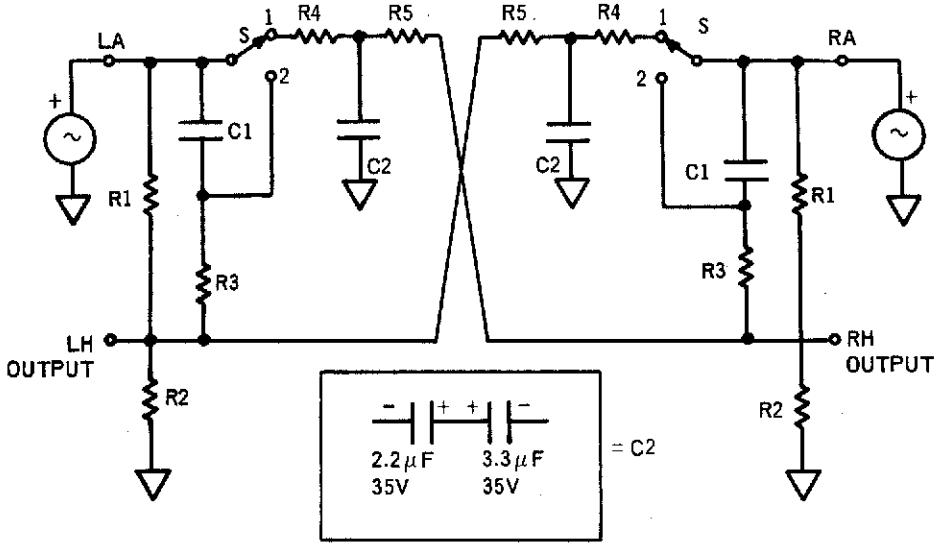


**Fig. 1**—Crossfeed network.

This circuit provides crossfeed between the outputs of the right and left amplifier channels in such a way that the separation between the channels is reduced to 3 dB for frequencies below 700 Hz and increases above 700 Hz. (See Fig. 2.) The reason for this is that at low frequencies with a correspondingly long wavelength (e.g. 1.6 feet at 700 Hz) the sound pressure will be in phase at each ear in a natural listening situation, because the distance between ears becomes less than one half of a wavelength.

However, it is assumed that there can be a difference in intensity at each ear, so the channel separation is maintained at 3 dB.

The two resistors, R1 and R2, in Fig. 1 form an attenuator between the amplifier LA and the headphone output LH. Crossfeed between outputs is obtained through the lowpass filter R4, C2.

The crossfeed signal adds to the direct signal when they are in phase and thus the headphone output voltage will increase for low frequencies. In order to partially compensate for this, the direct signal is boosted 2 dB for frequencies above 700 Hz by the highpass R3, C1.

Only partial compensation is attempted since it cannot be expected that all low frequency signals are in phase and will add on contemporary stereo records.

The DPDT switch, S, will in position 2 turn off the crossfeed and the high frequency boost, restoring the standard headphone outputs. The purpose of this switch is mainly to demonstrate the effectiveness of the crossfeed circuit and otherwise could well be left out.

Several observations can be made about using the crossfeed network:

1. If, for example, a radio announcer speaks only on the left channel, he appears to have moved his position forward toward the center by about a 40 degree angle. The feeling of being deaf in the right ear is gone.

2. In some cases there appears to be a loss in low frequencies. This is due to the cancellation of the unrealistic out-of-phase signals. The same effect makes vertical rumble from records inaudible, since it produces out-of-phase signals. The realism of reproduction is greatly enhanced by the corresponding improvement in the signal-to-noise ratio.

3. Finally, the main objective for the circuit, the appropriate reduction of channel separation has been very satisfactorily achieved. Rather than sitting in the midst of an orchestra with the violin against one ear and the drum against the other, the instruments now seem to have moved forward and away from the listener and a sense of depth in the forward direction is added. This is particularly felt on recordings which try to maintain the natural balance between solo instruments and the whole orchestra. It becomes easy to get a sense of the layout of the orchestra and the location of individual instruments. At the same time the positioning of the recording microphone becomes much more apparent. The crossfeed network reduces the sound space to known and familiar dimensions.

In conclusion it can be said that this simple and inexpensive circuit will, in combination with high quality headphones, improve the fidelity of reproduction to a degree which few loudspeakers can match. This hope is that hi-fi enthusiasts will find it easy enough to add the crossfeed to their system for greater fidelity and enjoyment. Æ

## Parts List

| | |
|---|---|
| R1 | 470 ohms, 1 watt |
| R2 | 100 ohms, 0.25 watt |
| R3 | 1k ohms, 0.25 watt |
| R4 | 330 ohms, 1 watt |
| R5 | 330 ohms, 0.25 watt |
| S | DPDT switch |
| C1 | 0.22 μF, 35 volts |
| C2 | 1.3 μF, 35 volts |

C2 consists of 2.2 μF and 3.3 μF capacitors in series, positive ends together.

Two of each required except for the switch, where only one is needed.

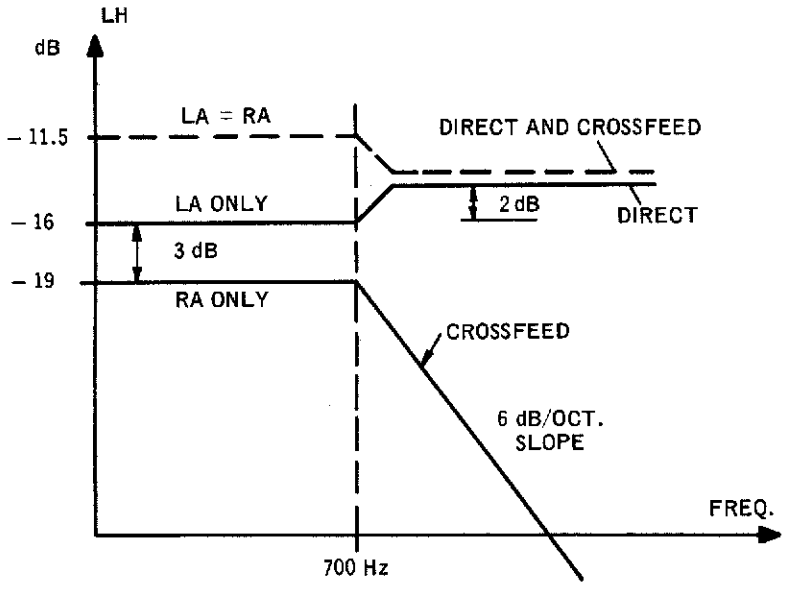


**Fig. 2**—Frequency response. The left channel headphone output (LH) is a function of the left and right channel amplifier outputs (LA, RA) using the circuit shown in Fig. 1.

**Hearing the sounds of Christmas.** A group of deaf children, all of preschool age, listen to sounds familiar to everyone else in this series of pictures by John G. Kenney, award-winning photographer for Elyria, Ohio Chronicle-Telegram.

These pictures won Kenney a first place, best picture series in the Inland Daily Press Assn. contest. He used a Nikon F with a 28mm lens.