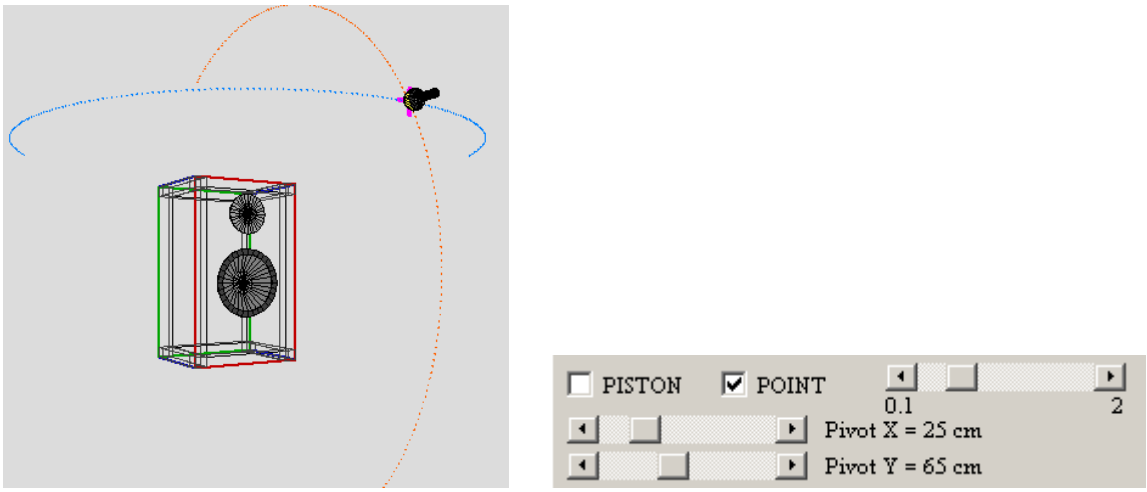
Using SE Optimizer For Quick Loudspeaker Design Part II

In Part II, we consider full system setup. That is: microphone location and distance, and driver's location on the baffle. Loudspeakers are simulated as point sources.

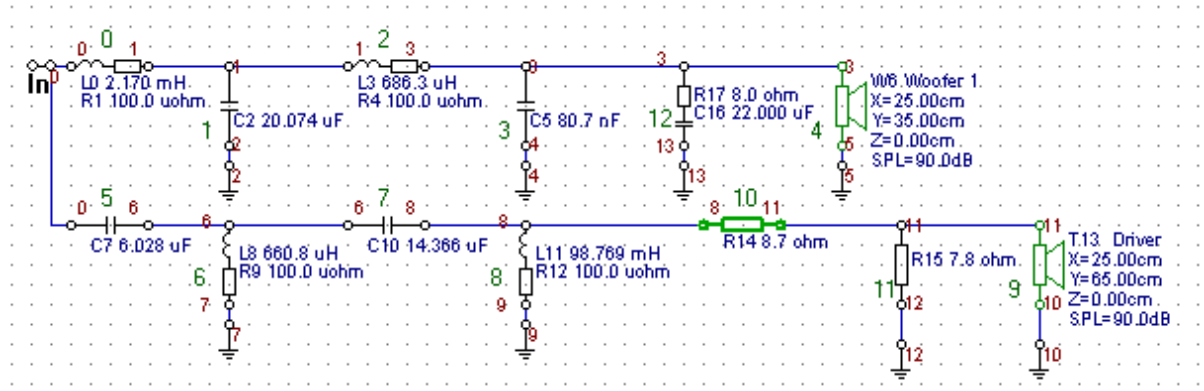
Microphone (pivot point) is located at tweeter's axis at 1m distance.

Select Driver From List

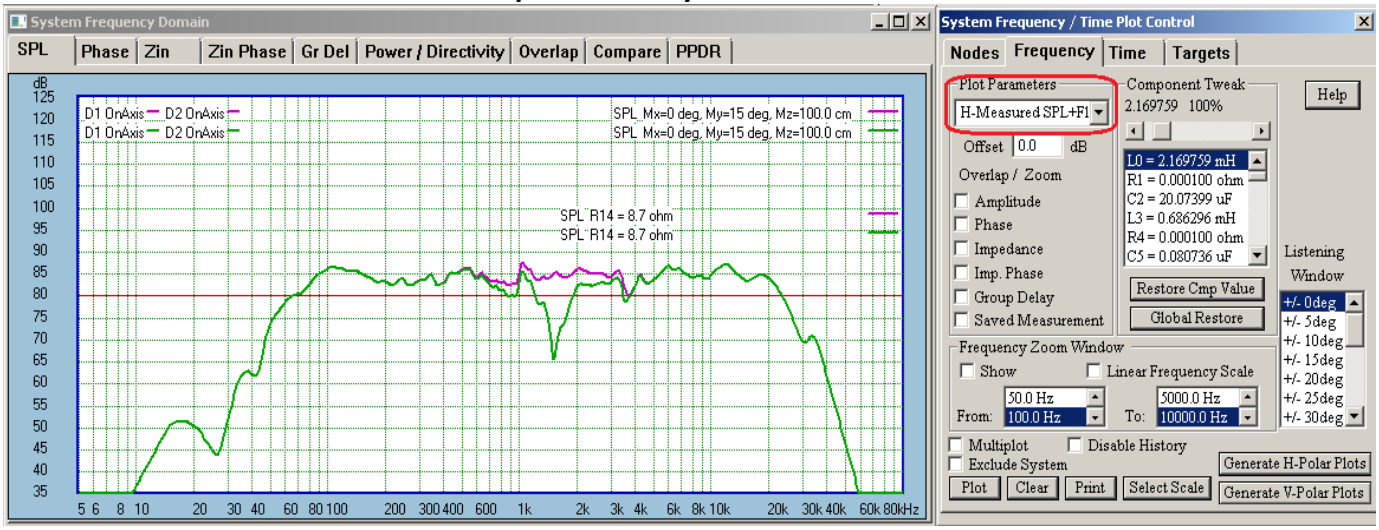
Type	AC[mm]	X[cm]	Y[cm]	Z[cm]	V_Tilt[deg]	H_Rot[deg]
Woofer	10.0	25.0	35.0	0.0	0.0	0.0
Tweeter	0.0	25.0	65.0	0.0	0.0	0.0



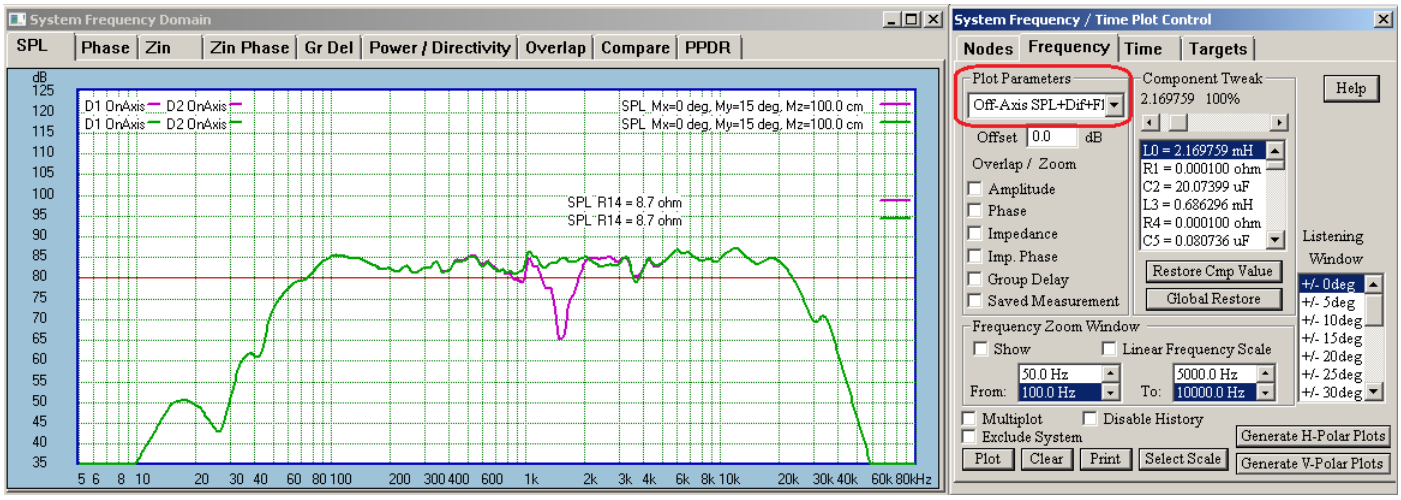
Firstly, given that microphone is now further away from the woofer, the tweeter's SPL has to be reduced slightly. Therefore, R14 was increased to 8.7 ohm – see below.



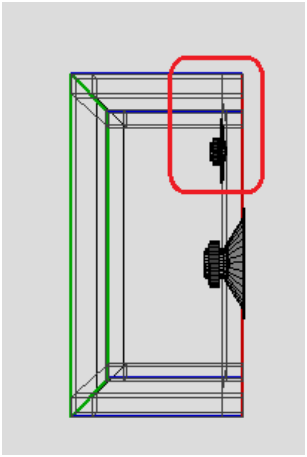
Just as a reminder, we can plot the SPL (pink) and reverse null (green) for the measured and stored SPL data curves. These curves were developed in CAD system.



We are now in the position, to plot the same curves, with system data (driver's location + mike location) included in the simulation plots. Interestingly, the SPL (pink) now has a notch and the reverse null (green) is flat.



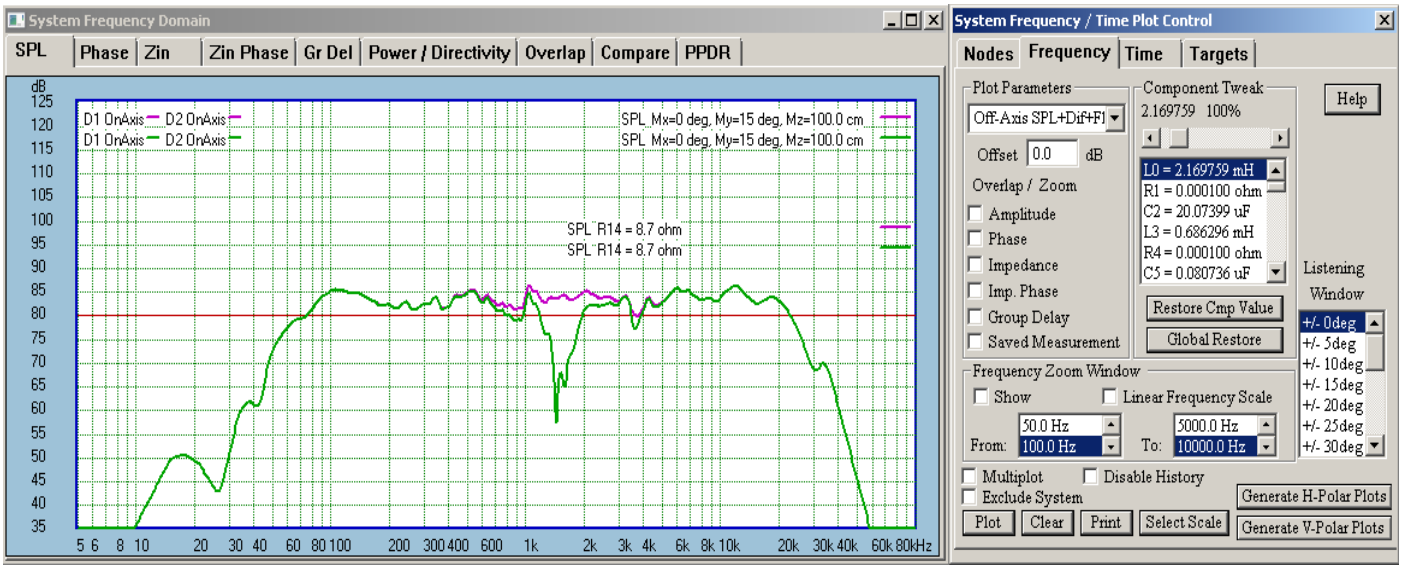
This is because there is a differential distance in acoustic paths between woofer and tweeter. Woofer is delayed. To remedy this, we can do a couple of things. First, we can delay tweeter by installing it 11cm backwards from the front baffle.



Select Driver From List

Type	AC[mm]	X[cm]	Y[cm]	Z[cm]	V_Tilt[deg]	H_Rot[deg]
Woofer	10.0	25.0	35.0	0.0	0.0	0.0
Tweeter	0.0	25.0	65.0	11.0	0.0	0.0
Driver	0.0	25.0	10.0		0.0	0.0

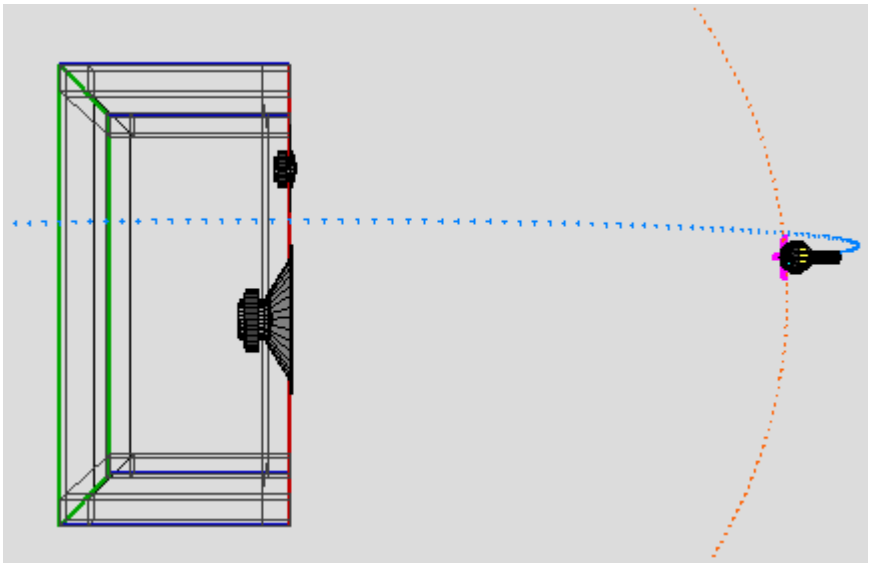
This brings the SPL (pink) and reverse null (green) back to the originally optimized performance, as shown in CAD system



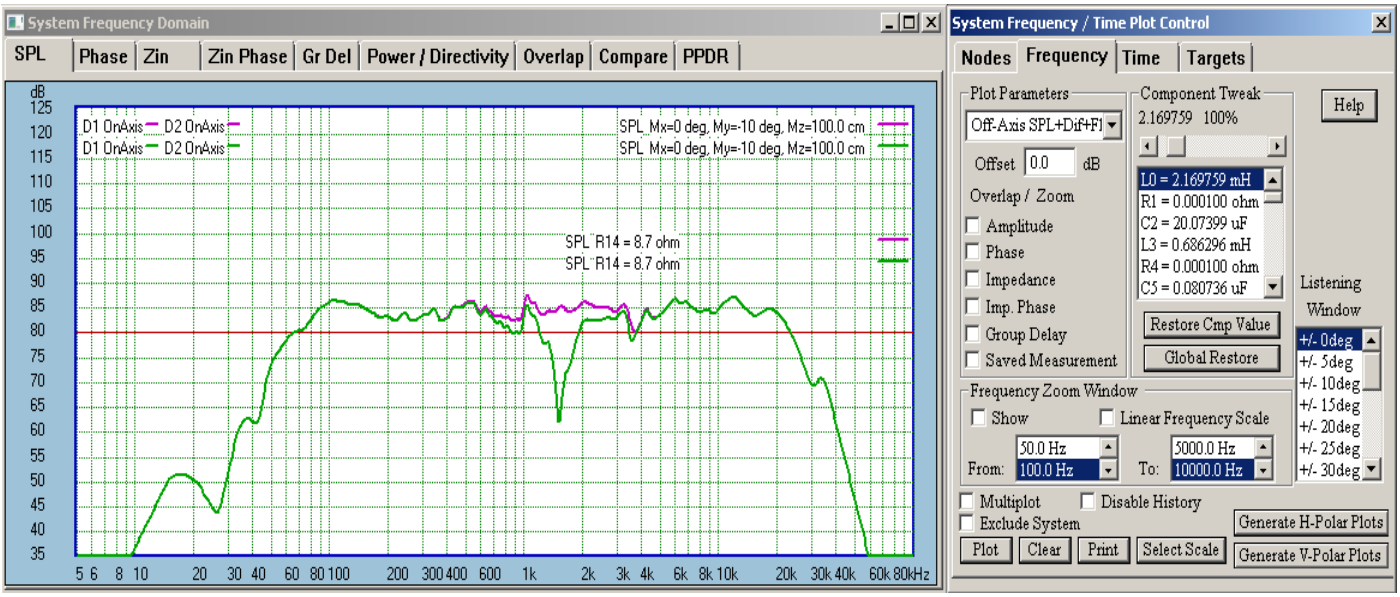
Second option is to tilt the loudspeaker backwards, so the tweeter works a little bit off-axis. But it is moved acoustically backwards in relation to the woofer. This is simulated by moving the microphone lower, towards the woofer. Now the acoustical distance between tweeter AC and woofer AC are equal.

Display Major Angles and Distances

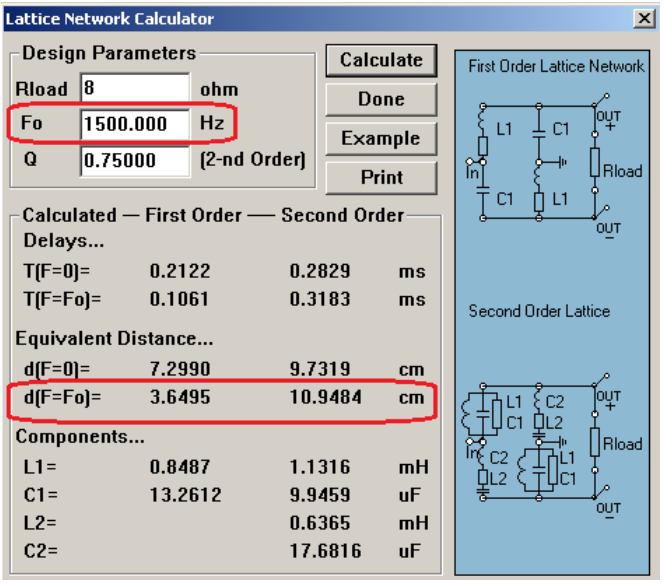
Type	Mk[m]	Mk-ACe[m]	Mk-ACd[m]	Mk-CtX[deg]	Mk-CtY[deg]
Woofer	1.00	0.99480	1.00279	-0.00	7.31
Tweeter	1.00	0.98480	1.00000	-0.00	-10.00



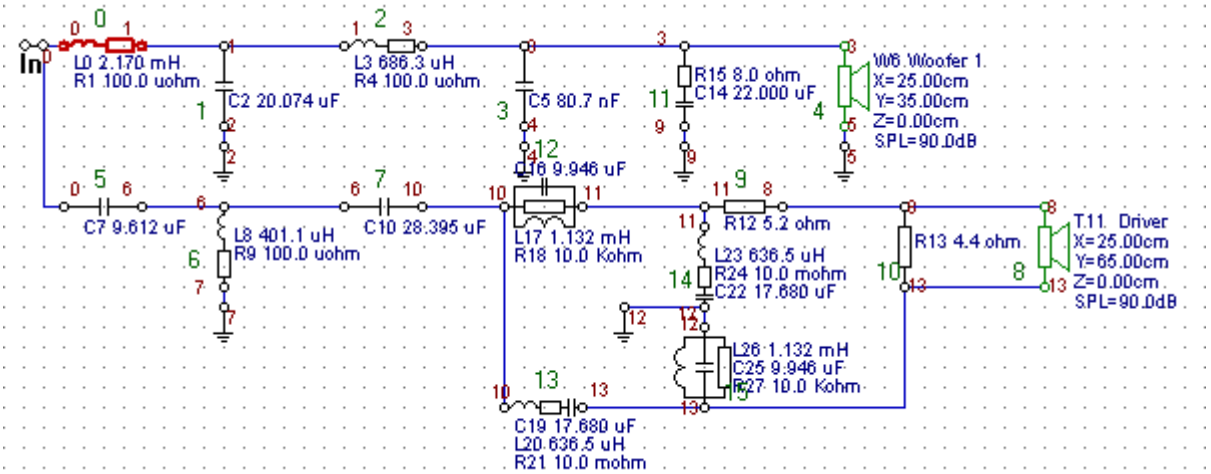
This also brings the SPL (pink) and reverse null (green) back to the originally optimized performance.



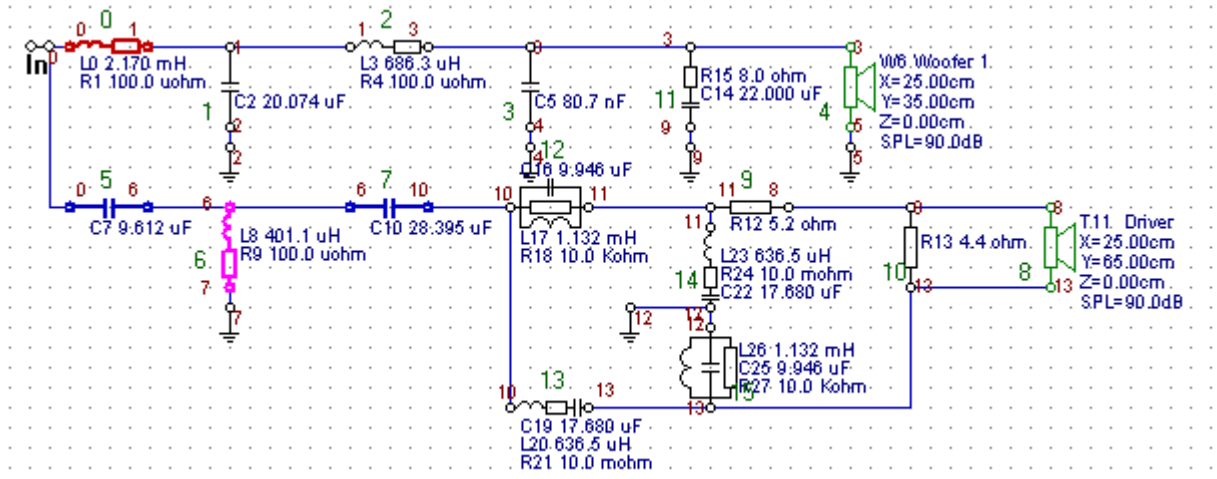
The third option is to insert a delay network into the tweeter path. The Lattice Network is calculated to provide 10.9cm distance delay at 1500Hz



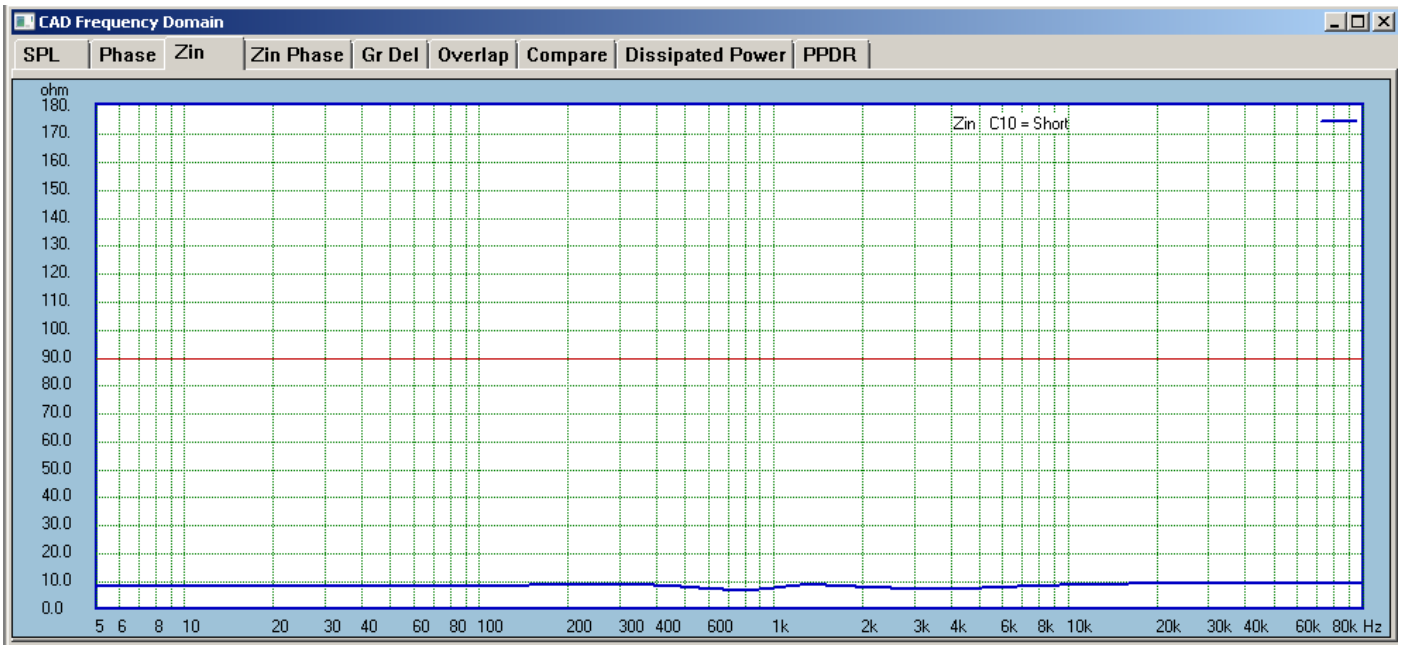
Firstly, Tweeter crossover was re-optimized to account for the possibility, that Lattice Network may slightly affect tweeter's SPL. Here are the new values.



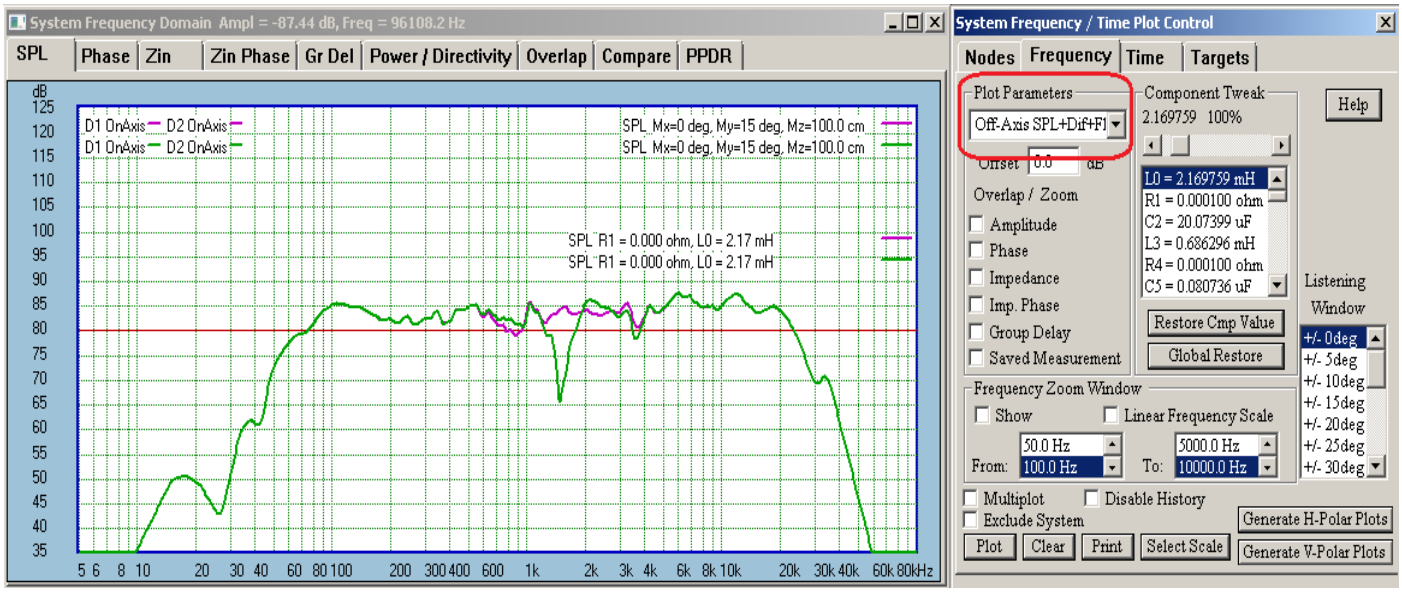
Also, the input impedance into the Lattice Network was confirm to hold reasonable well at 8ohm. Notice C7, C10 – SHORT, and L8, L0 OPEN to make this test viable.



This is input impedance into the Lattice Network + driver. It is the load impedance of the tweeter filter.



Now, with the components restored and Lattice Network inserted into the tweeter filter, this also brings the SPL (pink) and reverse null (green) close to the originally optimized performance. These curves are plotted in the System Module for "Off Axis SPL+Diff_Flt" option – see below:



Conclusions

Reverse Null is created on SPL when the acoustic signal from two drivers arrive at the measurement microphone with the same amplitude and with 180deg phase difference. These conditions can be created due to number of factors: drivers' SPL/Phase response, crossover performance, location on the baffle, microphone location.

Several options were presented for dealing with Reverse Null situation.

Possibly the easiest way to deal with this issue (if you arr concerned), is to tilt the loudspeaker backwards.