

# Dual Complimentary Symmetrical Linear Class A Headphone/Pre-/Line Amplifier

Design: Nico Ras

## Introduction

I have spent many years attempting to design a truly characterless amplifier that neither adds nor subtracts to any complex input stimulus. This new design fulfils this goal; it will produce a precisely amplified replica of any signal applied to its input

This amplifier is adapted from a design I devised 20 years ago from a Hewlett Packard DC to 15 MHz output stage for a signal/function generator. In that application I limited bandwidth to 10 MHz, but managed to achieve a flat frequency response over 10 MHz and a phase response of less than 0.3 degrees from 1Hz to 800 kHz

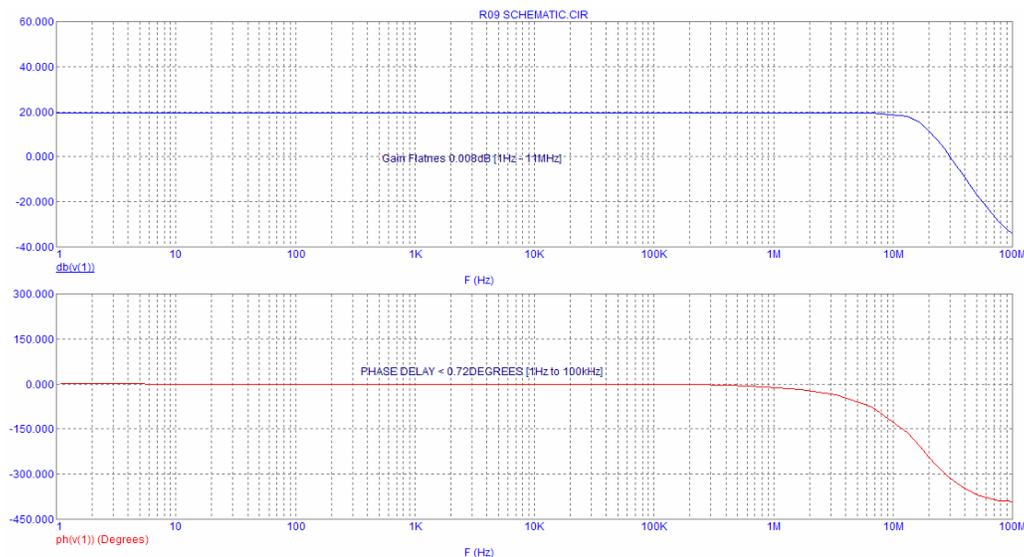
One crucial aspect in test equipment design scarcely mentioned by audio designers is, I believe, a major contributor to distortion. This phenomenon is group delay or phase non-linearity. Distortion is not only related to harmonic power density or THD, but is in fact time related.

Group delay identifies that, in a complex waveform, higher frequencies are time shifted with respect to lower frequencies. This throws the signal 'out of step', with some frequencies delayed more or less than others. Even for the finest audio amplifiers designers almost never consider this fact, an everyday consideration in the design brief for telecommunications and data transmission.

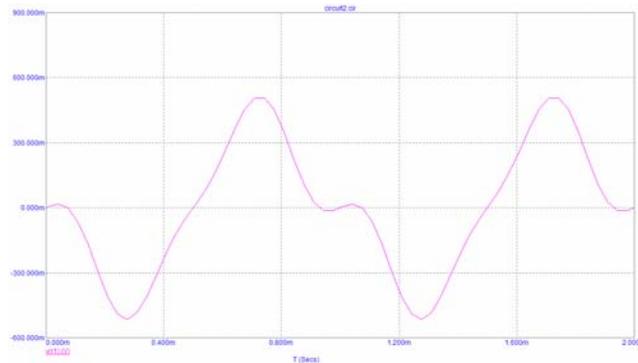
Audio designers often appear concerned only with the harmonic artefacts of amplification. They are unconcerned with the time coherency of the original signal, and how the complexity of the original signal is disrupted by the phenomenon of group delay. They appear to be obsessed with square wave response, overshoot, undershoot or slew and THD at some obscure and arbitrarily selected frequencies. Most know nothing of the third order intercept.

Two different instruments may have similar harmonic power density, but differ in the time relationship of the harmonics to the fundamental. The human ear can easily discern these differences, and it is largely this psycho-acoustic phenomenon which enables us to distinguish between different instruments.

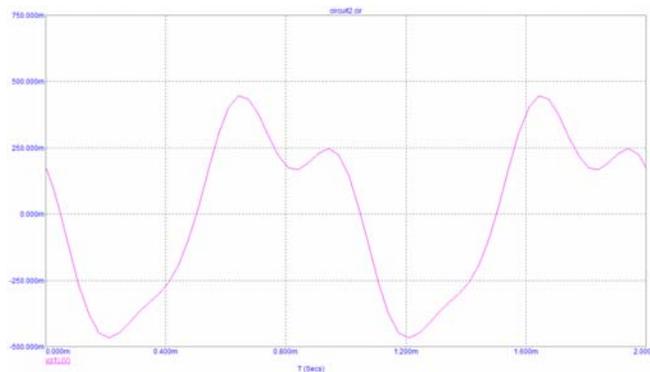
This amplifier will not in any way alter its input signal during the process of amplification. Acting within the constraints of the original recording quality, this amplifier nonetheless is a close approximation of a 'straight wire with gain'. The simulated frequency and phase response is illustrated below.



A further illustration is of the time relation between a fundamental plus two harmonics produced by a typical RAS HPL system which exhibits almost zero phase delay over the entire audio band. Let us assume here that there is an instrument which corresponds sonically to this stimulus. This instrument would produce a fundamental and only two overtones.

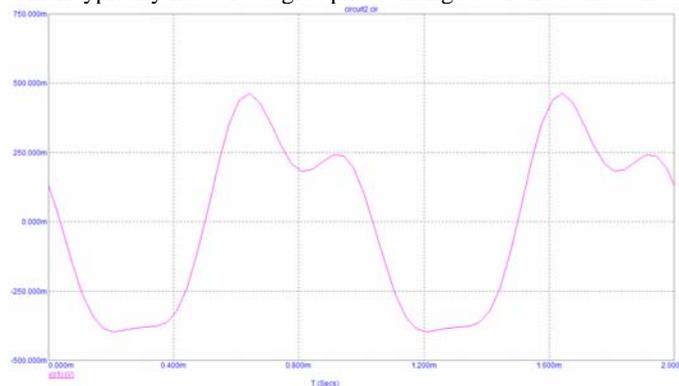


Now let us consider the same signal being produced by an amplifier with only 1 degree per decade phase change (for example, 1 degree at 100Hz, 2 degrees at 1KHz, 3 degrees at 10KHz).



Compared to zero phase delay, the sound character of this instrument has changed so that you might find it difficult to hear that the original and this instrument is the same.

Now let us use the zero phase delayed signal as before with some commercial audiophile preamp designs available which typically has a 15 degree phase change over the audio band.



It should be obvious that the waveform produced by many typical audiophile equipment is markedly unfaithful to the original signal and although the designer may claim harmonic distortion of less than 0.001%, these circuits cannot be favourably considered by serious music lovers who know their music.

This simple analysis reveals that it would be difficult to discern the sonic differences between a bass guitar and a bass drum, for example since neither would sound faithful to the original. Besides the amplifier, speakers behave far worse, hence the loudspeaker is the link in the chain that determines almost entirely what the system will sound like.