Hello Alan!

I have read your work on the study of the noticeability of noise in the sounds of music.
https://www.axiomaudio.com/blog/distortion
I think you went in the wrong direction in your research. You yourself write that in the era of records and tape recorders, neither the crackling of the records, nor the noise of the tape prevented us from enjoying music. It is not here that one should look for the reasons for a bad sound.

It is known that the results of measurements of nonlinear distortion do not correlate in any way with the sound quality. Different amplifiers with the same THD parameters (for example, with THD = 0.01%) can sound completely different on acoustics with distortions of 3% or more. Other testing methods give little in this direction, since we measure the wrong thing.

The sound quality primarily depends on the signal time propagation delay (tPD) and its behavior far beyond the audio band (at least up to 1 ... 2 MHz). Theoretically, the group delay should not exceed 100 ns in the audio range, it is desirable that the group delay is constant up to 1 ... 2 MHz and then has a smooth decline. The rise of the group delay outside the audio range is unacceptable.

To obtain the introduced distortion, it is necessary to subtract the output signal from the input signal, which is adjusted in level to the output by multiplying by Ku and the output signal delayed by the transit time in the amplifier. The method was proposed in the time of Baksandall as a vector distortion indicator, but it has not found widespread use due to a number of technical difficulties.

The simplest method for investigating vector errors and their dependence on the GD (tPD) was proposed by Hafler, see figure. For research, two amplifiers are required: one is a reference amplifier (preferably a broadband one with a full power bandwidth of at least 500 kHz), and the second is tested.

1. Measurement of speed distortion A rectangular signal (for example 5 kHz) is fed to the input and, using a trimming resistor, compensation of the signal at the load is achieved. Control and measurement of speed distortions are performed using an oscilloscope (preferably with isolated inputs). The distortion level is equal to the area of the up / down pulses synchronous with the edges of the square wave signal.

2. Measurement of signal transit delay (tPD)
2a) the signal propagation delay time is measured between the input and output signals using a dual-beam oscilloscope in the traditional way. As signals, you can use both a square wave and a sinusoidal with a frequency of 10 ... 100 kHz.
2b) Measurement of the delay using the Hafler circuit. For this purpose, a triangular signal with a frequency of 5 ... 10 kHz is used, with the help of a trimming resistor, a rectangular signal is obtained at the load. In this case, the amplitude of the triangular signals at the outputs of the amplifiers will be the same. Time Propagation Delay is calculated by the formula:

$$tPD = aT/4A$$

where
a - is the amplitude of the rectangular signal at the load;
T - is the period of the triangular signal;
A - amplitude of the triangular signal at the outputs of the amplifiers

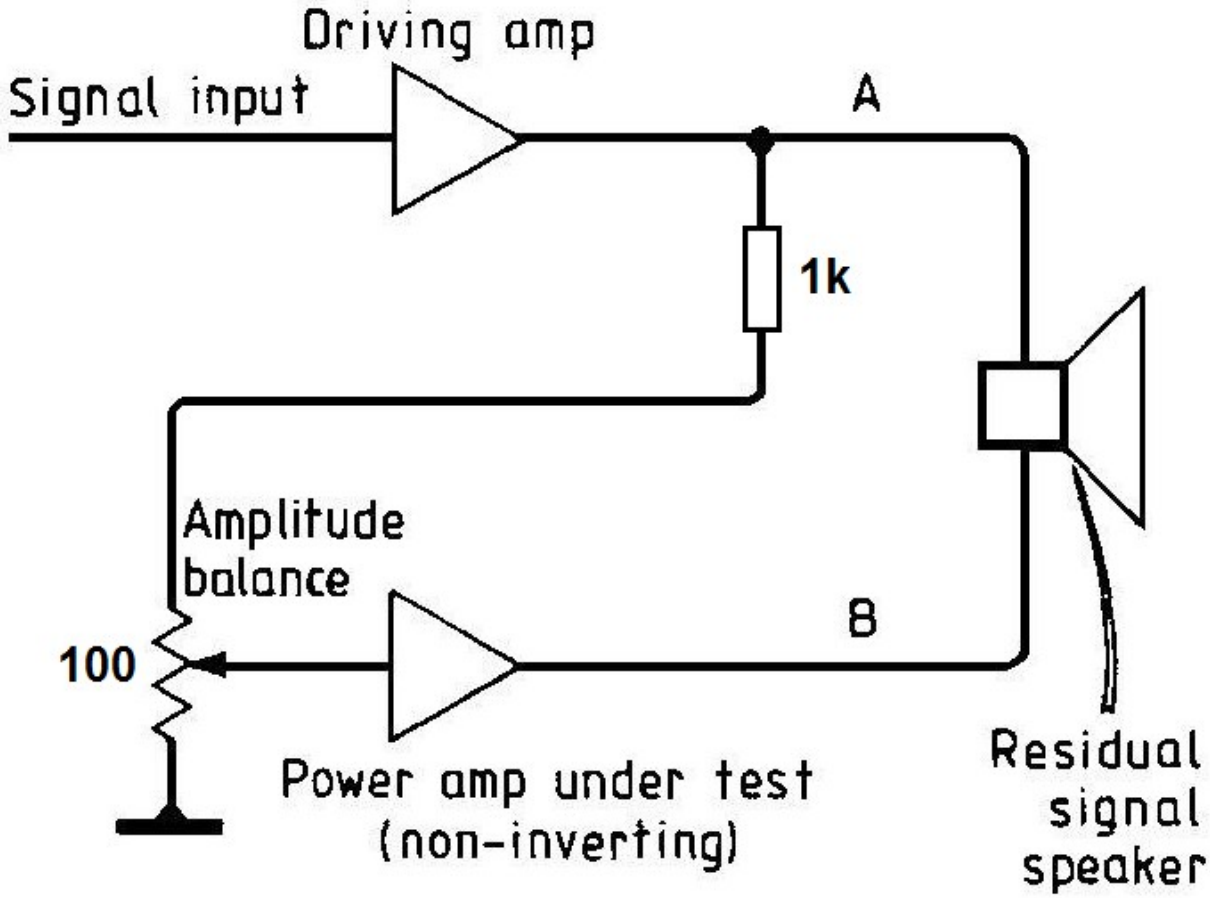

Fig.4. Hafler 'straight-wire' differential test.

Best regards
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