

Spice Simulation of a Loudspeaker with Thiele Small Parameter:

The parameters calculated by the online enclosure calculation (www.micka.de/org/en) can help you in using an electrical circuit together with spice to simulate an enclosure speaker system. For instance you can expand your schematic with a voice coil inductance, crossover or baffle-step compensation network. As a result you can find a sound pressure frequency response, step response or an impedance response for your loudspeaker system.

For this simulation you need:

www.micka.de/org/download/spice-tsp.asc.zip (Spice File)

www.linear.com/design-tools/software/ltpc.jsp (LTspice IV – simulation program free of charge)
knowledge of spice simulation

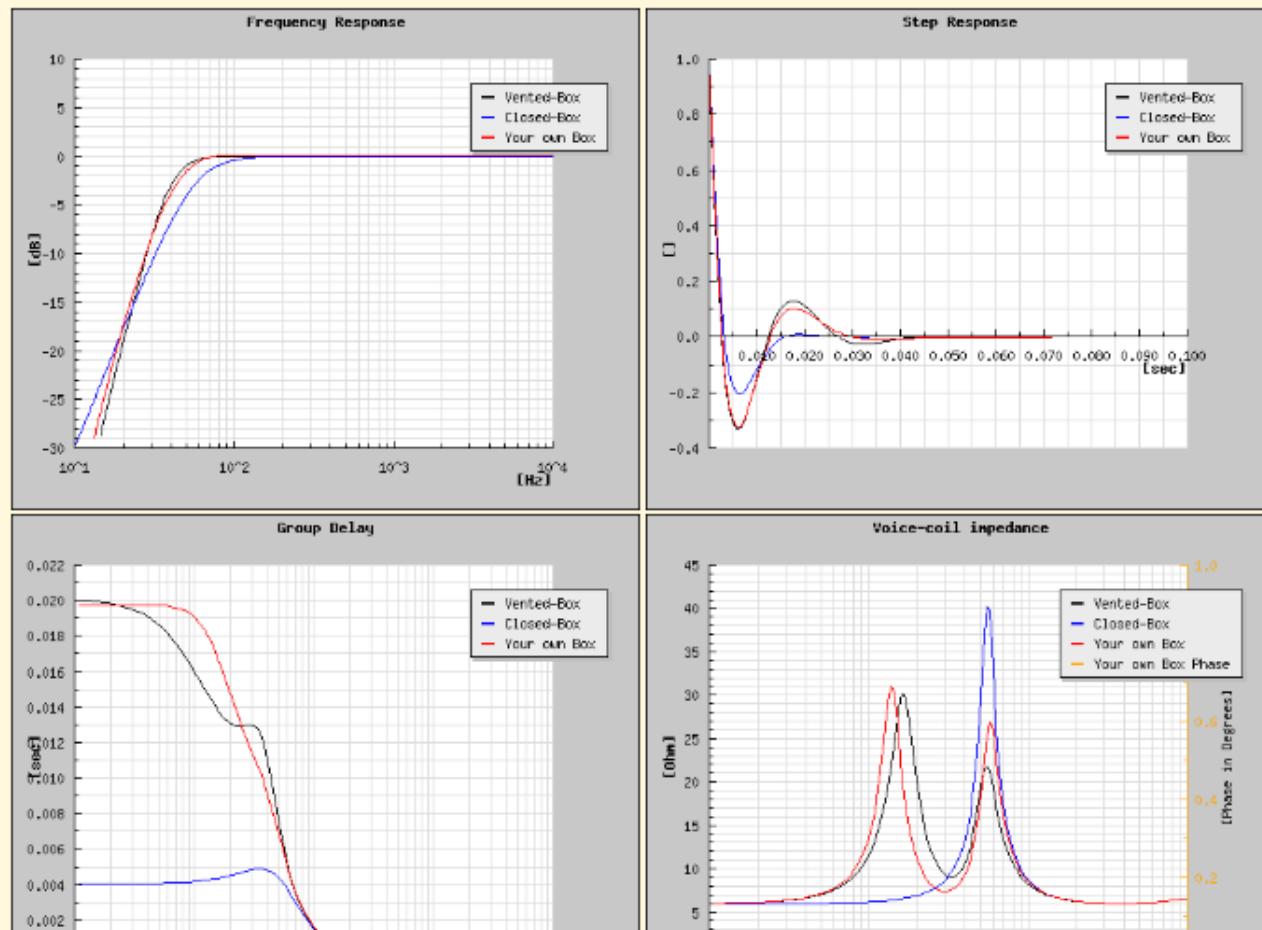
Example Simulation:

First we start with the online enclosure calculation (www.micka.de/org/en):

Thiele Small Parameter Attention: You can put in your own Thiele/Small-parameter only if the speaker-select "parameterinput" is selected. To display diagrams you must fill in all appropriate fields (zeros disables the curves). Speaker: parameterinput Resonance frequency f_s (Hz): 26 V _{AS} (litres): 109 Q _{Ts} : 0.33 Q _{MS} : 2.23 => Q _{ES} =0.39 DC voice-coil resistance R _E (Ohm): 5.96 voice-coil inductance L _E (mH): 0.53 R _g (Ohm): => Q _E =0.39 => Q _T =0.33	Enclosure Vented-Box Q _L : 3 enclosure > 70 litres Vent diameter r _d (cm): 5 Closed-Box Desired Q _{TC} : 0.707 (R _g =0) Your own Box Impedance Phase: <input type="checkbox"/> Enclosure volume V _B (litres): 40 Vent diameter (cm): 6 => (28.27 cm ²) Vent length (cm): 18 Q _L : 4.5 Air temperature (°C): 20 => C _{air} : (343.5 m/s)
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Fill in the appropriate fields for Thiele Small parameter and „Your own Box“ and calculate.

Result:	Vented-Box	Closed-Box without filling	Your own Box	Your own Box parameter for Spice Simulation
Volume of enclosure	56.09 litres	30.42 litres	40.00 litres	$f_s=26.00 \text{ Hz}$ $V_b=40.00 \text{ litres}$
Resonance frequency	34.35 Hz	55.66 Hz	30.72 Hz	$V_{AS}=109.00 \text{ litres}$ $Q_L=4.50$
Half power frequency	39.91 Hz	55.71 Hz	42.65 Hz	$Q_{TS}=0.33$ $h=1.18$
Vent diameter	5 cm (19.63 cm^2)	---	6 cm (28.27 cm^2)	$Q_{MS}=2.23$
Vent length	5.20 cm	---	18.00 cm	$R_E=5.96 \text{ Ohm}$
Reference efficiency	0.48 %	0.48 %	0.48 %	$L_E=0.53 \text{ mH}$
Sound pressure level (SPL)	88.78 dB/W/m	88.78 dB/W/m	88.80 dB/W/m	$R_g=0.00 \text{ Ohm}$



On top right you will find all parameters for a spice simulation.

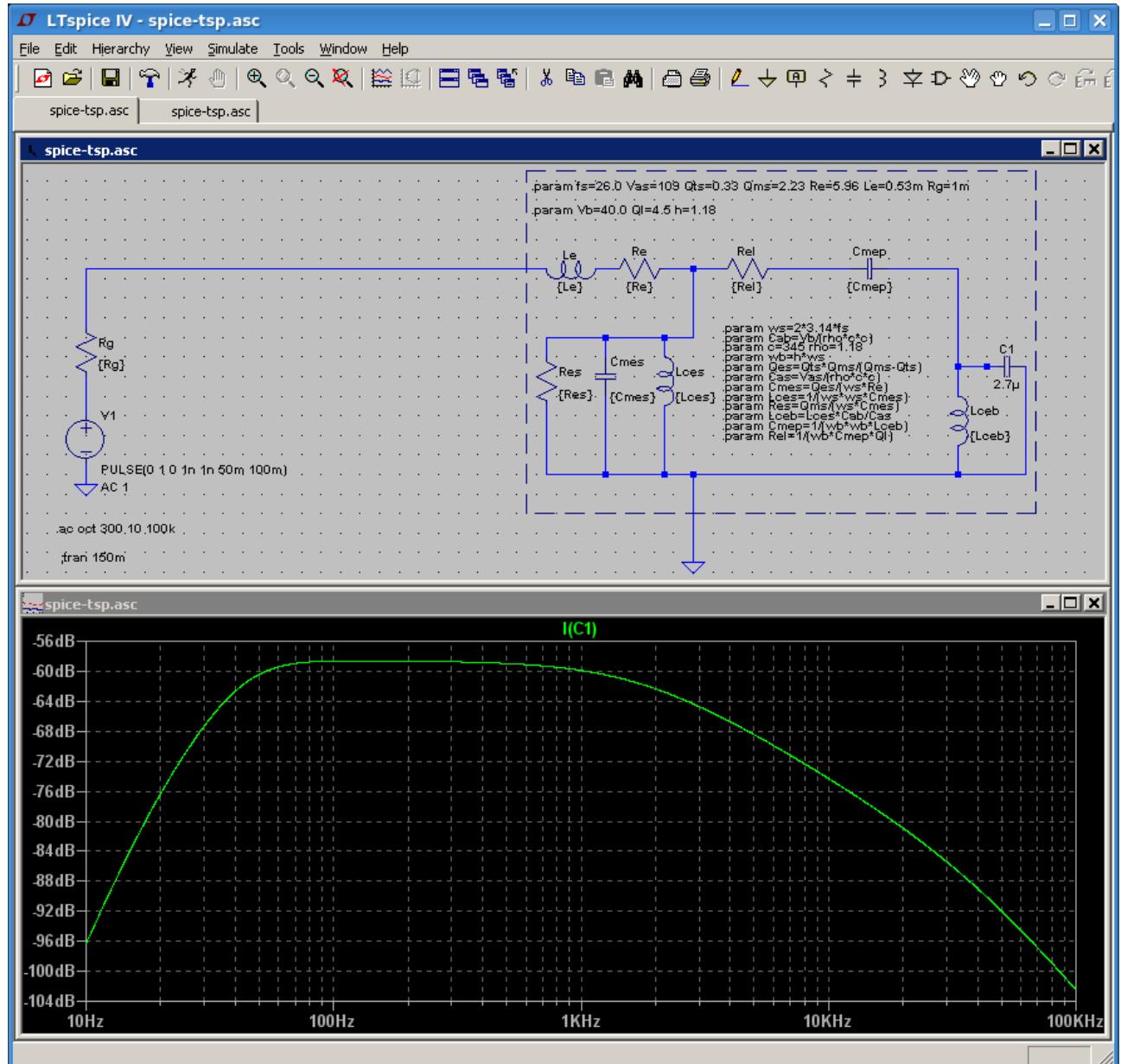
Open your spice file with LTspice. Fill in parameter:

.param $f_s=26.0$ $V_{AS}=109$ $Q_{TS}=0.33$ $Q_{MS}=2.23$ $R_E=5.96$ $L_E=0.53$ $R_g=1$ m

and

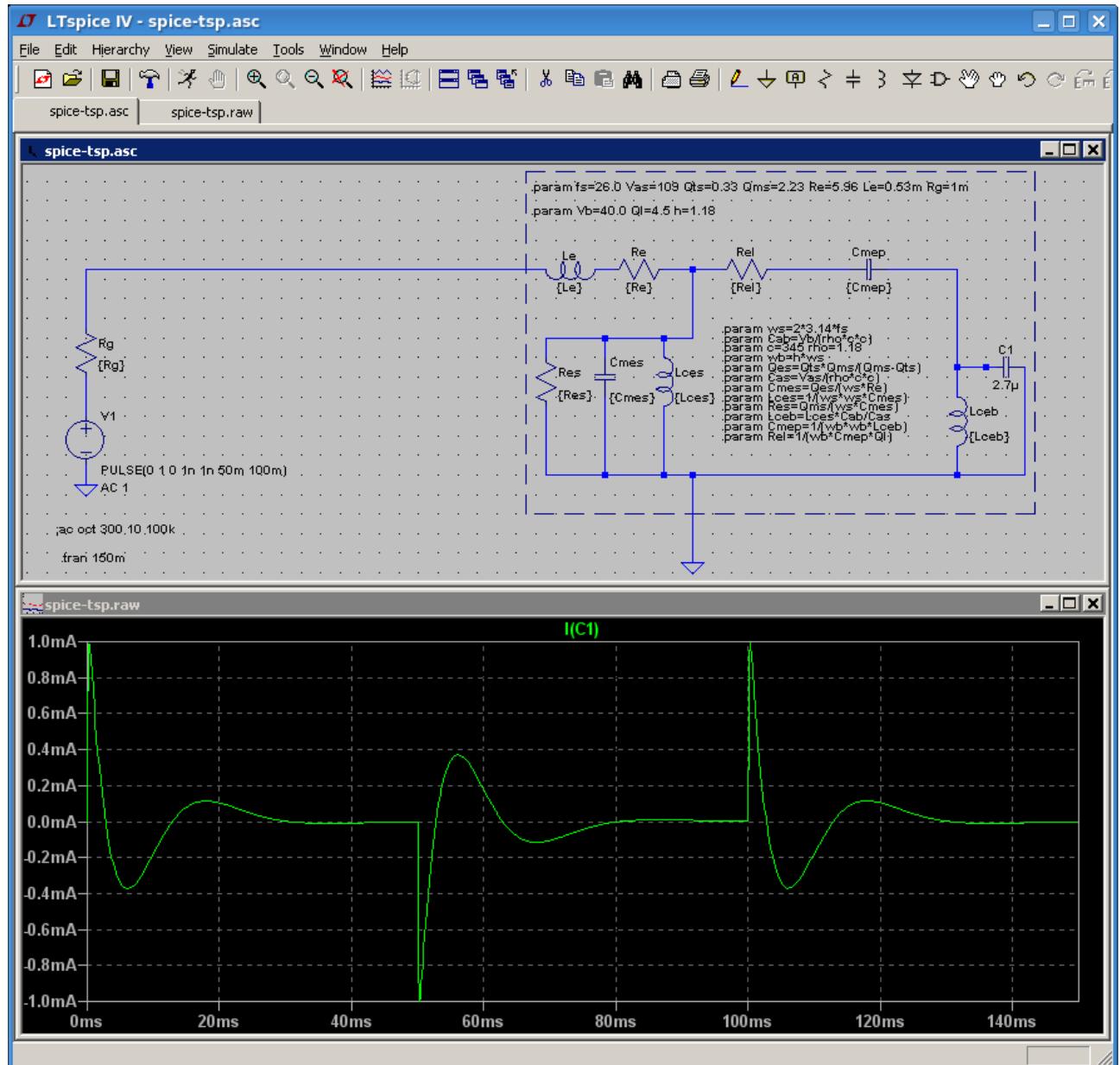
.param $V_b=40.0$ $Q_L=4.5$ $h=1.18$

To find the sound pressure frequency response start AC Analysis:



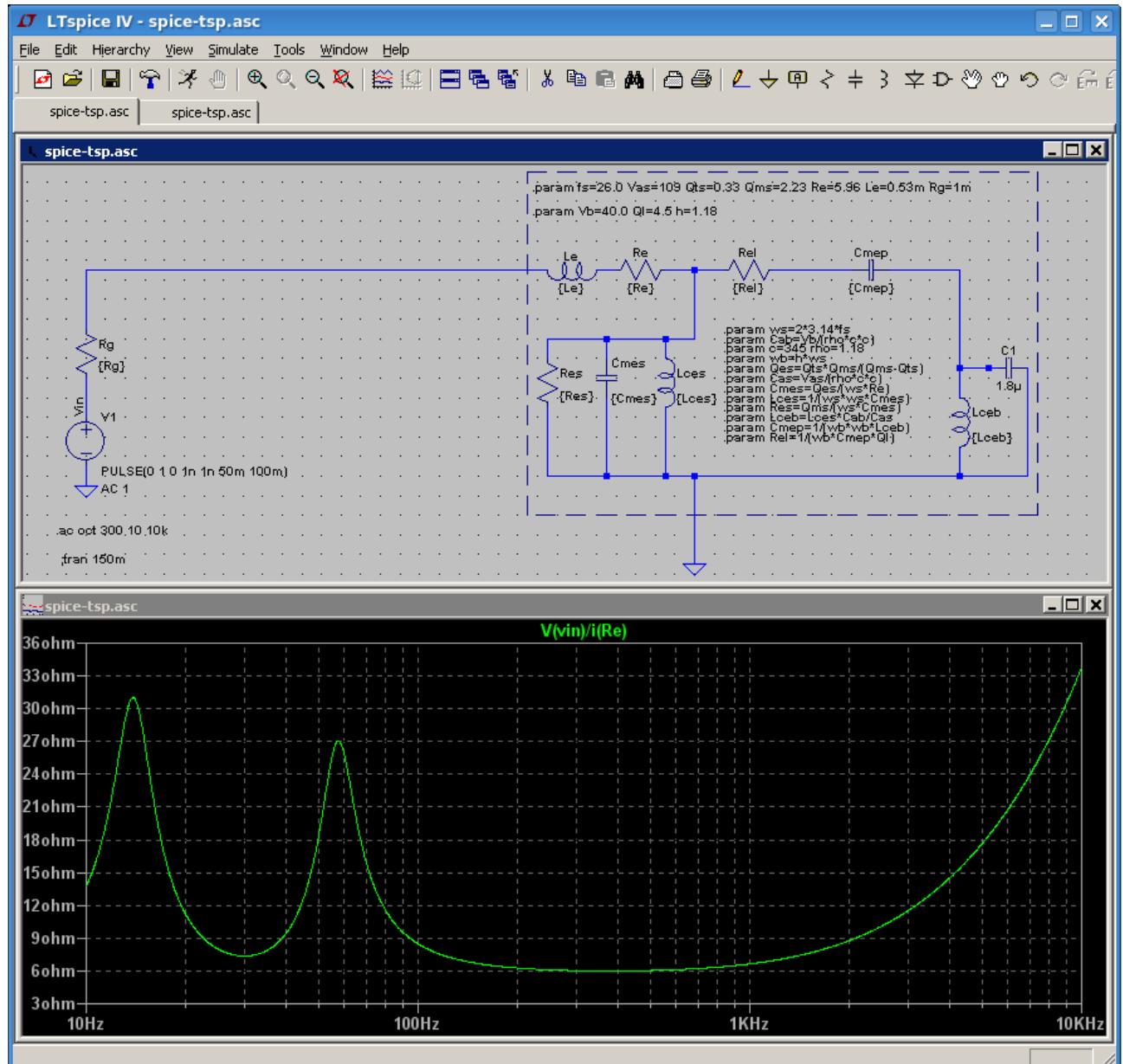
The current through the capacitor C1 corresponds to the sound pressure. The sound pressure fall-off (1kHz and higher) is caused by the voice coil inductance Le.

To achieve a step response we must start a transient analysis:



You can vary the value of C1, but it should be small to minimize its influence on the circuit.

Finally a simulation for a impedance response of the loudspeaker system:



Much fun!

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www.micka.org or www.micka.de/org