Two way passive crossover high end box impedance simulation

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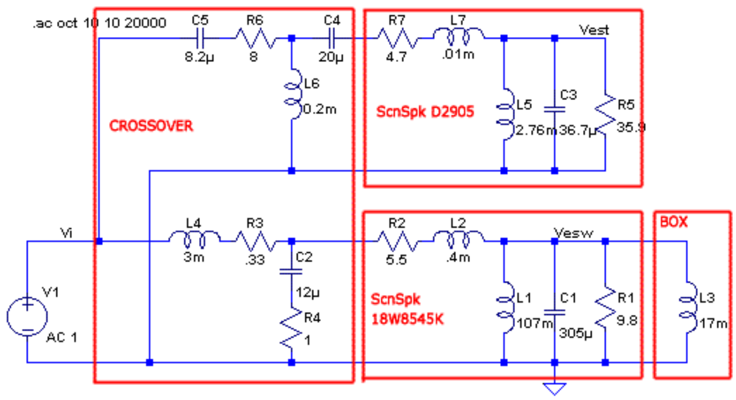
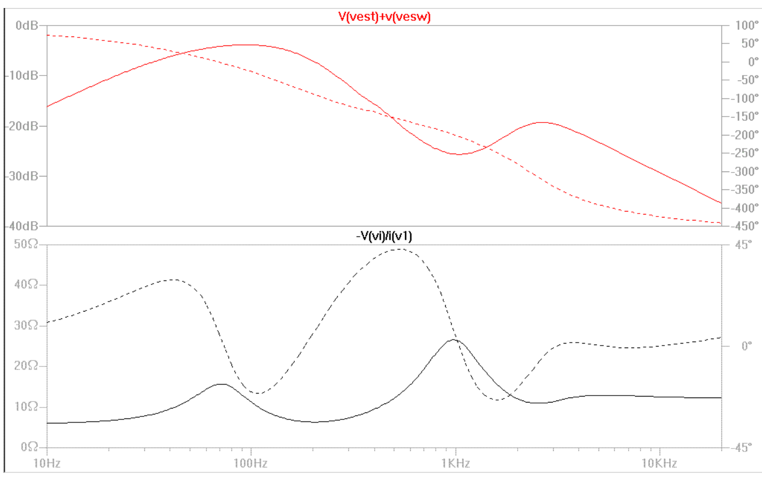
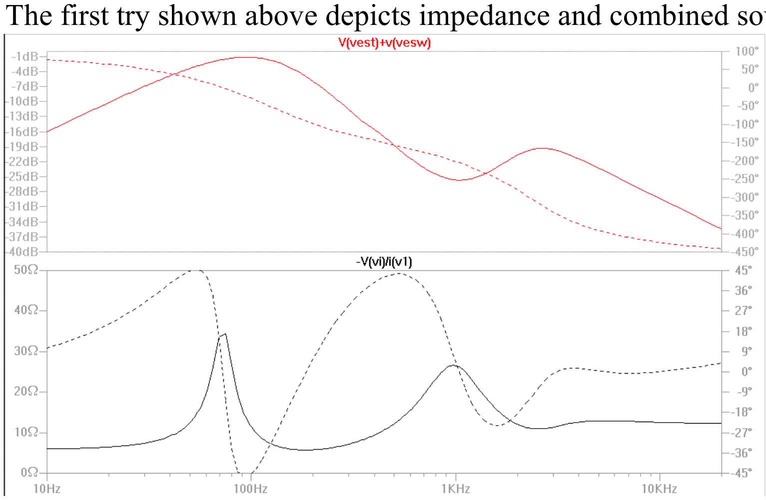
In order to get a closer to reality assessment of real world audio amplifier loading, we selected a high end 2 way design from Vance Dickason, the LDC-6 reference monitor built around Scan Speak drivers and a passive crossover network. Crossover elements were taken from the Parts Express publication, while driver and box parameters were derived from published manufacturer data. The electrical equivalent circuit is shown above. *L7* and *R7* correspond to the tweeter electrical resistance and inductance, while *L5*,*C3* and *R5* represent moving mass, suspension and acoustic elasticity, and electromechanical losses respectively. The same parameters for the woofer are given by *R2*, *L2*, *L1*, *C1*, and *R1*. *Vest* and *Vesw* are the corresponding electrical equivalents of piston velocity, which translates to sound pressure. Box loading is represented by *L3*. Radiation losses are neglected in the model, reflecting the fact speakers are notoriously inefficient transducers.





The first try shown above depicts impedance and combined sound pressure as per above equivalent circuit. Looking at the resonance peaks, both agree well in frequency with the measured results as published, and the peak impedance at 1 KHz also agrees with measurement.



The low frequency peak impedance for its part is far below the measured one, what can be traced to the low *R1* value corresponding to the *Rmes* parameter. I couldn't figure out the root of this anomaly, and for the sake of completeness I made a second try with *R1* tweaked to approximate the measured impedance as shown above. Any ideas / corrections to account for this discrepancy are welcome.

In both cases load phase is plotted as well as magnitude, from where a more realistic scenario can be considered at the time of amplifier simulation.

As with respect to amplitude / phase response, the dip at 1 – 2 kHz is readily seen in the published graphs, while the roll off at higher frequencies at difference with measurements may probably be accounted for because of on-axis beaming.

As closing remarks, it is possible to incorporate this sort of load model for amplifier evaluation, but on the premises there is no such thing as an universally applicable "standard load". Yet as much as strong frequency dependent magnitude and phase angle variations are included, I feel it a closer to reality in comparison with the proverbial 4 or 8 ohm load. Some output stage weaknesses not normally evident on resistive load can surface with the simple addition of these or suitably scaled model components.

Bench top dummy loads incorporating similar equivalent circuits built from passive elements may also be constructed, in order to perform tests not compromising expensive speakers (and ears / neighbors).