Part2

How to go for a differential configuration?

The design gets even easier in the case of a differential filter because you can combine different standard values for the capacitors. In Fig.2 C1, C2, C3 have their values calculated with the method above and a differential filter can be implemented in practice just by observing the formulae indicated. Of course this is a "monster" version, just for the show (still a 3rd order despite the number of capacitors) and it is preferable (if possible) to choose a '0' value for as many as you can. Concerning the resistors: their values are the same as in Fig.1, there are twice as many though. It is a good idea to keep their values low by design (issues of noise, offset, parasitic capacitance on inputs and pcb…) So the next filter is the differential version of the filter in Fig.1. I have rounded the values a bit but it is still basically a Bessel with fc= ~51kHz (-3dB @ 36.3kHz)

C1 = C12 + 2 x C11 = 8.2n C12 = C13

C2 = C22 + 2 x C21 = 8.1n C22 = C23

C3 = C31 = C32 = 1.3n

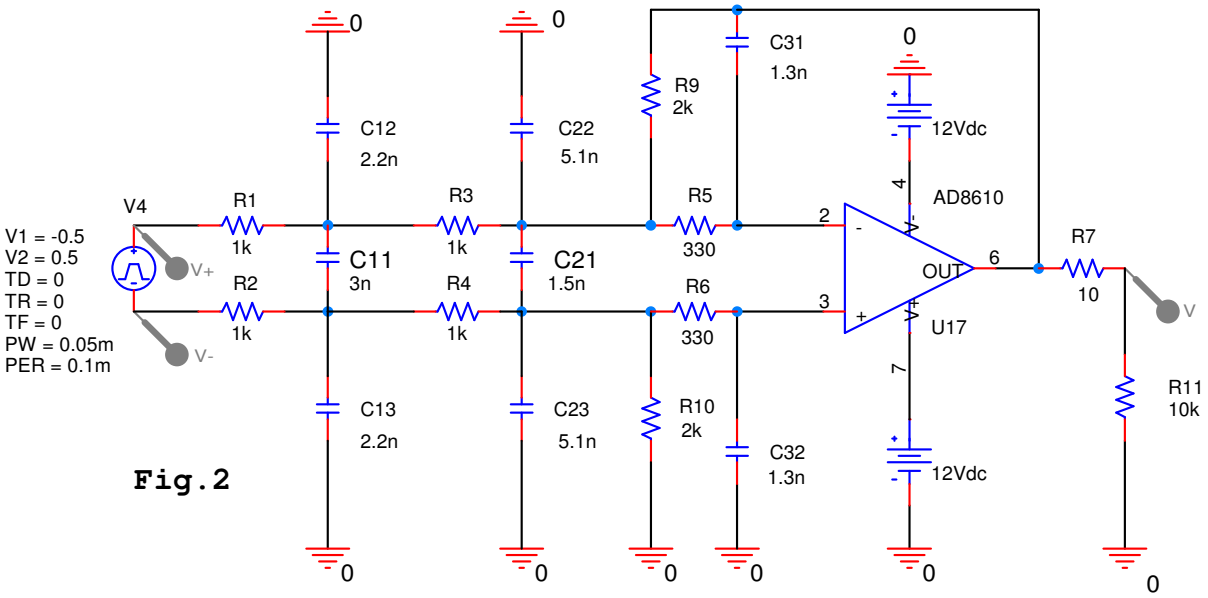


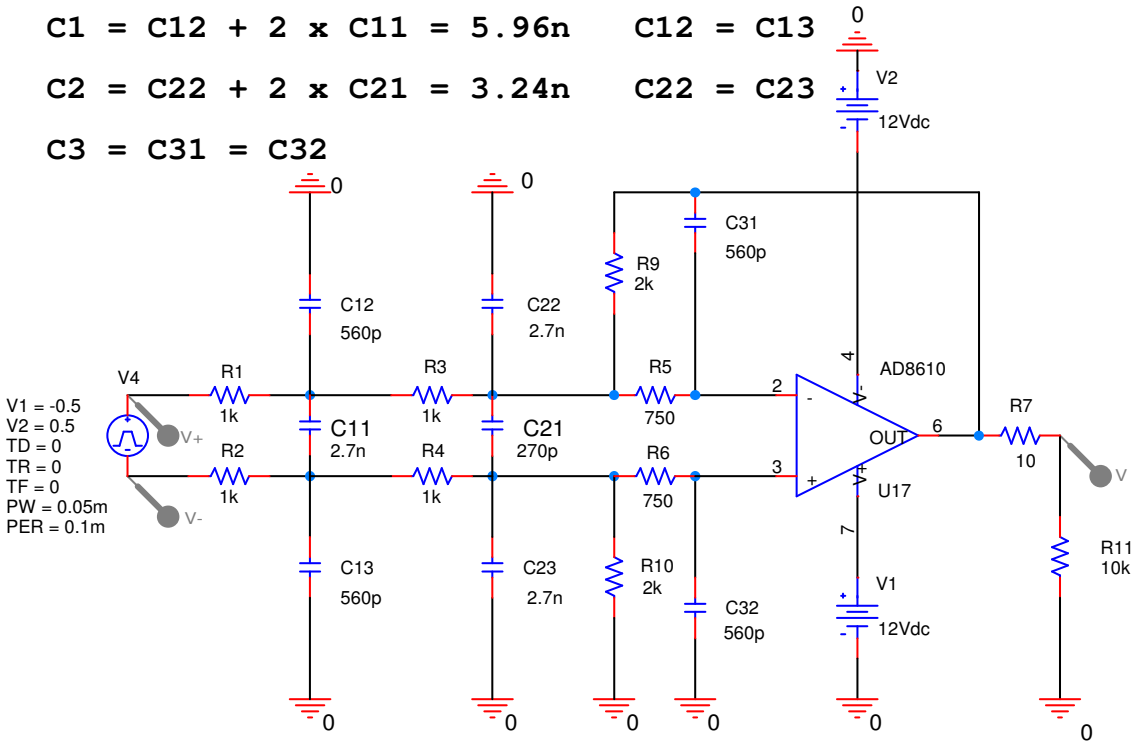
Fig.2

The one on the next page is another example "optimized cost", also a Bessel but with fc= 80.5kHz. It is also faster but has poorer attenuation.

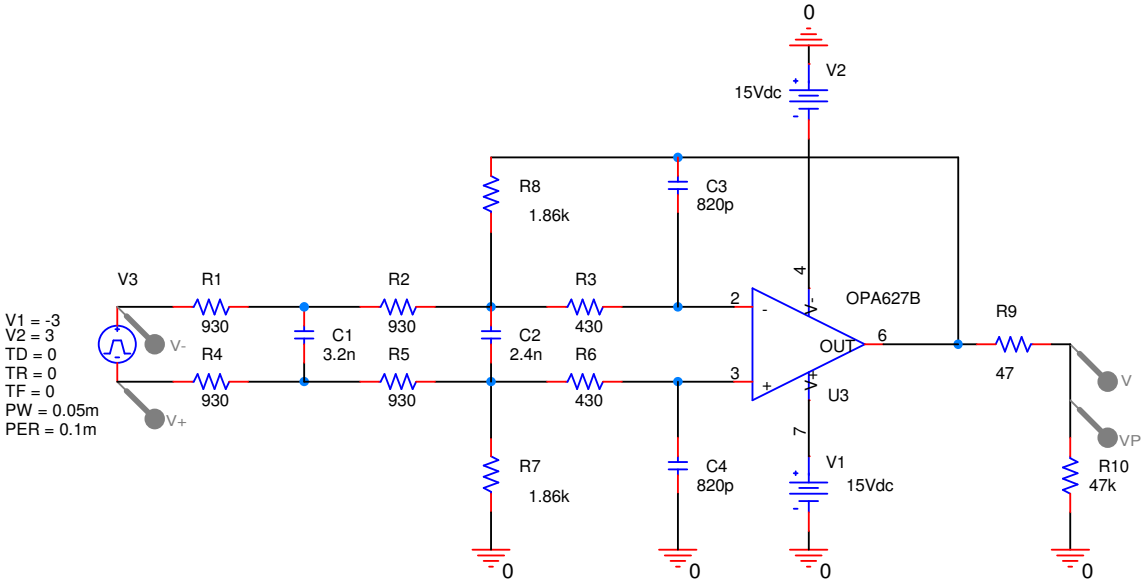
C1 = C12 + 2 x C11 = 5.96n C12 = C13

C2 = C22 + 2 x C21 = 3.24n C22 = C23

C3 = C31 = C32



The next filter is on the waiting list for my next (the ultimate and the best, of course ☺) DAC. Already got the chipset: CS8416, CS8421, PCM1794, OPA1632, OPA627B (or the AD8610) This guy will run with a 45.1584MHz TCXO clock at a 176.4kHz up-sampled rate, although I choose the f_c rather low at about 75.5kHz.

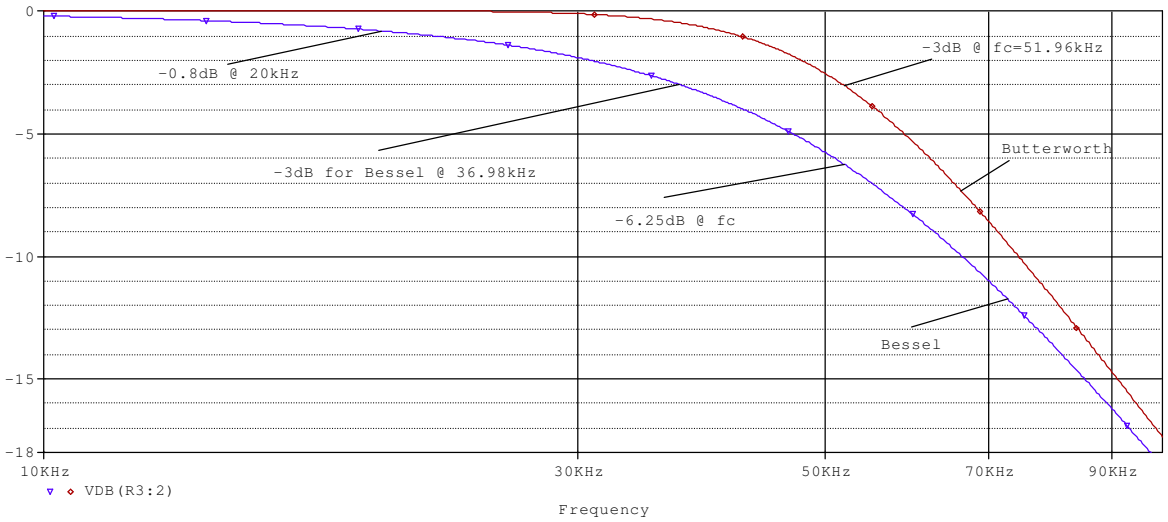


While building my DACs (four of them – a true DIY-er never quits ☺) I have tried all sorts of filters: no filter, 2nd, 3rd, 4th, 6th order Sallen and Key or MFB (either single op-amp where possible or cascaded 1st and 2nd order cells) but finally the 3rd order MFB proved to be the best compromise, the simplest and the best at audition. Also I have calculated similar equations for 3rd and 4th order Sallen and Key (in single op-amp configuration with no gain!… if needed…although I don't recommend these). I used also for a while a 3rd order GIC filter (not bad…easy to design also)

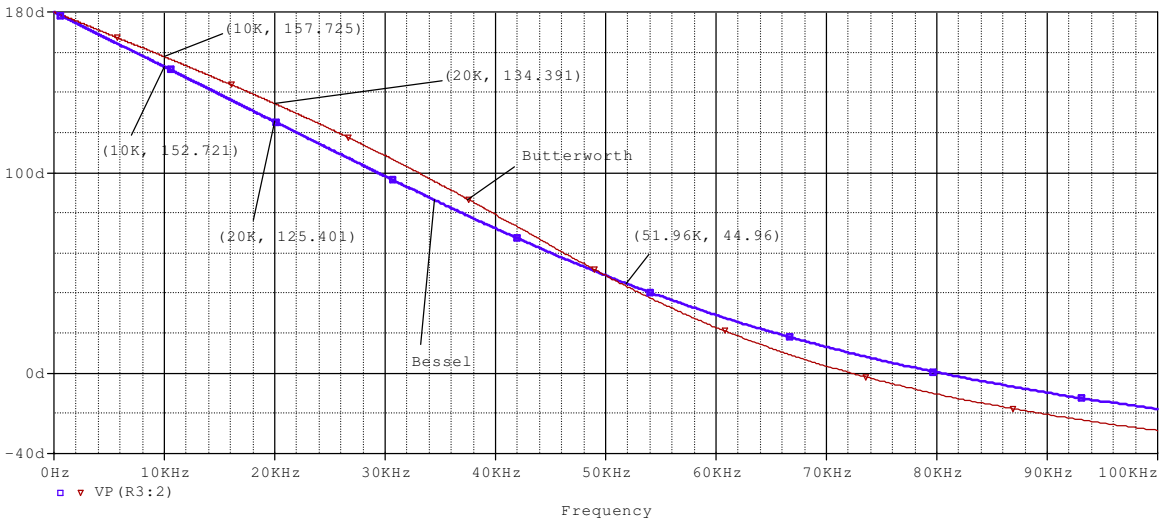
As for response types I even tried a 0.5 dB ripple Cebaschev once, then Butterworths and Bessels. The last type is the clear winner in my opinion.

OK I'll stop with an observation: for me the whole point of using a DAC in differential configuration is to avoid 'contact' between the DAC's analogue ground (this one goes to the digital ground also) and the analogue's filter stage ground (ha! so you can't use transistors for mute as in many CDP, DVD around ☺ - this is funny because some of them have indeed a separate supply for the analogue stage just that at the end the cost-cutting guy said: "What relay? …Throw in some transistors!"… So they ****** the whole thing)

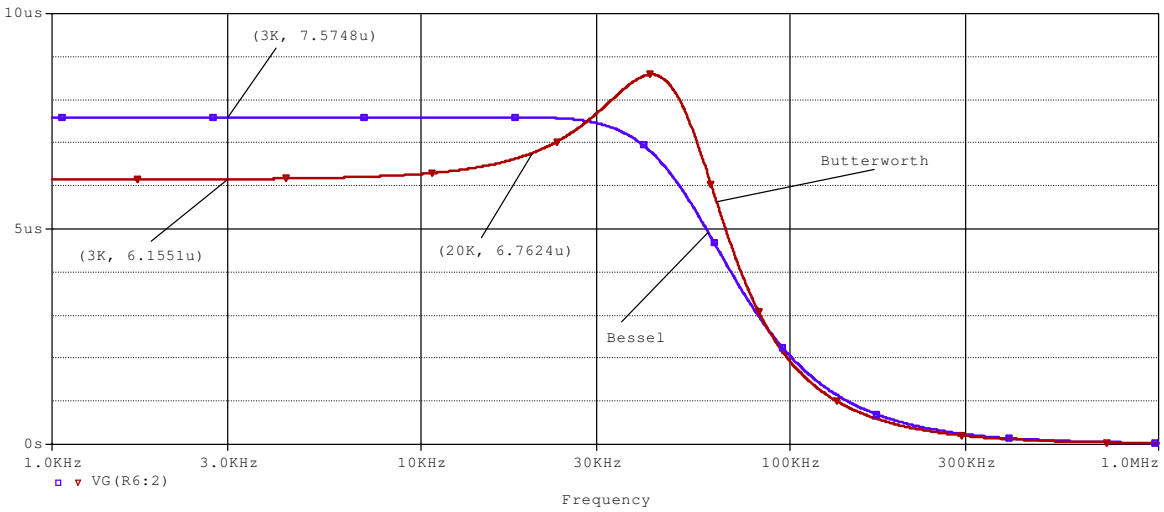
And, why not, the simulations for the filter in Fig.1:



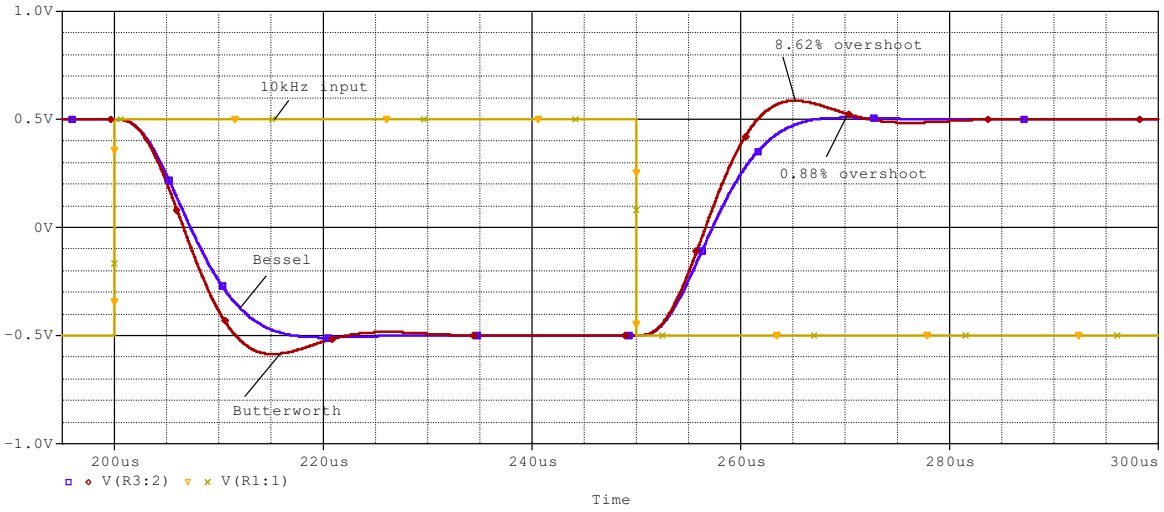
Amplitude vs. frequency response of the filters in the example – Fig.1



Phase vs. frequency on linear scale



Group delay vs. frequency



Transient response