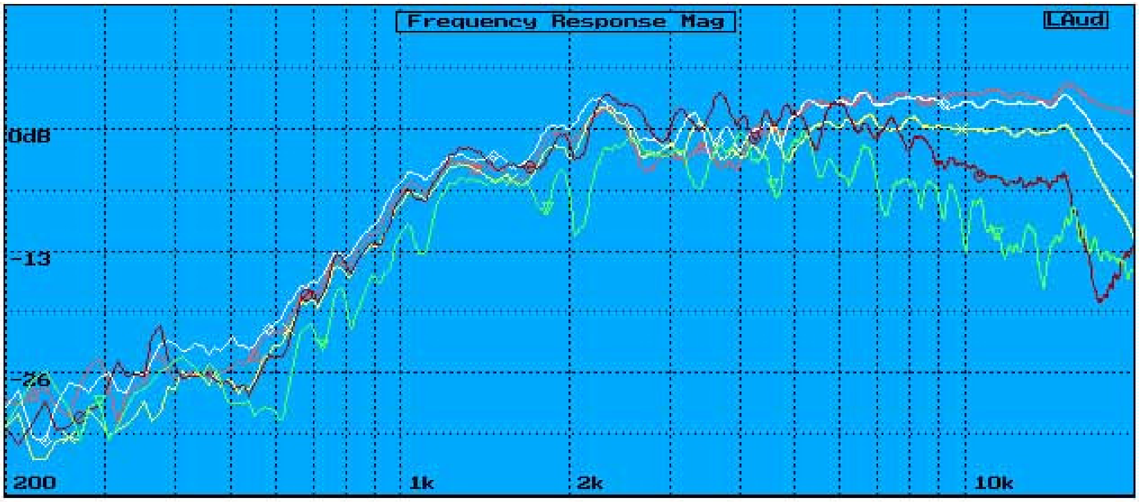
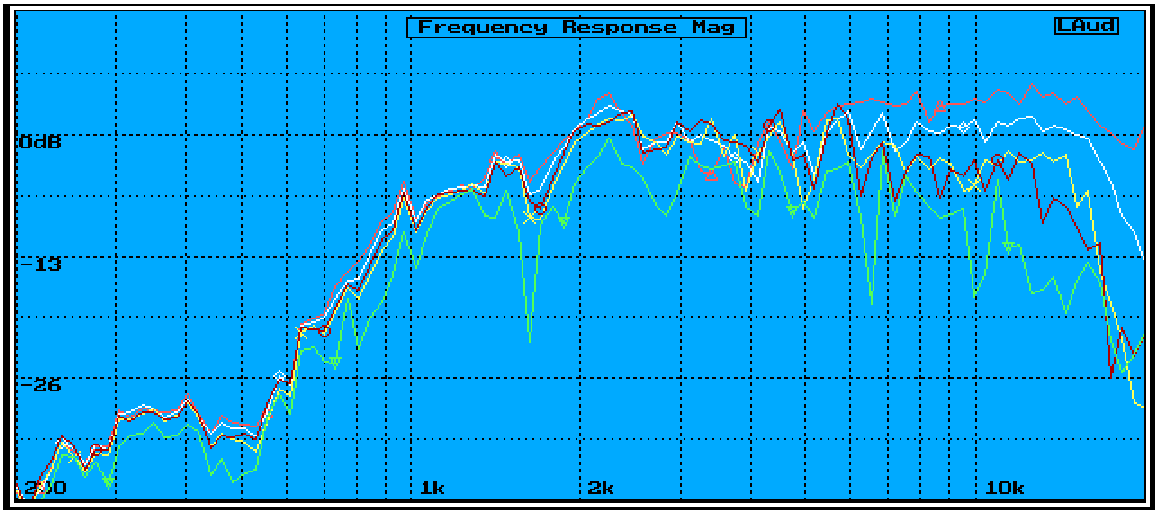
A- 1” HIGH FREQUENCY DOME DRIVER WITH ETL



Red curve is on axis
White curve is 10 degrees off axis
Yellow curve is 20 degrees off axis
Dark red curve is 45 degrees off axis
Green curve is 60 degrees off axis

B- 1” HIGH FREQUENCY DOME DRIVER WITHOUT ETL



Red curve is on axis
White curve is 10 degrees off axis
Yellow curve is 20 degrees off axis
Dark red curve is 45 degrees off axis
Green curve is 60 degrees off axis

ACOUSTIC IMPEDANCE

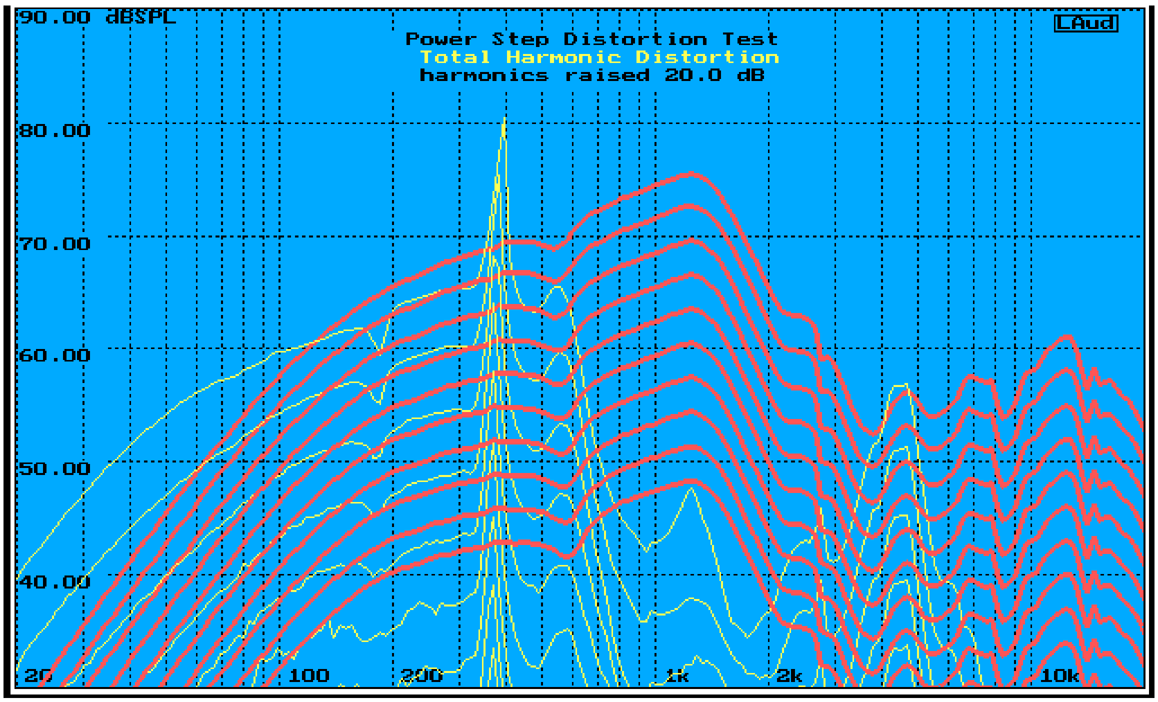
The graphs above illustrate the benefits of the Embedded Transmission Line (ETL) for a typical loudspeaker driver. This driver in B relates the effects of unmanaged pressure behind the diaphragm and the disastrous effects it can have on the driver response. Typically loudspeaker designers choose stiff diaphragm materials to resist this modulation. This does not improve the Acoustic Impedance (AI) of the diaphragm only altering it further. We are illustrating the effects on a high frequency driver operating in normal ambient environment. This problem carries over to smaller and larger diaphragms used in speakers, earbuds and headphones.

The AI of the single broadband driver is a subject not taken seriously in loudspeaker design. While using multiple drivers and necessary crossover networks is associated with this problem it fails to address the broadband distortion experienced by each and every driver used. The driver's AI is not proper in any situation that does not maintain pressure and velocity in phase for the broadband response. The sound emitted by the driver is the result of compound waves where varying wave content combines to produce the modulation errors.

Here we are showing two graph overlays A and B indicating the response curves of a silk dome high frequency driver. B is a standard construction and only has a fixed rear diaphragm volume related to the driver construction and that of the voice coil gap. The extreme peaks and dips are due to backpressure interfering with the driver at certain frequencies to cause severe cancellations and peaks in response. The off axis response illustrates this worsening condition with diaphragm vibrational modes affected by rear diaphragm pressure phases. Diaphragm breakup is the common name given for this phenomena and it worsens when the input signal is a compound wave consisting of many different wavelengths and energy levels. Typically a driver designer will attempt construction using different diaphragm materials alone or with other changes that alter the diaphragm vibrational modes in response to this pressure. This typically only changes the vibrational modes relative to that of the new material structure to change the sound character not maintain it neutral. The sagging response in B illustrates a changing in Acoustic Impedance for the higher frequencies as well as the resonance cancellation modes throughout. The response to increasing levels will not be linear as is indicated in B by the loss of response at a fixed swept level. The varying acoustic impedance is also indicated by the loss of low frequencies both in rate of level change and the lower limit reached.

With the graphs in A the ETL is maintaining the AI of the driver by altering the dynamic resistance of the enclosure so as to maintain critical damping for the driver's broadband response. The ETL is acting as a dynamic low-pressure region for the enclosure using friction and confinement to force heat removal by turbulence creation and viscous heat dissipation. Conversion of vortical energy elements into a coherent turbulent mass dissipates heat and therefore reduces pressure in real time. The result is a coherent output with improved smoothness on all axes. The off axis information combines in a room to determine the sound heard by the listener. These variations in diaphragm vibrational modes combine in an earbud canal producing varying effects caused by the ear canal details and the stiffness of an individual's eardrum. Exposed drivers in earphones will exhibit results more as a room with reflections from canal walls and eardrum affecting the AI. The resonance characteristics of a specific ear will affect the sound characteristics of an earbud/phone without pressure management of the diaphragm just as the room affects the driver. The short distances and small ambient volume involved typically keep the sonic variations smaller as the pressure differences on each side of the diaphragm are less. (Mic@ 18" distance from driver at respective angles)

Power Input vs Output Level



BEB prototype in ear headphones- step response mic input attenuated –40db

The above graph is indicating the step power response of a low cost ETL based in ear headphone. The level indicated at the left represents an input attenuation of –40db to prevent preamp distortion. The top level represents a maximum level at 1.2k of 116db SPL (76db + 40db =116db). The power is stepped up 10 times (+3db each sweep) from 88db SPL (48db + 40db = 88db) to the highest step. There is less than 2db of compression over the range of 88db (lowest level) to 118db (highest level) tested. Of course the compression would be very low below the 88db reference. The full range sweep indicates how well the driver maintains the 3db level change with frequency. The distortion indicated in yellow must be reduced in level by –20db as indicated for accurate reference. The main distortion feature is at driver resonance of 380Hz. As can be seen by the red stepped graphs that the driver tracks the input level accurately with frequency.

Mic @ 1" distance from driver coupled with .375" ID closed cell foam coupler