Applying a Matched Impedance Drive to the Electrodynamic Speaker for reaching a BL parameter 1st-order independency.

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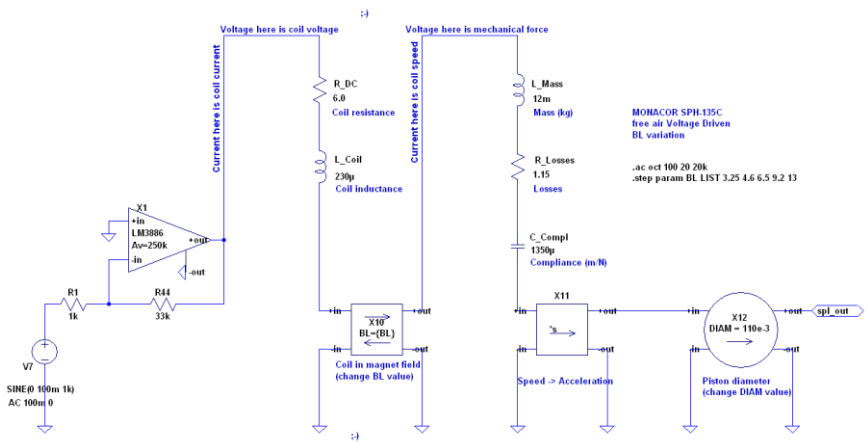
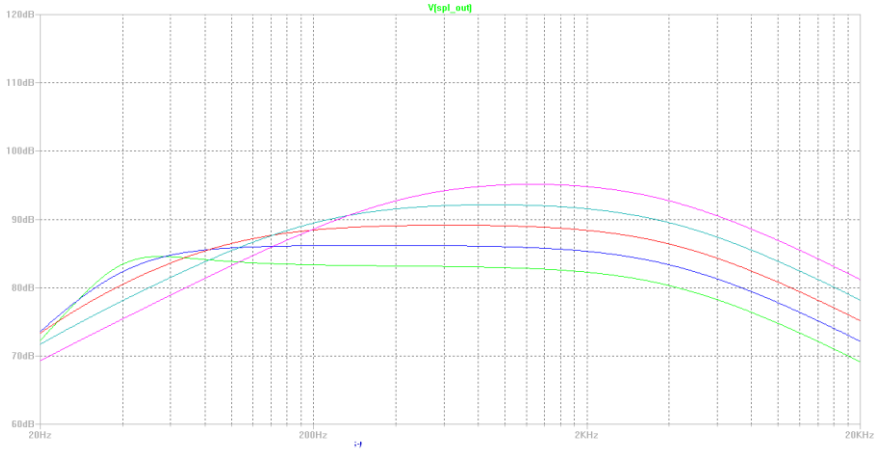
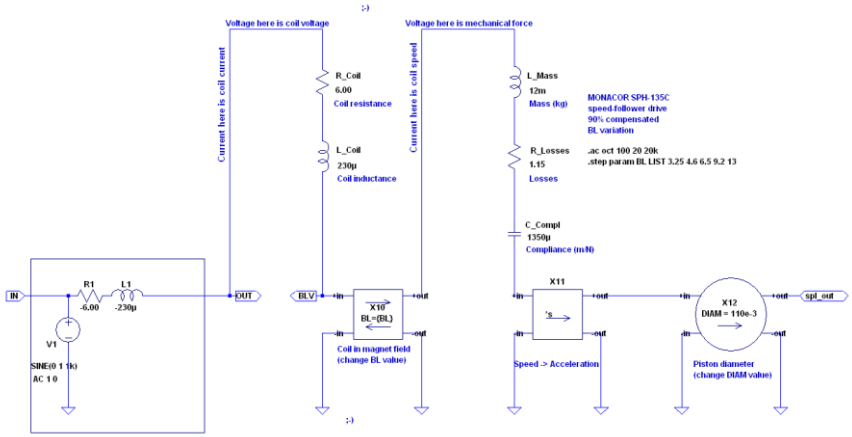
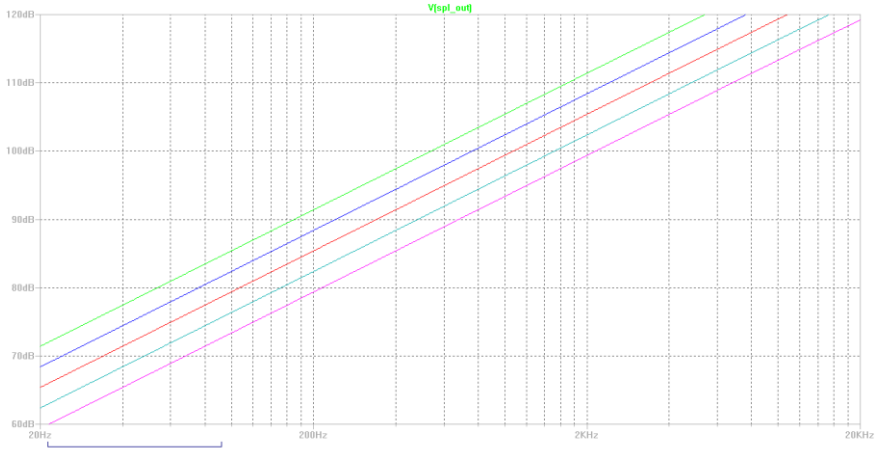
The conventional **Voltage driven speaker** exhibits a straight dependency to the BL factor. If B drops by 50%, then the acoustic output drops by 50%. This is the problem, and this is why people want more elaborate speaker driving schemes.



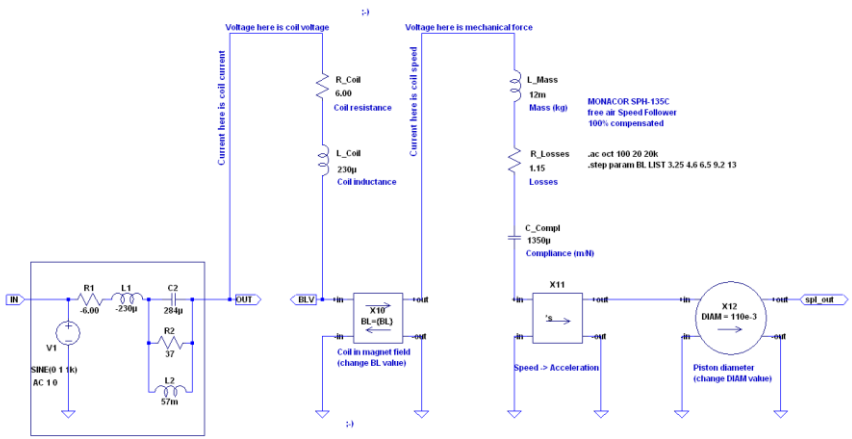


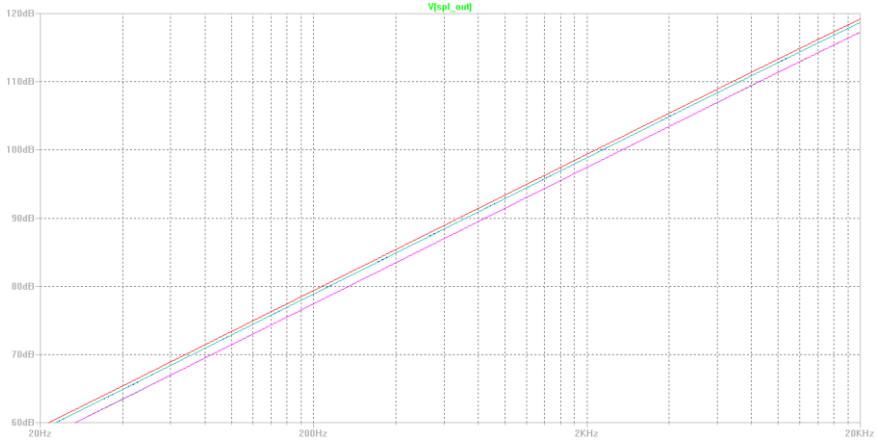
The **<u>Speed-Follower</u> driven speaker** exhibits a reciprocal dependency to the BL factor. If B drops by 50%, then the acoustic output increases by 50%. You get distortion again. That's plain normal, as Speed-Followers are those systems monitoring the voice coil voltage, applying global feedback from it. They require an extra coil as pickup, or a dead-coil voltage cancellation scheme. The dead-coil voltage cancellation scheme implies measuring the instantaneous current in the coil, and knowing precisely what's the coil resistance and the coil inductance. Anyway, the voltage coming from the coil will be equal to B.L.V with B=magnetic field, L= coil wire lenght, V=coil speed. In a feedback system, if B happens to decrease, the system will react by increasing V, the speed. As the frequency is the same, it has no other choice than increasing the amplitude.





There is another driving method between those two extremes. It is known as the **Matched Impedance driven speaker**. You implement it by building a Speed-Follower, **adding a parallel CRL network in series with the speaker**. Such parallel CLR network materializes the reflected impedance of the speaker that's located at the secondary side of a transformer which is the BL process. Indeed, at the secondary side of the BL transformer (for a closed box system), there is a series LRC circuit composed of the moving mass, the air damping, and the compliance. The BL system acts as transformer and you know that a transformer is reciprocating its load impedance. This explains why the matching impedance located at the primary side must be a parallel CRL network in series with the speaker. From the general theory, you know that once you get Impedance Matched, that the energy gets transferred in an optimal way, with minimal losses. You also know that your BL transformer is not a lossy component. Thus the energy gets transferred in an optimal way, with minimal losses, even when you change the transformer ratio. The transformer ratio is the BL. From there comes the BL independency in the Matched Impedance driven Speaker.



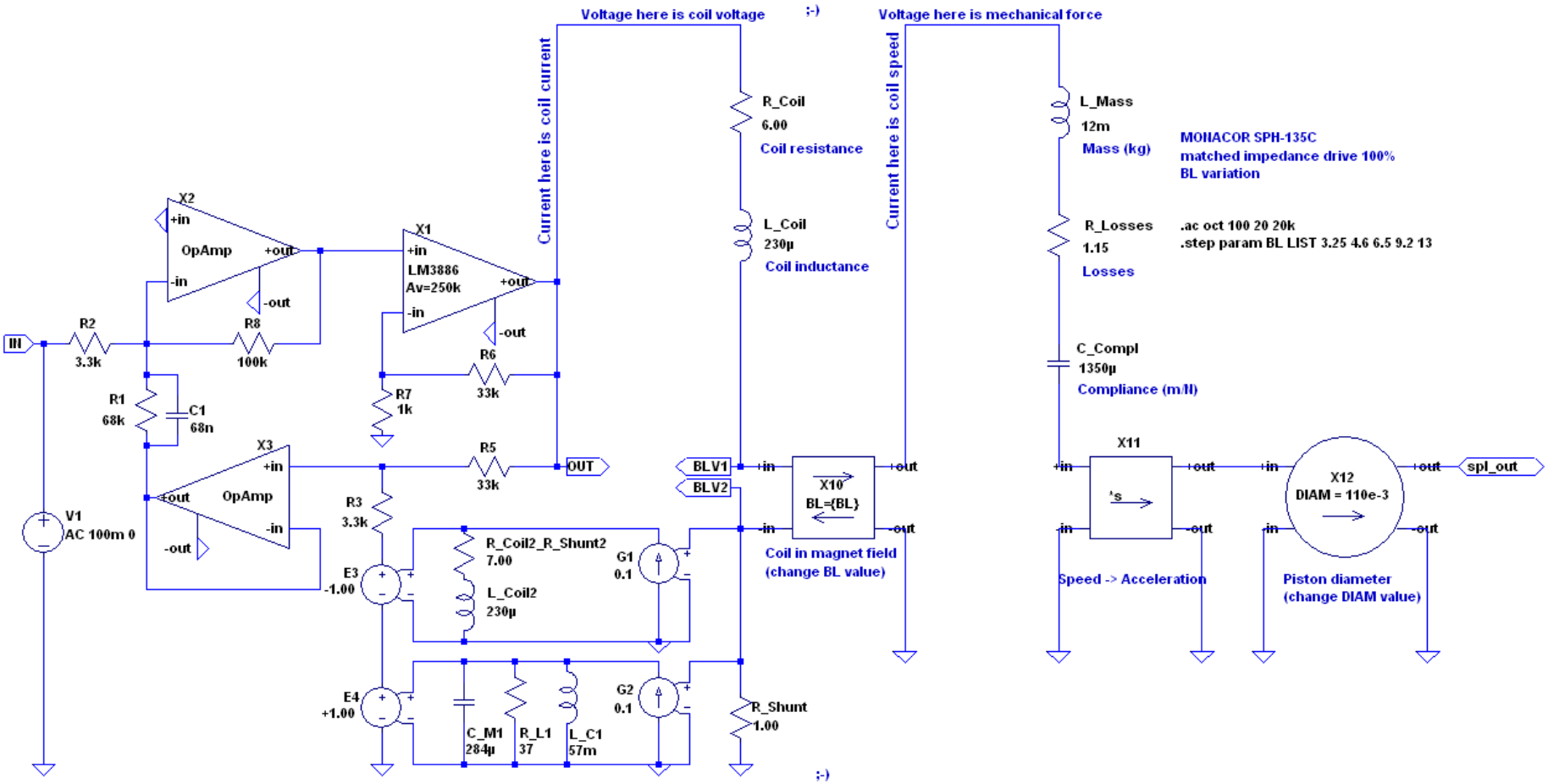


So it a nutshell, yes, as soon as you see a speaker drive scheme measuring the current, you may hope that the guys having designed it did their homework, and duly calculated all resistors values and capacitors values for implementing a Matched Impedance driven speaker. If they did their homework, the system will then provide the required BL independency for ironing out distortion, even when very close to the Xmax.

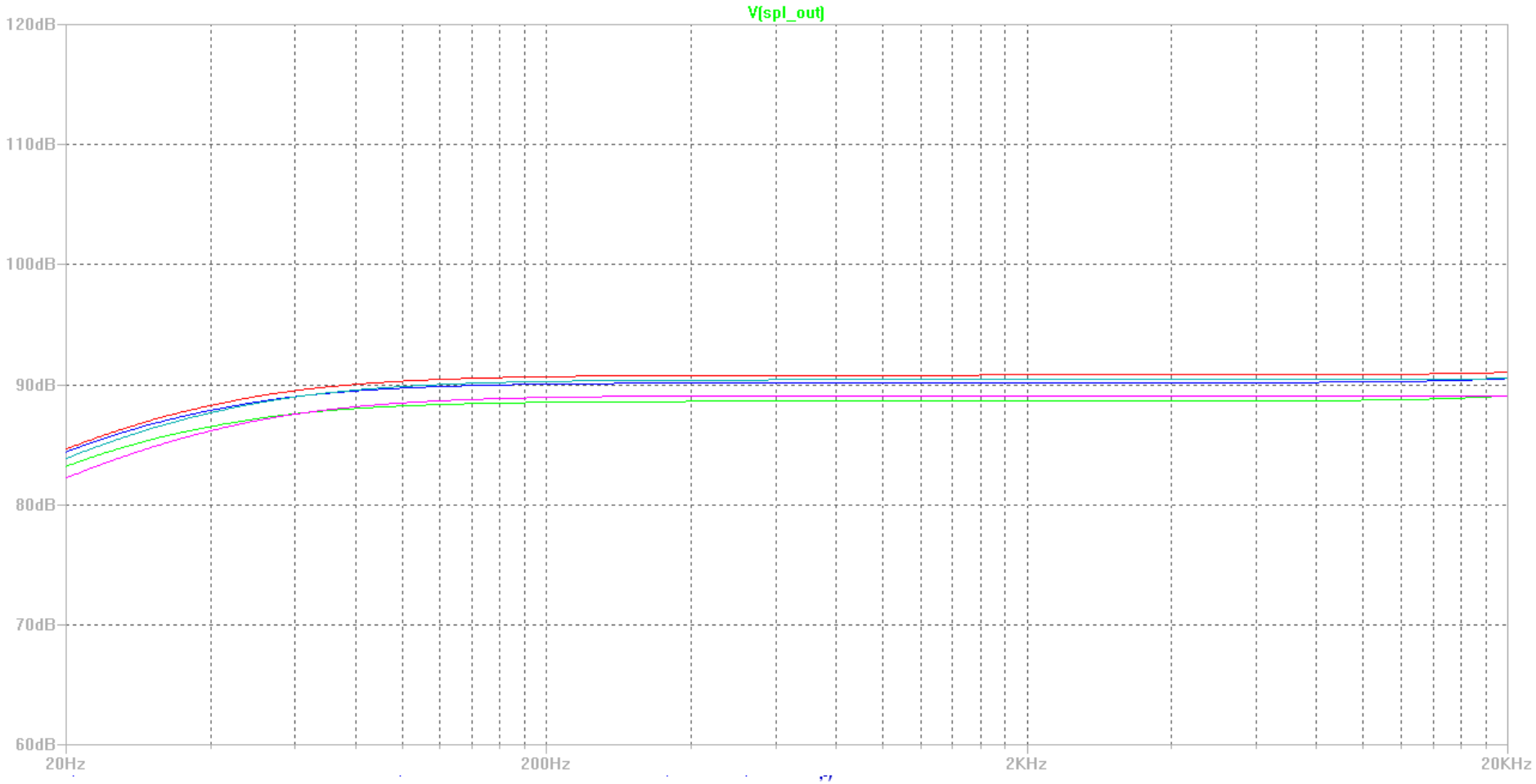
Don't make me say what I didn't say. When BL is changing, like being nonlinear, the circuits **detunes** which means that the CRL values that you have put at the primary do not match anymore with the reflected secondary. This way the energy transfer departs from being optimal, this way you get acoustic amplitude variations, and this way you get distortion. But it's a 2nd-order effect. The main goal of ironing out distortion remains fulfilled.

I would thus say that the Matched Impedance driven speaker is a kind of MFB, really and scientifically featuring a THD reduction.

100% Matched Impedance Drive embodiment (schematic)

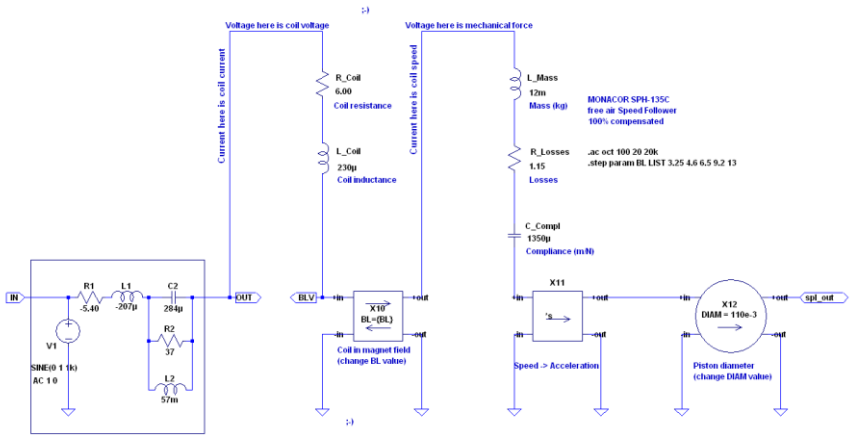


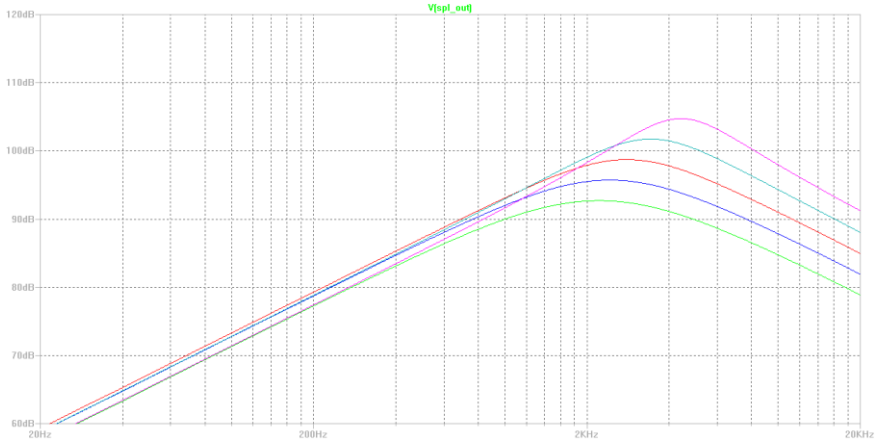
100% Matched Impedance Drive embodiment (resulting acoustic output and BL dependency over frequency)



Practically, one cannot exactly cancel the coil resistance and coil inductance. Factory dispersion, temperature variations, eddy currents and aging effects prevent the negative values synthesized by the power amplifier to exactly match the positive, physical values. On top of this, one must be very careful never over-compensating as this would result into on overall negative output impedance leading to instability. Reality forces us to slightly under-compensate the coil resistance and coil inductance. Say we only 95% compensate the coil resistance and only 95% compensate the coil inductance.

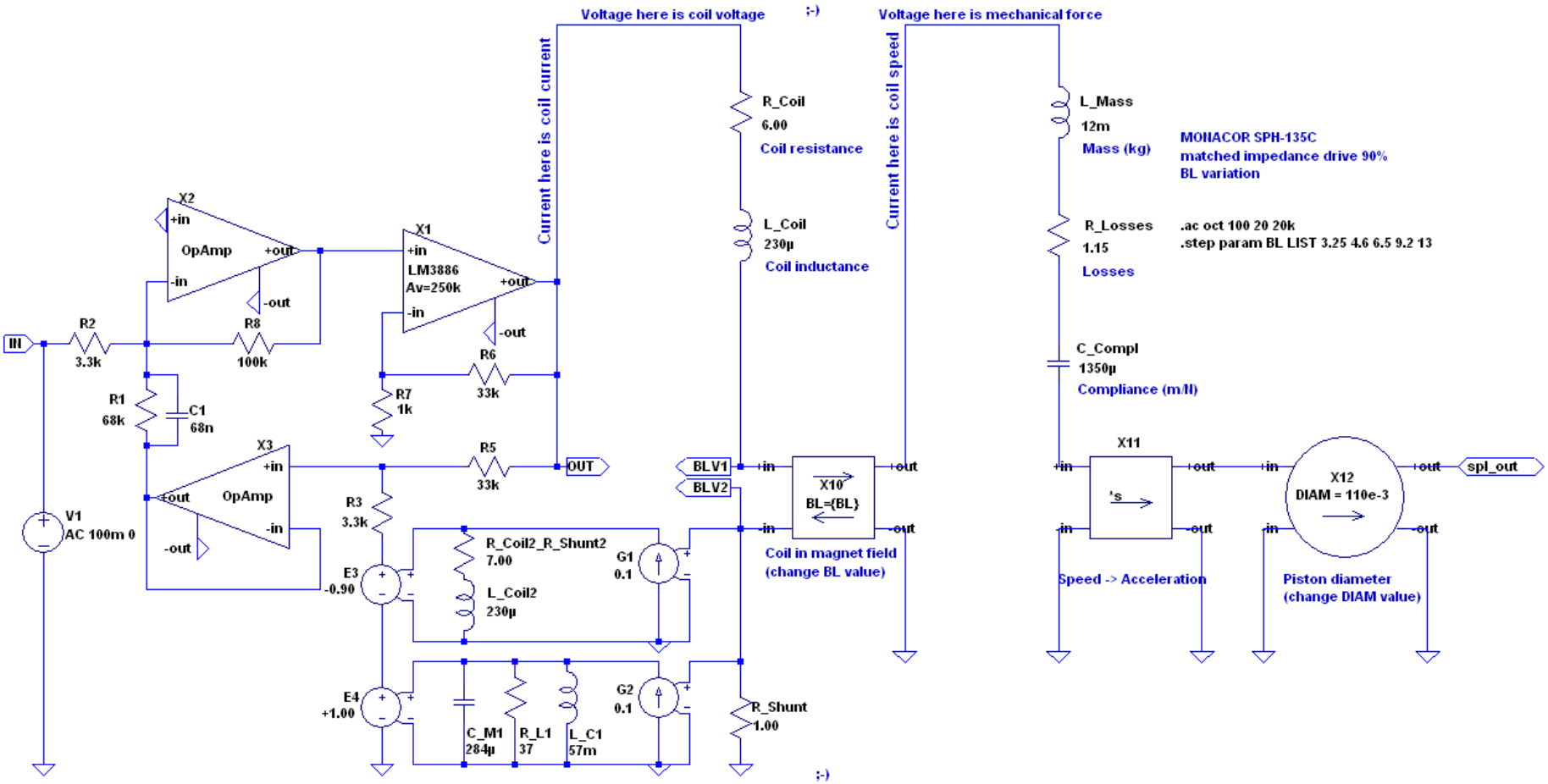
Here is a practical, realizable 95% Matched Impedance drive :





The BL independency is only there in the low and mid frequencies.
Above 2 kHz, the BL dependency equals the Voltage driven speaker.
Above 2 kHz, the acoustic output falls just like the speaker was Voltage driven.

90% Matched Impedance Drive embodiment (schematic)



90% Matched Impedance Drive embodiment (resulting acoustic output and BL dependency over frequency)