

The Pepsi Challenge

By Richard Murison | Issue 14



With the rise of computer-based high-end audio playback, a very interesting question is whether it is best to perform volume control in the digital or analog domain. I thought I might share some of my thoughts on the subject.

The very best DAC/preamplifier combos have sufficiently low noise that they can resolve perhaps the 21st bit and even the 22nd bit of an audio signal. However, to achieve that level of performance with commensurate linearity you may have to choose between that and buying a fast car! The merely “very good” are capable of resolving the 19th to 20th bit as a rough guideline. If you implement volume control in the digital domain, every 6dB of attenuation results in the loss of one bit of resolution. So if you play back music with 24-bit bit depth, then all digital volume control results in irrecoverable loss of data via bit-depth reduction. However, if you play 16-bit music, and pass it to your DAC in 24-bit format (something which most high-end DACs require anyway), then, depending on the quality of your DAC/preamp combo, you can in principle dial in up to 18-36dB of attenuation without effectively truncating the music data.

All this assuming that your digital volume control is done in a first-class manner, using a 64-bit audio engine or something comparable.

So that's the theory.

On the other hand, volume control performed in the analog domain requires passing the signal through some sort of variable attenuator – such as a potentiometer, an active electronic equivalent, or a switched resistor ladder. These components do actually degrade the sound, and to quite an alarming degree! If you are in the habit of “tweaking” your audio equipment, you will know that a hardy market exists for after-market volume control potentiometers costing up to thousands of dollars each (!!!) in an effort to eliminate these sonic defects. So the answer to the question boils down to whether or not the sonic degradation introduced by Bit Depth reduction is less intrusive than that introduced by a preamplifier's volume control.

As it happens, I have done some extensive listening tests on this subject. Regardless of whether the music is 16-bit or 24-bit, I have found that performing volume control in the digital domain is qualitatively superior to performing it in the analog domain. And the difference is not subtle – it is really quite massive. No contest, actually. I will temper that statement by saying that it for sure depends on the preamplifier you are using and the volume control circuitry it implements. For example, I had a chance to discuss this with Dan d'Agostino, and while he agreed with me, he assured me that his new \$30,000 preamplifier has a volume control that introduces no sonic degradation whatsoever!

There are significant practical considerations to performing volume control in the digital domain. Basically, your DAC is essentially acting as though it were connected to a preamplifier permanently set to maximum volume. Depending on your computer setup and the rest of your audio equipment, the consequences of accidentally playing music (or, heaven forbid, “You Got Mail!”) at maximum volume may represent a risk that you are just not willing to take. Most computer playback systems have a user interface that has not been designed with this concern in mind. You might have to be very particular indeed about the procedures you go through each time you start to play music. To be fair though, after over three years of this I am no longer nearly so concerned by that, but I still think it only fair to mention it.

When I first ran these experiments I had a Light Harmonic Da Vinci DAC which I could either play through my Classé CP-800 preamplifier, or connect directly into the inputs of my 300W/ch Classé CA-2300 power amplifier, feeding B&W 802 Diamond loudspeakers. Most of my serious listening was done with about 20–30dB of attenuation dialed in either (i) directly on the Da Vinci; (ii) digitally using my player software, BitPerfect; or (iii) using the analog attenuator of the Classé CP-800. Both digital options sounded identical, and sounded massively superior to their analog counterpart.

Since I am in the high-end audio software business it was relatively easy for me to put together a playback test setup that progressively reduces the bit depth of a recording while maintaining the same overall volume. By doing so, it is possible to listen in isolation to the sonic changes induced through bit depth reduction alone. I could then compare those to the changes introduced by going from analog to digital volume control. Bit depth reduction, when properly dithered, simply adds noise to the sound, but when introduced as a consequence of digital

volume reduction, the added noise itself is also reduced in volume and therefore can't be detected as an additional sound. By contrast, connecting the analog attenuation stage in line with the signal notably muffled the dynamics and smeared the imaging.

These days I am using a PS Audio DirectStream DAC which I connect directly to a pair of PS Audio BHK 300 Signature monoblock amplifiers. It works perfectly, and there have been no usability concerns that have ever arisen. The DirectStream's design is such that its volume setting can be relied on to be found at whatever exact level it was at previously, and I can power it up and down without causing alarmingly loud bangs from my speakers (which was a problem with the Da Vinci). On the other hand, the DirectStream does not have the facility to allow its volume control to be accessed directly from the computer, which is very frustrating.

I suppose I ought to point out that the DirectStream's digital volume control is entirely different in the way it works. It is implemented in an SDM, which to my knowledge is quite unique (or at least unusual) and really requires a separate discussion of its own, which I don't have space for. But for all practical purpose, its effect is entirely analogous to that of a conventional dithered digital volume control.

In closing, though, Paul McGowan insists that with his new BHK Signature preamplifier between the DirectStream and the BHK 300's the sound actually improves. Well, he would say that, wouldn't he! Unfortunately I don't have the budget to take that particular Pepsi challenge. (*Richard: I'm supposed to be the resident cynic here—Ed.*)