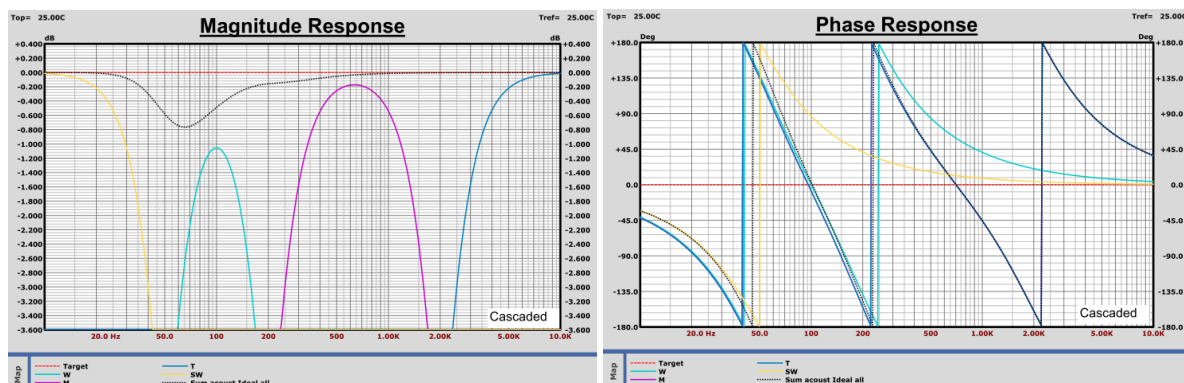
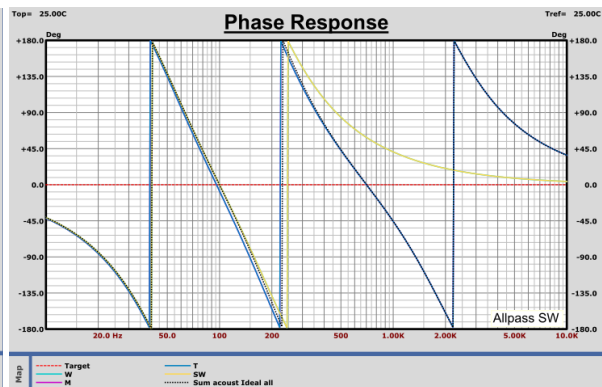
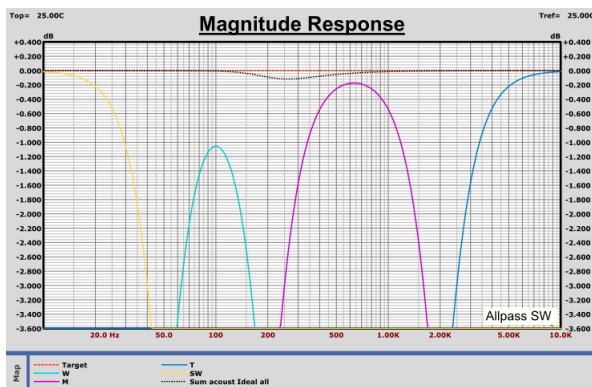
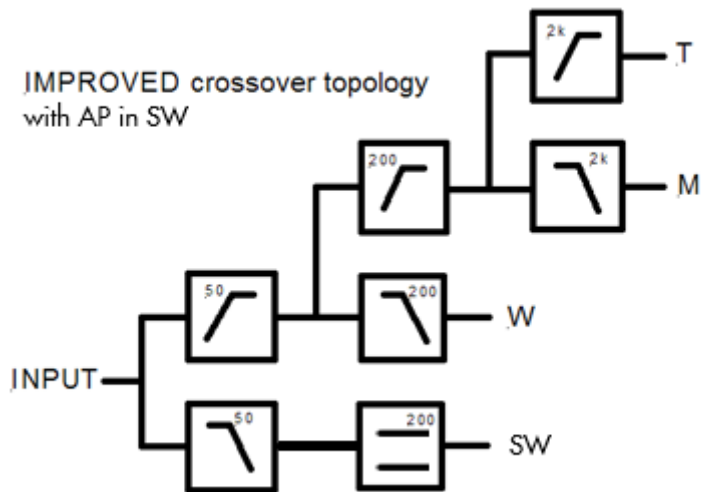


FB: Duplicating SLs simulation in a different scale, with same colors of curves. Yellow SW curve is a little harder to identify on white background:



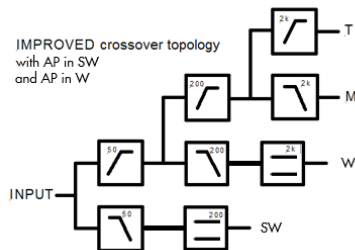
SL: "But this is not the complete solution in itself. **A maximally flat response is obtained when also the 200 Hz lowpass filter phase shift in the W channel is duplicated in the SW channel by an allpass filter with the same phase response.**"



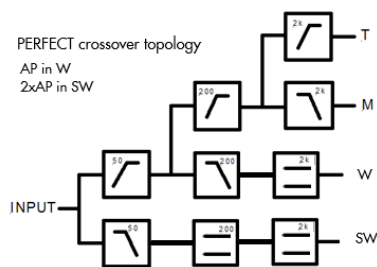
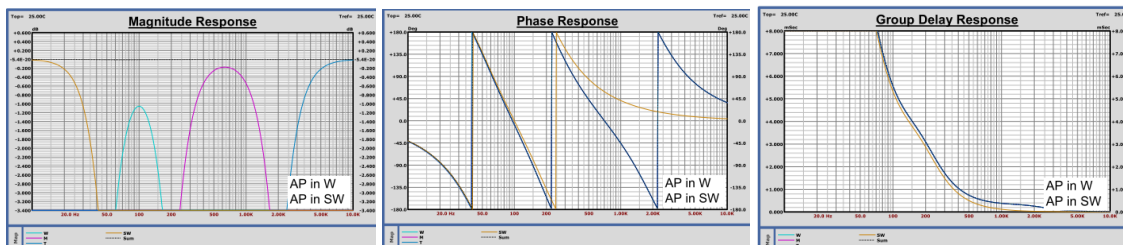
F.B.: Now, the summing deviates less than 0.2dB from ideal. Relate this number to individual deviation, which is unavoidable during driver series production.

All four channels could be summed perfectly in magnitude and phase, if another allpass is added to the W channel (and consequently to the SW-channel as well). More parts needed for the circuit is to be considered, though:

Another allpass in the W channel compensates the phase shift of the 2k lowpass in M.

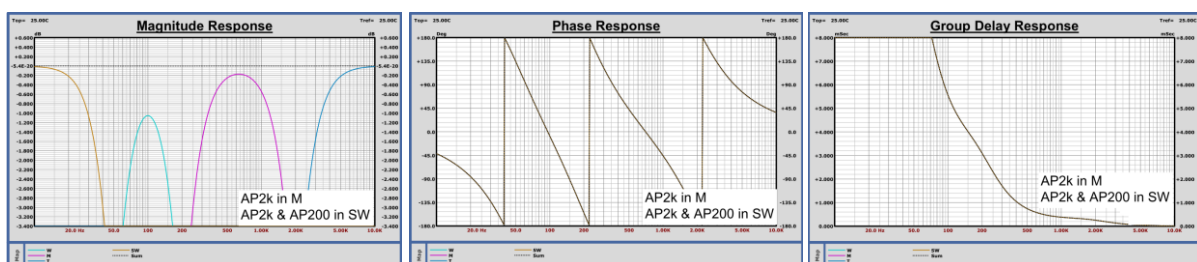


The magnitude summing looks flat, now. Phase response matches ideally for T, M and W. Still a little deviation in subwoofers (=SW, yellow) phase response and group delay:

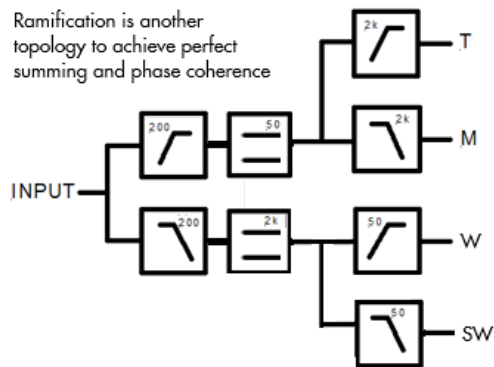


Add a 2k-allpass to the SW channel, a **perfect** magnitude summing and fully **congruent phase** response of all four channels is achieved. Consequently, group delay matches identically for all T, M, W and SW.

This topology was chosen for LX521s [precisionASP V2.0](#)



The same perfect summing and phase coherence can be achieved by ramification topology of the four branches (tree structure):



After choosing the general filter topology, analog filters may be realized via various circuit architectures: Sallen-Key, Multi-Feedback, State Variable, Delayed-Subtractive Lipshitz/Vanderkooy... These circuit architectures have their pros and cons in terms of distortion, noise, impedance, component count and component sensitivity.

The final filter circuit will have additional filter blocks in each channel to meet the desired acoustical response curve.

26MAR2021 by Dr Frank Brenner