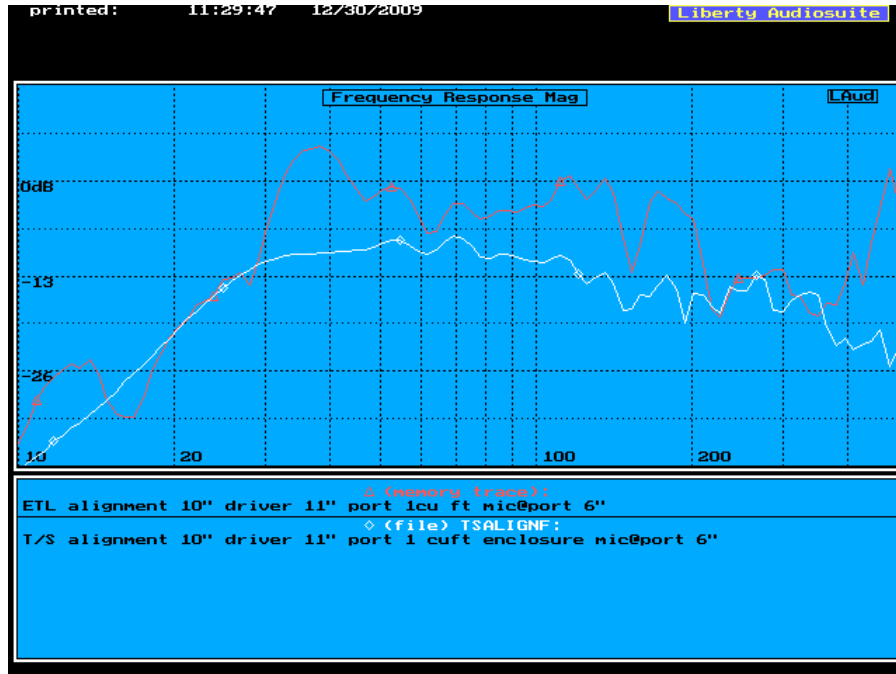
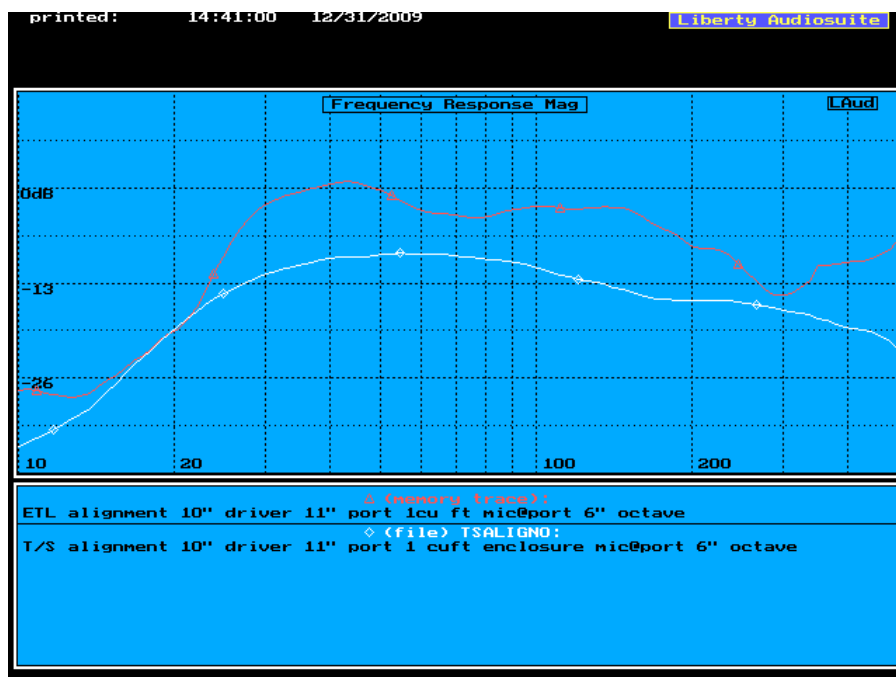


ALIGNMENT DATA T/S vs. ETL™

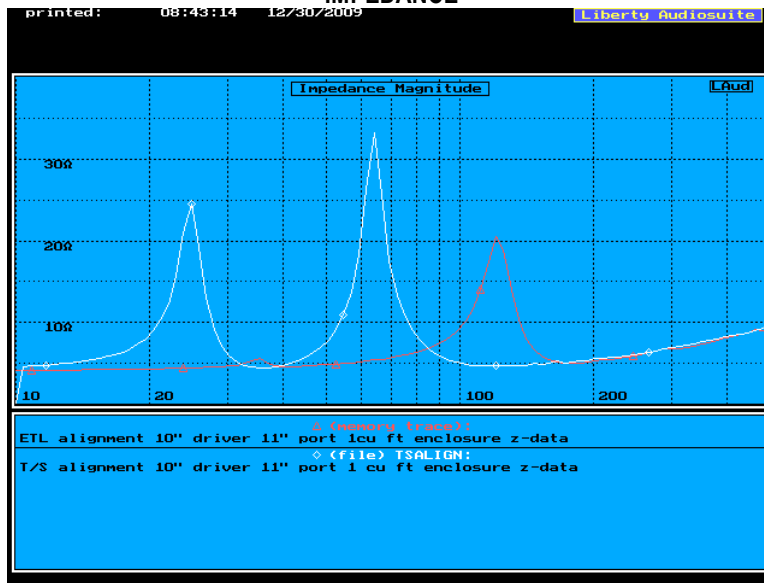
LEVEL



The above graph indicates the SPL difference for a T/S alignment vs. the same driver, box and port using the same reference amplifier and signal input but with the ETL™ modifying the enclosure volume in real time. The below graph indicates octave smoothing to illustrate the total energy gained. The white T/S graph is misleading, as the compression resulting from increased output will distort the response. The impedance and phase variations caused by the resonant features of the T/S alignment will cause less current to flow during resonant events preventing the driver displacement from following a linear momentum. With less force there will be less motion of the cone therefore distortion. The amplitude graphs mean nothing if there is a relative change in level when input signal demands linear motion for the entire bandwidth. There is no getting around a flat constant phase impedance curve for low frequency systems.

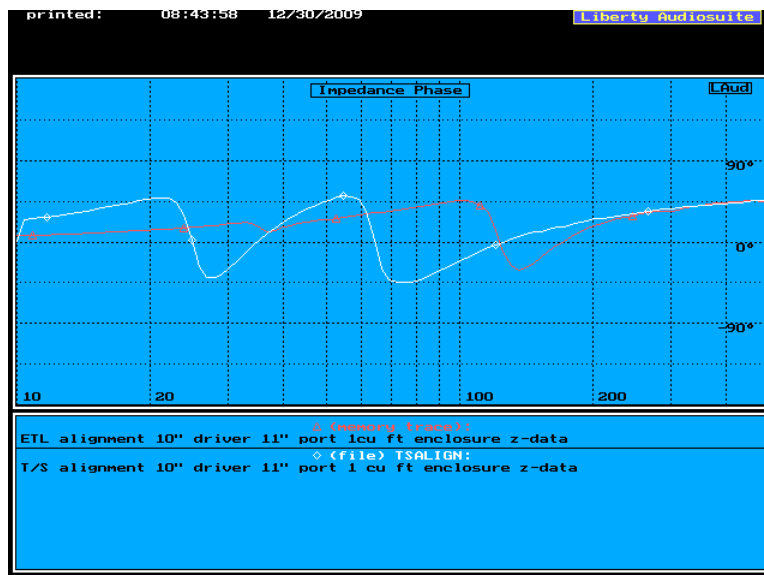


IMPEDANCE



The white graph above illustrates the impedance of the conventional T/S alignment of the above referenced driver, enclosure and port. The impedance and phase of the load should remain constant at the desired impedance throughout its range of operation. Low frequency performance, unlike any other band can be readily determined by the impedance curves. As low frequencies are not directional and don't suffer from cone breakup in their operating band, the primary performance indicator is the impedance. This determines how the amplifier transfers its power not unlike a typical electrical circuit into a resistor. In the T/S alignment the driver has useful impedance at driver and box resonance. The output at port resonance (white graph) is declining due to added resistance to airflow offered by the occurring port misalignment as frequency lowers. The output below this peak is cancelled due to interaction with the drivers' output at that frequency. The driver provides its output in opposite phase at its resonance directly modulating the ambient air but without the required force to maintain amplitude control. The amplifier can deliver its current only when the box is loading the driver while the output above and below this frequency is delivered at decreasing currents. The result is a lack of force for the driver to overcome the compressive effects of the enclosure providing a pronounced boom at and near its minimum impedance. The impedance variation is 800% below 80 Hz in the T/S vs. 25% for ETL™ without it reversing through the zero plane. The ETL™ alignment of the same enclosure results in a near constant 4-ohm impedance not unlike a 20% resistor, as the impedance does not vary by more than 1 ohm between the 10 Hz and 70Hz. The impedance remains below 8 ohms up to 100 Hz and remains entirely capacitive to 125Hz.

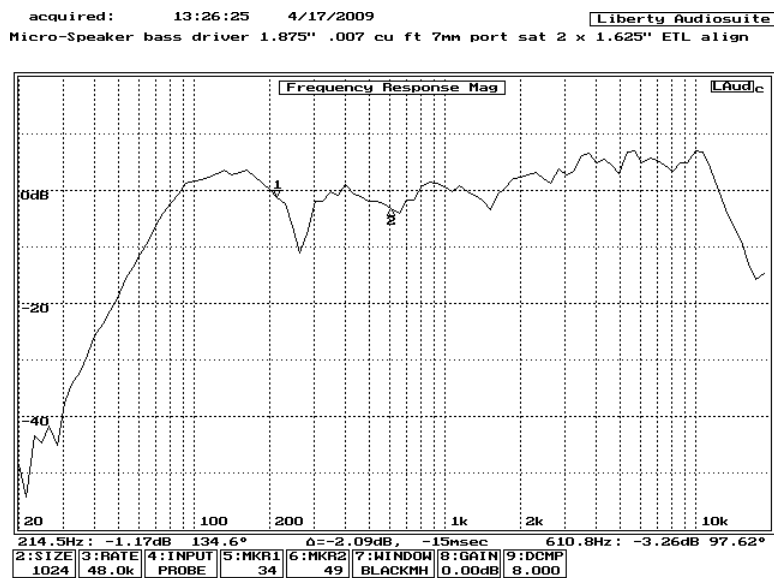
IMPEDANCE PHASE



The phase is constant throughout this period with a total phase shift less than 45° throughout its bandwidth to 125Hz. The impedance phase does not cross the zero plane throughout a 125 Hz bandwidth with a single zero crossing occurring at driver resonance vs. 4 crossings for the T/L alignment. Driver output is in phase with port output with both being delivered to the ambient using a single 3" diameter port. Compression is minimal with constant impedance providing continuous current and the ETL™ loading the driver at constant pressure. The slight peak at box resonance on the red graph indicates a slight impedance change due to increased port resistance at box resonance. Below this small peak the impedance remains resistive and with the driver isolated from the port, acoustic cancellation between driver and port is eliminated. The ETL™ alignment can be executed using a longer port where this would normally reduce the efficiency of the T/S alignment. The Box volume is dynamically modified by the ETL® allowing improved efficiency at a lower box frequency maintaining the low impedance. The ETL™ system operates vibration free, as the constant impedance indicates. There is very little vibration without altering the cabinet thickness or using additional bracing. The balanced operation provides for incredible speed and ease of integration.

The ETL™ allows for scaling of the dimensions below those useful for T/S designs with the limiting factor being maximum SPL as dictated by driver/enclosure size. Very low frequencies (<40Hz) may lose effectiveness but with ETL™ very small drivers (<2") and enclosures are able to reproduce the main audible lower frequencies at a usable level for the product application. The bass is audible at low levels without excessive boost (2W available) and represent efficient operation for the products dimensional class. There are low cost lifestyle products available on the market today that demonstrate this ability for iPod® and HDTV.

Frequency response miniature iPod® dock



The graph above illustrates the response of a miniature iPod® speaker dock with .007 cu ft available for a ported low enclosure. The driver is 1.875" in diameter and is fully enclosed inside of the tiny enclosure. The port is 7mm in diameter with room for the electronics inside. The left/right satellites have even less dimension available for operational volume again sharing it with electronics. The alignment is maximally efficient near 100 Hz but due to the continued loading of the driver below box resonance the useful output is extended to below 50Hz. With available room gain, as when placing the unit near a wall or in a corner, the output lifts even more since the driver remains acoustically loaded and there is no canceling of output below the port/box resonance. There is no T/S equivalent for this alignment making most of those parameters useless for this application.

The dispersion and dynamic range are improved by providing constant loading via ETL™ for woofer and satellites. This application represents one of the smaller uses of a speaker and the output including the available bass extension dramatically improves with size. Typically this application would be for personal sound within a confined space close to the listener.