**Modifications of Marantz CD63 and its derivates**

Analog filter

CD63's analog stage comprises two opamps around which is built an analog filter, and output buffer (HDAM). The first opamp serves to convert signal to unbalanced. Also, it has its own RC low pass network. The second opamp has further 2nd order Chebychev type filter and one notch filter tuned to the player's (over)sampling frequency. First filtering stage, being a RC filter can not have high Q, so it introduces ~0.7dB roll-off at 20kHz. Hence the second stage with peak which that way corrects the previous stage. Peak means inescapable ringing. The second stage has own 15% overshoot. The final result is a bit overcompensated in the frequency domain (+0.1dB) and speaking in time domain there is 10% overshoot with ringing lasting 1.5 cycle (the graph applies to the analog filter only).
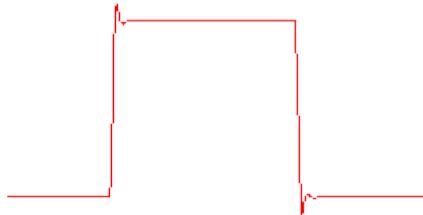
The thing that can be rather annoying for some is in this way it introduces a non-linear group delay.
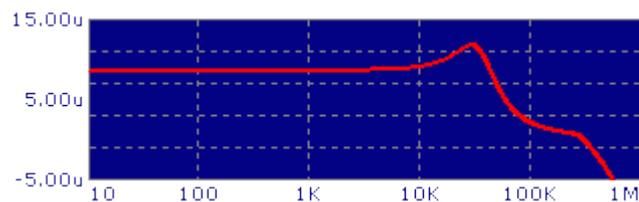
I decided to try Bessel type low pass filter, which is the steepest filter that still does not introduces group delay errors and ringing. This was already proposed by Martin Clark but I suppose it will be useful to explicate something about it. Filter can be changed to Bessel type simply changing the values of C605 and C606 to 390pF. This way we have a Bessel filter with -3dB point at 47kHz. However, as L601 and L602 in series with them form 8fs notch filters, they should be retuned to 520uH. More common value of 470uH could do the job with slight error in the tuned frequency. Again, it could be corrected raising the value of the caps (with 430pF it is at 354kHz), but this way filter becomes steeper than Bessel (marginally though). With 400pF and 470uH which are the values I used, group delay of the whole analog stage looks this way:
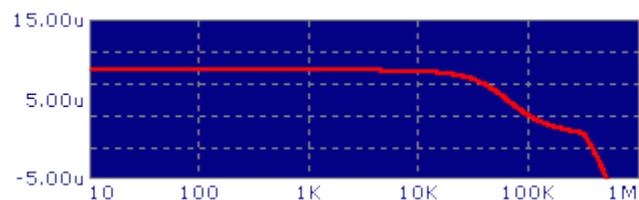
This 2nd order Bessel filter has its own ~0.5dB treble roll-off at 20kHz, which in sum with that of the first filter stage gives ~1.2dB. It is the price of clear group delay diagram. So, I just did something opposite to making those treble peaking filters for non-o/s. So, what is the point?

First, something about the sound of this mod. The difference is not huge. But it exists and it is audible. It mainly concerns more stable soundstage. And some sort of naturalness in the upper regions appeared. Shortcoming: I can hear 1.2dB treble roll-off. Really. But I consider this shortcoming less important than the benefits. At the other side, non-o/s's roll-off of more than 3dB clearly defines non-o/s's tonal balance. That is the point. A quantity.

Pedja Rogic, April 2003
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