PCM versus DSD

Recently the introduction of computers into home audio playback systems has made possible an unforeseen occurrence — the reintroduction of DSD, the modulation scheme used in Sony's failed format of SACD from the turn of the millennium.
At the end of the 1990s as the CD patents were expiring, so was a huge revenue stream for Sony and Philips, developers of the Compact Disc format. Anxious to replace the CD with another exclusive format that would also generate licensing income, Sony and Philips tried again with the Super Audio Compact Disc or SACD. In the meantime, none of the other hardware manufacturers were having any of it. They all saw the explosive growth of DVD as the wave of the future and wanted to base any new format on DVD. Thus began one of the most bizarre chapters in the history of audio formats.

MP3

They say that the function of time is to prevent everything from happening all at once. For a while it seemed that time had broken. First the lossy compression of MP3 was developed to allow streaming of audio over low-bandwidth Internet connections. This soon led to massive piracy (politely referred to as "file sharing") and also made possible ultra-compact portable music players that could hold thousands of songs.

DVD?

While Sony and Philips worked on the SACD, almost all of he other major audio manufacturers worked together to make a DVD disc specialized for music. By fudging the numbers to the point of mendacity Sony claimed an implied performance of 100 kHz bandwidth with a dynamic range of 120 dB. The only way to fight these totally misleading numbers was with numbers as big or bigger, which forced the DVD-Audio disc (as it came to be known) to be incompatible with the millions of DVD players that the early adopters had already purchased.
Then a teenaged Norwegian hacker broke the encryption method used in DVD. This put the fear of God into the record companies, who (almost certainly inaccurately) blamed "file sharing" on dwindling record sales. So Sony promised the record companies that SACDs would never be playable on computers, by building special transport mechanisms that modulated the width of the laser pits and bumps.

Surround sound?

There was one thing that both camps agreed on completely, and which they were completely wrong about. Since surround sound had been such a hit for DVDs in home theater setups, they were sure that any future music format had to have surround sound to succeed. The iPod disproved that notion completely.
There was some overlap in the need for text for lyrics and or album cover art, which DVD-Audio gave more attention to than did SACD. But for the audiophile, only one question mattered. Which format sounded better?
It was a good question. Sony was doing fantastically well at the time and spent millions of dollars promoting their format, first by hiring top-level engineers Ed Meitner (now with EMM Labs) and Andreas Koch (now with Playback Design) to build the original machines used to make the original SACD recordings for release. This equipment was owned by Sony and loaned at no charge to any major studio that wanted to make a high-quality disc that was, in essence, copy-proof, and not able to be shared.

DVD

But the DVD-Audio camp was a committee of over a dozen large companies that could agree on very little. And so like the kitchen with far too many chefs, the product that emerged tried to be all things to all people and didn't really resonate with any group. It was so complex to operate that it required a video monitor to navigate a confusing menu just to start the disc playing, let alone select a specific song.
Furthermore there was no single entity organizing the roll-out of DVD-Audio. The first releases were made by specialty audiophile labels that only spent a few hundred dollars on their recording hardware. When doing battle head-to-head against the juggernaut led by Sony, it was several years before any serious releases were made by any of the major labels.
But the problem was a classic chicken-and-egg problem. Nobody could sell enough software to realize a profit until a critical mass of hardware was sold. Neither format appealed to any group in large numbers and virtually every title ever made in either format lost money. So it wasn't long before both formats withered on the vine.

USB DAC

Cut forward a half decade and the introduction of the asynchronous USB DAC by Gordon Rankin o Wavelength Audio suddenly made computer-based audio a real and still-growing market force that continues to gain momentum. Adding higher resolutions, such as 96/24 and 192/24 was trivial with this new hardware model. Many claimed that a $100 hard disk drive gave better playback fidelity than a $50,000 optical disc reader. With the growth of high speed Internet lines,

downloading large audio files became a reality so that one needn't even leave the house to purchase new music.

Then in 2006 Sony made an unexpected move. Since SACD was a clear failure, they introduced a format called "DSD-Disc", which was basically an SACD but playable in a computer by leaving out a layer of content protection. To my knowledge not a single one of these discs has been made or sold, but it did open the door to make and sell DSD downloads.

DSD versus PCM

Ever since Sony's early (convoluted and self-contradictory) marketing claims about the performance advantage of DSD, backed by the fact that their multi-million dollar budget was generally able to make better sounding products than the disorganized renegades that released DVD-Audio, many, audiophiles have believed that DSD is inherently superior to PCM.

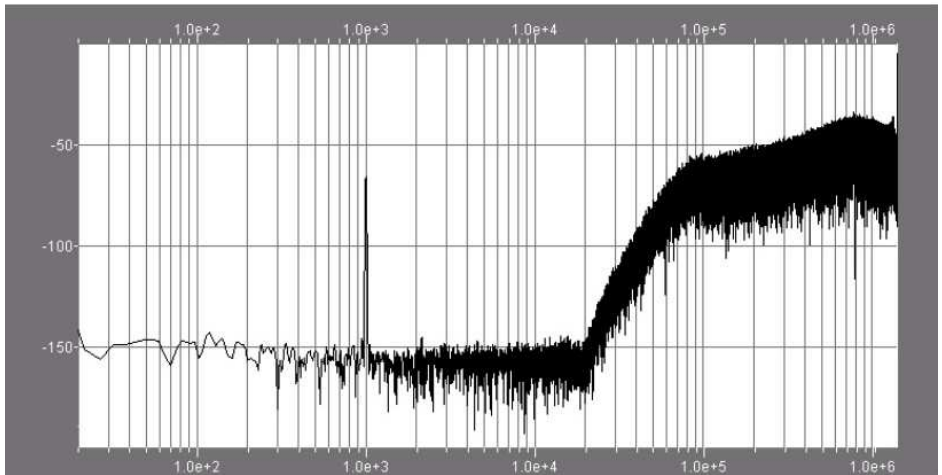
At the highest levels of audio engineers there has been little consensus as to which format sounds better, but most audiophiles have had first-hand experience with SACDs generally sounding better than DVD-Audio disc. So the prospect of being able to play downloadable DSD files via computer has led to a great deal of excitement, even controversy in the audiophile community. This article aims to sort out some of these claims.

All through 2013 a small infrastructure has been built and is slowly growing to record, distribute, and play downloadable DSD files. Now it is well known from a technical standpoint that there are many technical drawbacks of the DSD format when compared to PCM:

1. Standard DSD has low noise levels *in the audio band*, but at 20 kHz the noise rises sharply, leading to one of Sony's more obviously amusing marketing contradictions. On the one hand they say that its extended bandwidth leads to a more natural presentation of high frequencies in the music, but on the other hand, they say that the high amounts of high frequency noise doesn't matter because it is inaudible. I suppose the answer to that question depends on which marketing person you are speaking to on any particular day...

   However it does cause serious problems when recording with the techniques that have become commonplace over the last fifty years or more. Any time that the signal is manipulated, more and more noise is added to the signal. These high-frequency noises can lead to damage of downstream equipment including amplifiers and loudspeakers. Therefore the official Sony specification (the "Scarlet Book") specifies a third-order low-pass filter starting at 50 kHz, and the actual usable frequency response of SACD doesn't extend much beyond 30 kHz.

   To minimize this problem in professional gear, most DSD recordings today are made at double the rate of the DSD used on SACDs. It is modulated at 64Fs so is often called DSD-64, while the professional equipment running at double this rate is often called DSD-128. While this reduces some problems it introduces others, such as doubling of the file size and of course the download times and storage space required.



2. Since DSD is a one-bit format it is literally impossible to perform any signal manipulation at all — even a fade-out. So to perform recording in the modern methods where signals are mixed, EQ'd faded, reverb added, et cetera, all of the DSD signals must first be transcoded into PCM (or analogue) signals, then the signal processing applied, and finally re-modulating the signal back into DSD, adding another layer of high-frequency noise and more.

3. Except for the microphones, amplifiers, and loudspeakers, all of the equipment in both the recording and playback chain must be replaced with new hardware that can accommodate this new form of modulation.

We can see that DSD has quite a few strikes against from the very start. So the only justification for it whatsoever would be for the hard-core audiophile, and this would only be in the case if DSD could provide audibly superior sound quality over 16 bit 44.1 kHz PCM. So to settle this issue once and for all, for the first time available to the general public, **Channel Clasics** has made available a series of splendid recordings in both DSD and PCM that allow the listener to judge for himself if there are any audible advantages to DSD.

Before building a USB (or i2S) DAC for DSD, I upgraded a Sony SACD XF940 player to compare SACD with my extensively upgraded CD624 (for PCM). [See the next document in this site.] There I come to the conclusion that the higher resolution of DSD compared to 16 bit 44.1 kHz PCM not only serves the higher audio frequencies but enhances the total frequency range: the clarity of the sound and the better standing out of the sound stage did make more than worth the effort!

Rob de Lugt (Audio 4) meldde mij onlangs:

> De DSD-files komen vanaf mijn NAS op de netwerkspeler van PinkFaun die een rechtstreekse verbinding heeft op de i2S-ingang van mijn DAC in de Lyngdorf TDAi-2170 (dus niet via de USB die velen gebruiken).

Large parts of this article has been copied from Charles Hansen at Ayre Acoustics, Inc.

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