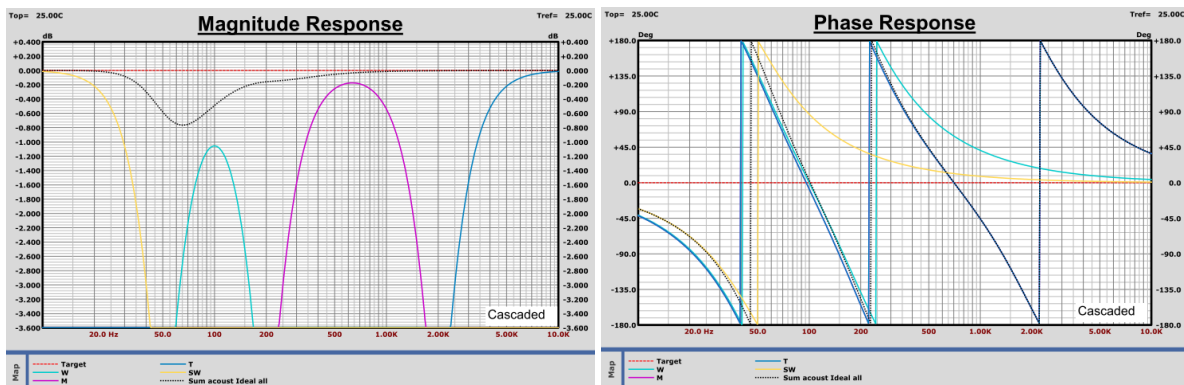
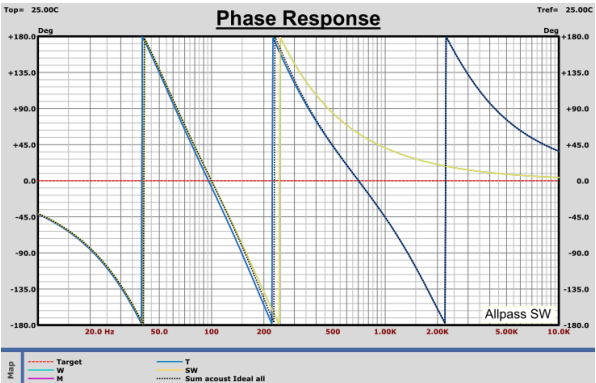
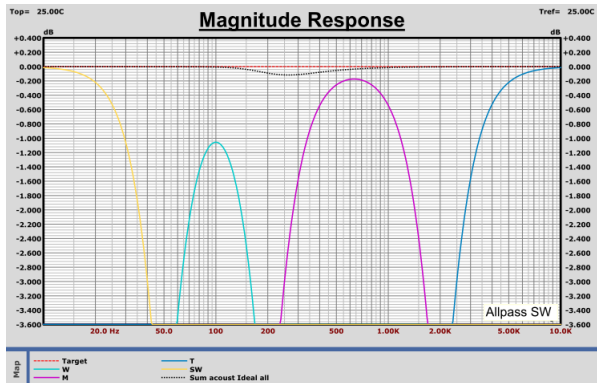
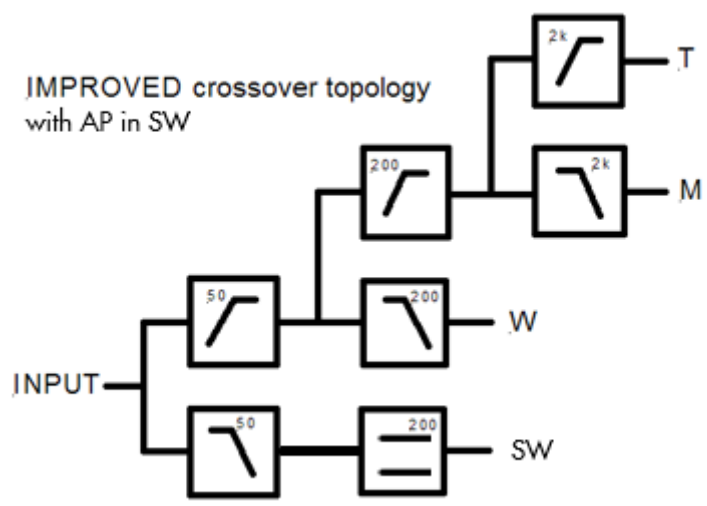


FB: Duplicating SLs simulation in a different scale, with same colors of curves. Yellow SW curve is a little harder to identify on white background:



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."

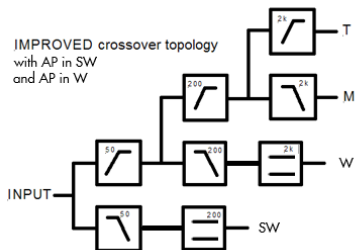
IMPROVED crossover topology  
with AP in SW



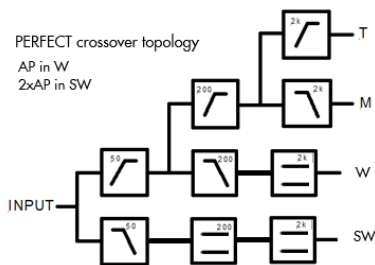
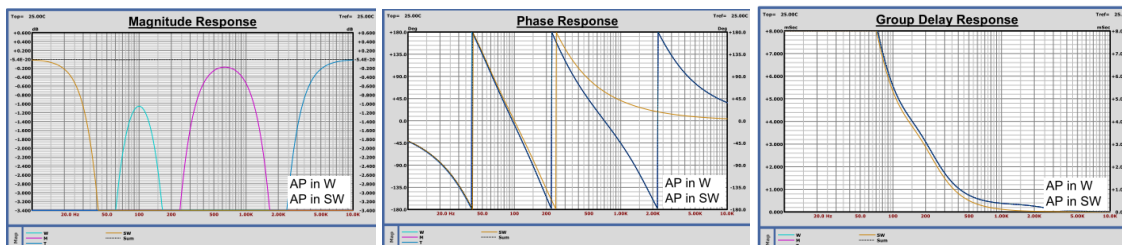
*F.B.: Now, the summing deviates less than 0.2dB from ideal. Relate this number to individual deviation, which is unavoidable during driver series production.*

*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.*

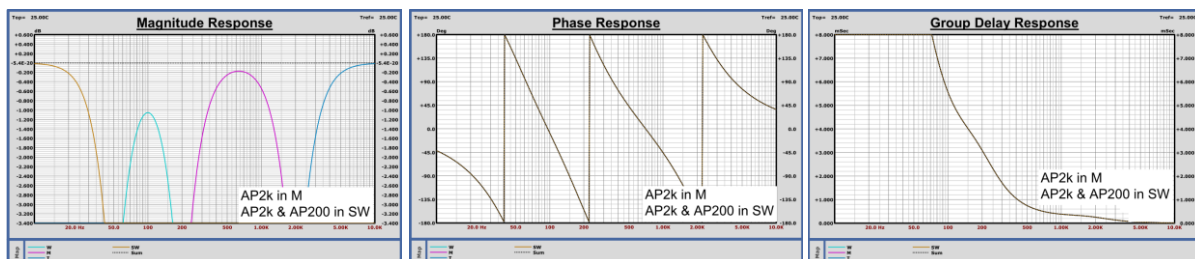


*The magnitude summing looks flat, now. Phase response matches ideally for T, M and W. Still a little deviation in subwoofers (=SW, yellow) phase response and group delay:*

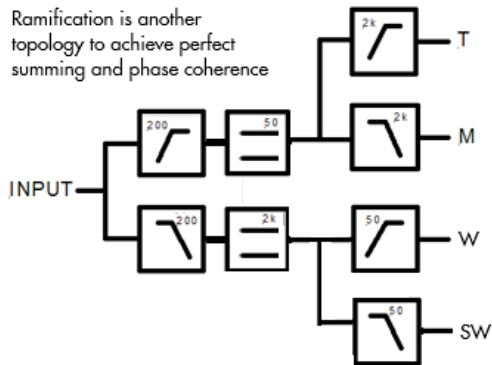


*Add a 2k-allpass to the SW channel, a **perfect** magnitude summing and fully **congruent phase** response of all four channels is achieved. Consequently, group delay matches identically for all T, M, W and SW.*

*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 i.o. to target a flat acoustical response curve.*

26MAR2021 by Dr Frank Brenner