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 **What do you think makes NOS sound different?**

<https://www.diyaudio.com/forums/digital-line-level/371931-makes-nos-sound-post6643742.html>

Under the above title, Ken started this thread, in an attempt to get his finger behind a supposed sound difference between NOS and OS .

In the above link, he points with several links to important postings with several supposed causes of the sound difference, worth reading for those who missed the tread from the beginning.

No attempt is made in the following text to go deep into details or into mathematics.  
Enough documentation is available on the subject easy to find when Googling if needed.

## I/V conversion

There are several ways to convert current produced by a Dac's output into a voltage such as passive conversion with low value resistors connected to xformers or active conversion with opamps to name just a few.

While NOS Dac's are mostly used in the DIY scene when I'm right and because many DIY NOS designs are using passive I/V conversion, the first thing was to find out whether the active conversion with op-amps as used in many OS Dac's could be a reason for sound differences.

Since switching from one current output value to the next one is accompanied by sharp nsec wide transients, it could very well be that an op-amp gets into slewing or overload problems, resulting in noticeable distortion.

For this test, I used the popular PCM179X Dac and found that 1mA transients with a duration of just 2nsec were produced. This was measured when terminating a Dac with 25R.

As a next step the voltage at the virtual input of the I/V converter op-amp was measured and at the same time it's output voltage. See figure 1.

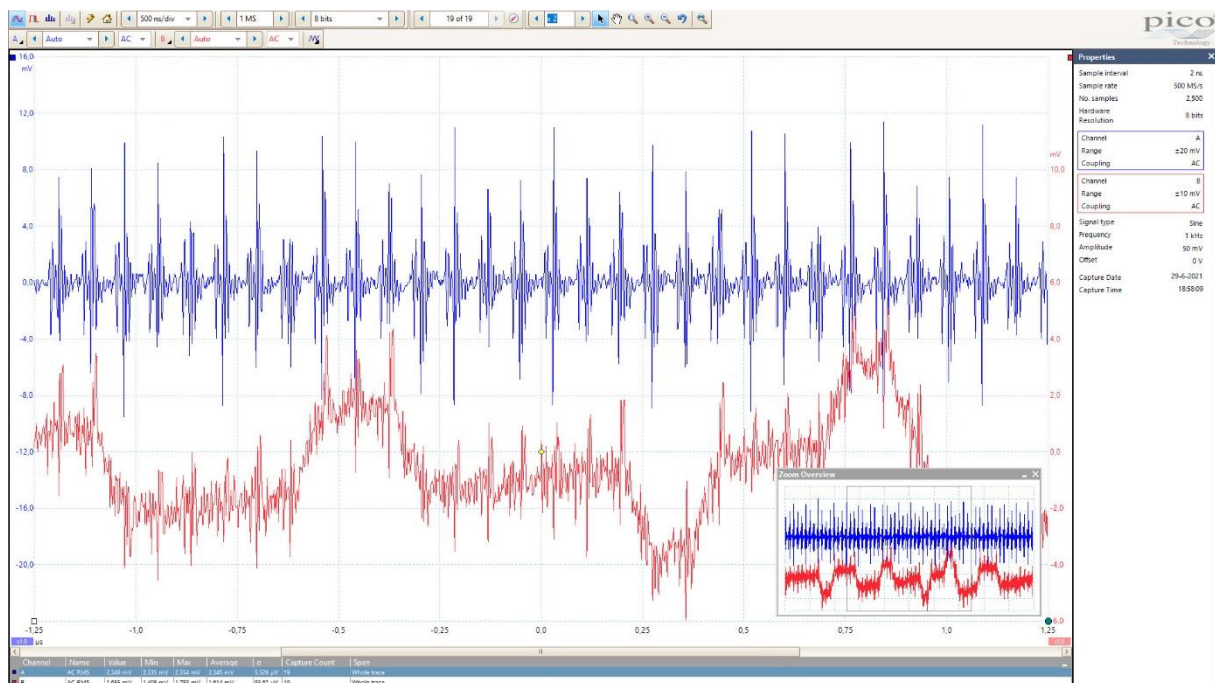


Fig 1 Virtual input signal of an I/V converter Op-Amp in blue, versus its output in red

It is clearly visible for this combination of Dac and op-amp, in this case a 90Mhz LT1468, that the input signal never exceeds 10mV, but since an attenuation /2 because of a used 50R series and 50R termination, it should be read as 20mV.

With 20mV max at the op-amp input, it is still safe below the point where slew rate and overload problems are to be expected. So, for sake of the tests in this thread, let's assume that the I/V converter will not play a dominant role in sound differences,

## FIR Filter test by up- and down-sampling

Important part in the up-sampling process is the removal of images between the original ( $F_{s1}/2$ ) and the ( $F_{s2}-F_{s1}/2$ ), where  $F_{s2}$  is the newly up-sampled frequency.

This filtering is usually done with a FIR filter of some length, although variations like apodizing additions and alternatives like IIR are available.

Our first attempt in this search was to find out what role the FIR filter could play in changing the perceived sound.

That's why three 44.1/16 files were selected and resp. up-sampled to 192/24 and back to 44.1/16 with Audacity in its best possible settings.

Result was overwhelming in as far that the five contenders selected 12 right out of 13, a significant percentage, saying that Fir filtering can indeed very well negatively influence sound perception.

	Bach		Kenny Rankin		Eva Cassidy	
	orig	up/down	orig	up/down	orig	up/down
	21	1	5	13	2	17
Magicbus	X		X		X	
Ddac	X		X		X	
Thom	X		X		X	
TNT	X		X		X	
Extreme					X	

Fig 2. Three files up-sampled with Audacity to 192/24 and =back to 41.1/166

This process is illustrated with time domain images in fig 2, showing a sinc filtered impulse response resp. from top to bottom sampled at 44.1/16, up-sampled to 192/24 and finally down-sampled to 44.1/16.

As can be seen, the impulse is almost perfectly reconstructed but at the same time it is clearly visible that the FIR filters used for up- and down-sampling are not very long, in the order of 20 to 30 msec.

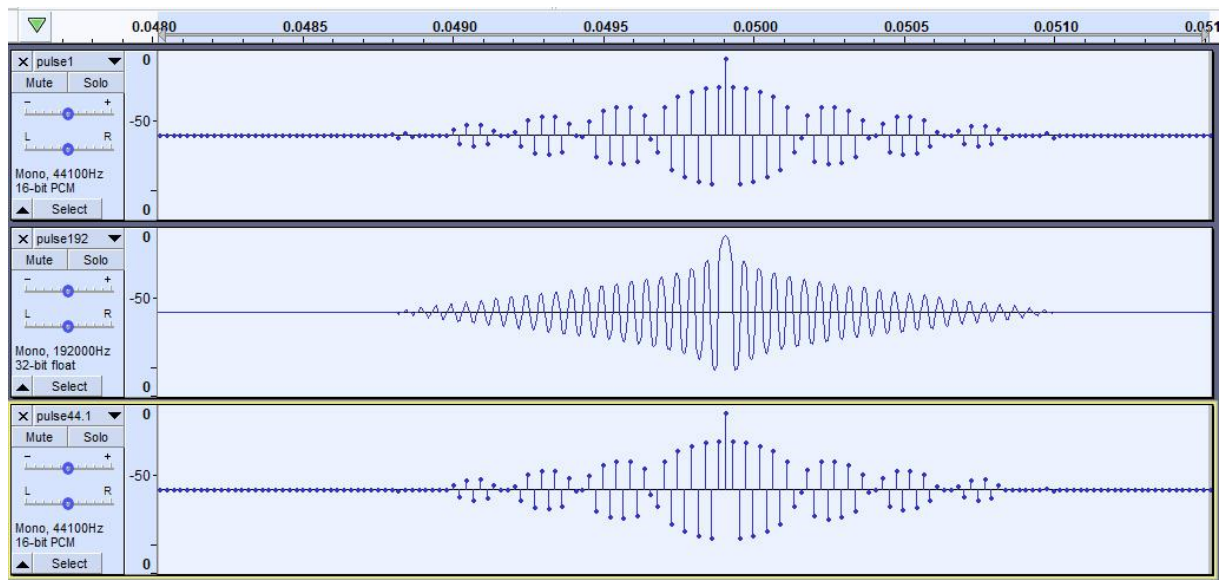


Fig 3. Time domain signals of an impulse response before and after down-sampling.

Because of the intriguing results with the Audacity up/down sample test, Ken found ZB willing to support us with his PGGB software. This software uses Mega long FIR filters with many options for different settings, approaching as close as possible an ideal Sinc filter and thereby at the same time reducing pre and post echo's to insignificant proportions.

So, we made a new run with four fresh 44.1/16 files up-sampled to 88.2/24 and back to 44.1/16. Results with contenders were quite different from the earlier Audacity test, see Fig 2.

	Bach Pastorale			Still got the Blues			God give me strength			Day 0	
	13	8		16	22		24	7		14	10
MagicBus		x		x			x			x	
Hierfi	x			x			x			x	
Bansuri		x		x			x			x	
DDAC		x			x		x			x	
Ken (OS)	x				x			x		x	
TNT		x		x				x		x	
mvs0		x			x		x			x	

Fig 4. Four files up-sampled to 88.2/24 and then back to 44.1/16

Looking at the first three files, from 21 options 12 were correct, a result that's absolutely insignificant with 50% chance to guesstimate between original in green and processed version in yellow.

This may be seen as a clear indication that the used FIR filter can make a lot of difference independent of NOS or OS.

The fourth file is however an unsolved mystery. This one was recorded from an LP at 192/24, brick wall filtered at 20Khz and down-sampled to 44.16.

With this file the outcome was 100% correct for all contenders, completely deviating from the other three files taken from existing CD's. I have no clue what the cause can be, so this may be left for a future test.

## FIR Filter test by comparing 44.1/16 to PGGB up-sampled 88.2/24

Now that we have seen that an almost perfect FIR filter has likely no significant influence on sound reproduction, next in line was to test whether a difference could be noticed between the original 44.1/16 file and the 88.2/24 up-sampled file.

The idea behind this is that a NOS Dac has a frequency droop of 3.16dB at 20Khz because of the zero-hold function and also has images starting directly at 22.05Khz and upwards.

With an up-sampled file to 88.2/24, droop becomes much smaller at 0.75dB at 20Khz and images now start at a much higher frequency of 66.15Khz

When the PGGB up-sampled files would make no difference for a NOS Dac, it would mean that both effects are playing no role in sound perception.

If it makes a difference, it would have to lead to further investigation which of the two effects are taking their toll.

Results are now visible in figure 4.

	Equal	44.1 preferred	88.2 Preferred	NOS	OS
DDAC	4			X	
Ken	2		2		X
Hierfi			4		X
MagicBus	4			X	
mvs0	3		1		X
Lampi	4			X	

Fig 5. Comparing four 44.1/16 files to PGGB up-sampled 88.2/24 files

Quite obvious is that the NOS Dac users hear no difference between 44.1/16 and PGGB up-sampled 88.1/24 files, indicating that neither the frequency droop, nor the HF content directly above 22.05Khz is playing any role in sound perception.

Be aware that only 3 NOS Dac users have done the test, making a statistical validated conclusion

not possible, but nevertheless these NOS Dac users heard no differences after up-sampling with an almost perfect filter, reducing the gap between NOS and OS to nil.

For the OS Dac users it is a close call between no difference at all and a preference for up-sampling. In a very careful way one could say that it roughly makes no difference for the OS users whether the file is up-sampled or not with 42% preferences for no difference versus 42% preferences for the original 44.1/16 files, a statistical insignificant result.

Only 16% files were selected as sounding better in 88.2/24, probably because part of the internal up-sample process was taken over by the much better PGGB up-sampler,

But because again of the very low statistical value of these results, no further attempts were made to go in any further detail.

But the indications are still fully pointing in the direction there that perfect up-sampling leads to no loss of sound perception.

## FIR Filter test between four 88.2/24 versus 176.4/24 and 176.4/32 files.

One last test in these series of tests, was to find out whether 176.4/24 or 176.4/32 could still give an improvement on the 88,2/24 files

Results are shown in figure 6 below.

	OS 88.2Khz versus 176.4 Khz				NOS			
	Fedde	Jurgen	Hans		Kostas	Doede	George	Thomas
Dac Type	OS	OS	OS		NOS	NOS	NOS	NOS
SRC	Yes	96K	192K		No	No	No	No
32 bit Dac	No	No	No		No	No	No	No
Dac chip nr	AD1852		PCM1792A		PCM1794A	PCM1794A	TDA1387	Discrete
1) Bach Pastorale	+1	0	0		+1	0	+1	+1
2) Still got the Blues	+1.5	0	0		+2	0	+0.5	+1
3) God give me strength	+1.5	0	0		+1	+1	0	+1
4) Day 0	+1	0	0		+2	0	0	+1
176.4/32 improves sound on 176.4/24 ?	Slightly	No	No		Slightly	N.A.	Slightly	N.A.

**Fig 6 Comparing four 88.2/24 files versus 176.4/24 and 176.4/32 files.**



## **Conclusions for as far possible from this last test**

- 1) No one preferred 88.2 over 176.4
- 2) In case of Jurgen, the 176.4 files were down-sampled to 96K, making the difference with 88.2 up-sampled to 96K very small.
- 3) Kostas heard no differences between 88.2 and 44.1 in the previous test. However, for some reason that I can't explain, he now preferred all 176.4 files over the 88.2 files.
- 4) No one has a 32 bits Dac, nevertheless the 32 bits version was preferred by 3 of the participants.  
On top of that, if the connection was made via Toslink, S/PDIF or AES/EBU the AES-3 protocol would restrict word length to 24 bits even before the data reached the DAC.  
Hence, here is another unsolved mystery.  
Could it be a psychological effect, i.e. longer is better ?
- 5) Hans preferred the original 44.1/16 files , although by a very small margin, just because it had just a little bit more punch.

Doede also preferred the 44.1/16 versions by a very small margin although in the previous test he heard no difference, so differences are also likely to be very small.

George found the 44.1/16 worse because they sounded a bit harsh. I think this is exactly what Doede and Hans heard, but depending on the rest of the installation, it may be reproduced differently.

But one has to be very careful here. The PGGB software has many possible settings, so may be a slightly smoother setting was selected for the FIR Filter.

## **Overall conclusions based on all the above**

- 1) Because the tests were all done on completely different systems, it is hard to compare results, but this was known from the beginning.**
- 2) Nevertheless, there is a very strong indication that the difference in sound between NOS and OS is caused by the length of the used FIR reconstruction filter. PGGB has an excellent position in this field and is now also available in Foobar.**
- 3) The frequency droop and images starting directly at 22.05 Khz for a NOS, does hardly seem to play a role, although this is always the biggest critique on NOS.**
- 4) The I/V converter as cause of a sound difference seems less likely as long as the active solution is fast enough**
- 5) It could be that 176.4K files sound even a bit better for some, but results are inconclusive according to figure 6.**

**Hans Polak  
08-28-2021**