We have yet to find a substitute for distortion analyzers and squarewaves, and I doubt we will.

Jeff Nelson
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There's always the human ear, but we all know what a notoriously unreliable device that *is.* **—LA**

David Hafler responds

Editor:

Mr. Nelson's objection to the SWDT (straight wire differential test) is based on the fact that all amplifiers have time delay, and that the concomitant phase shift causes a residual signal when the output of the amplifier is subtracted from its input. Yes, I agree. It is not only conventional non-linear distortions that show up on the SWDT, but *all* aberrations, including those not necessarily objectionable.

Whether phase shift is audible or not is a controversial subject. Phase shift is one of the few parameters which varies widely from amplifier to amplifier, and I will not arbitrarily assume its inaudibility. I prefer to take the viewpoint that all errors be reduced to a minimum rather than theorizing that some are not audible and can be neglected. Therefore we have tried to reduce all distortions in our XL-280 amplifier and have compensated for phase errors so as to have very low phase shift in the audio band.

Mr. Nelson objects to this compensation as he states that this leads to resonant circuits which, he claims, "smear" transients. His hypothesis does not prove out in practice. Our well-damped minor resonance, which falls above 400kHz in our production XL-280s, introduces no detectable flaw in the audio range. The SWDT would show a "smear" as part of the audible residual signal if this problem existed, and we cannot hear such distortion with music or other transient signals.

Mr. Nelson suggests that the differential test would be workable if a linear network, which exactly matched the amplifier, would be used for the straight wire. If that were the case, the amplifier and compensated wire would match; there would be no residual due to such factors as phase or amplitude response errors. Mr. Nelson's suggestion "bends" the straight wire, and assumes that phase and amplitude errors are inaudible. This is too great an assumption. To take an extreme example: an amplifier with very limited frequency response, -3dB at 100Hz and 10kHz, could be tested against the not-so-straight "wire" which includes passive components giving the same frequency response as the amplifier. The amplitude error would be subtracted out, and the "bent" amplifier would exhibit no amplitude error in this comparison with the "bent" wire.

The SWDT puts a premium on bandwidth. This is necessary to obtain low phase shift in the audio range. This wide range, plus phase compensation, permits a null which remains deep over a wide range. Since the sensitivity of the ear decreases at low and high frequencies, the residual which increases at the frequency extremes because of phase shift has very low audibility. This test is primarily a listening test, so an inaudible null indicates there is no audible distortion.

Mr. Nelson bases his objections to the SWDT on the short description given by J. Gordon Holt when he wrote of his experiments with the technique. I suggest that Mr. Nelson refer to my article in *Audio*, February 1987, which covers the rationale of the SWDT and mentions some of its limitations. I would like to point out particularly that my discussion of evaluating amplifier distortion by listening tests includes comparison on an A/B basis between the amplifier and a straight wire. I have observed that for an amplifier to be indistinguishable from a straight wire on the A/B comparison, using music or noise as a source, it must perform well on the SWDT. This means that, in addition to low distortion, the amplifier must have wide bandpass and relatively low phase shift. Of course, we will never see the perfect amplifier with infinite null on the SWDT. However, when our null exceeds 60dB over a wide spectrum, I contend that the aberrations are essentially inaudible; an amplifier with different sonic qualities is less accurate. Mr. Nelson's argument does not refute my contention: a null level deep enough to be inaudible means an accurate amplifier, and any which sounds different is not as accurate.

We are all seeking accurate sound. Computerized models of "perfect" amplifiers (or imperfect ones for that matter) are fine for the