ART DUDLEY

PS Audio PerfectWave DirectStream

D/A PROCESSOR

It's like hearing the name of an old friend and then seeing him, in your mind's eye, as he was when you were both much younger: Whenever talk turns to Boulder, Colorado–based PS Audio, I can't help picturing that company's Model IV preamplifier, of the early 1980s—most likely because that was the preamp I longed to own at the time. (Tragically, I couldn't afford to buy it, so I struggled on with my NAD 1020.)

An awful lot has changed since then, including, in recent years, a shift of PS Audio's emphasis from audio amplification to AC-power regeneration. Even more recently, under the direction of co-founder and CEO Paul McGowan, the company has added to its line a series of digital-to-analog converters, culminating in their new flagship, the PerfectWave DirectStream DAC ($5995.95). The DirectStream is notable for converting any and all incoming datastreams to DSD—which, in case you haven't been paying attention, is hot. *Again.*

Description

The DirectStream DAC has its origins in a 2011 visit by former Microsoft engineer Ted Smith to the Colorado mastering studio of digital-audio pioneer Gus Skinas. Smith was already a DSD convert, he told me—"The first time I heard an SACD, I went out and bought a Sony SCD-777 right away, which was unusual because I'd never before spent that much money on an audio product!"—and he brought with him a laptop full of music files and a D/A converter he'd just designed and built that decoded pure, single-bit DSD.

Skinas was so impressed that he got on the phone to his friend Paul McGowan and said, in essence, *Get over here on the double.*

McGowan went straight to Skinas's place and was, as he puts it, knocked out by the sound of Smith's prototype: "Ted was playing his laptop through a TosLink-to-USB converter. With a wall wart. And it *still* sounded amazing." A visit to the PS Audio factory ensued—Smith says he was impressed by the lack of a *not-invented-here* attitude among PSA's engineers—and an arrangement was made for Smith to design the company's first DSD processor, with final voicing to be done by McGowan and Arnie Nudell, the latter of Infinity and Genesis fame. The first samples of the PerfectWave DirectStream DAC shipped at the end of April 2014.

Aside from an XMOS chip used as an asynchronous USB receiver, the DirectStream contains no off-the-shelf chipsets: all of its code is written by hand into a field-programmable gate array (FPGA). In Ted Smith's conversion system, all input data—regardless of format, regardless of native sampling rate—are synchronously upsampled to a 30-bit word length running at 28.224MHz, which is 10 times the standard sampling rate for DSD. The next stage is a 5x downsampler, which brings the signal back down to 5.6448MHz, or twice the DSD rate. There follows a digital volume control: this operates on the incoming 30-bit PCM with 20-bit coefficients, meaning that the datastream after the volume control is 50 bits wide. A extra "top bit" is added, to eliminate any possibility of overload, then the 51-bit PCM data are converted by a sigma-delta modulator to single-bit DSD, still running at twice the standard sampling rate: "It's double because we need another octave to deal with the rolloff at the output stage," according to Smith. That final stage is based on high-speed video amplifiers and a custom-wound output transformer.

Smith says that while good power-supply design and careful parts selection played significant roles in maximizing the sound quality of his design, equally critical was a careful, comprehensive approach to eliminating all sources of jitter from the data flow. "Only anti-jitter techniques that work in real time are going to work in audio," he says, "and you need to apply them all, even if one technique, on its own, doesn't seem to have a huge effect. For example, you need a single, high-quality clock, and you don't want to run it

SPECIFICATIONS

Description Single-box digital-to-analog converter. Formats supported: all PCM and DSD codecs (AIFF, WAV, DSF, etc.). Sample rates accepted: TosLink, 16–24-bit/44.1–96kHz; all other inputs, 16–24-bit/44.1–358.2kHz, plus DSD 64 and 128. Digital inputs: 6 including AES/EBU, TosLink, USB. Analog outputs: 2. Frequency response: 20Hz–20kHz, 40.25dB. Output levels: high range, 2.81V RMS; low range, 1.41V RMS. Output impedance: 100 ohms balanced, 200 ohms single-ended. **Dimensions** 17" (430mm) W by 4" (100mm) H by 14" (360mm) D. Weight: 29.7 lbs (13.5kg). **Serial number of unit reviewed** PWS-A1-4C066987.

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Update: GK Datum: 21.01.2015

through a digital multiplexer: Not knowing when something is going to happen—that actually *is* jitter. You also need to use RF cables instead of ribbon cables: RF cables have cleaner edges, and cleaner edges *are* less jitter!"

The DirectStream's cast-alloy casework—which proved impenetrable by all of the reasonable, nondestructive means at my disposal—is finished in a nice-looking textured paint, and the top is fitted with a sheet of glossy, piano-black MDF that may function as a mechanical damper of sorts. In addition to a small rocker Power switch and a slot for an SD card—I'll return to the latter in a moment—the rear panel is home to a selection of digital inputs: XLR (AES/EBU), RCA (S/PDIF), TosLink (S/PDIF), USB, and two I²S inputs using HDMI sockets—the last can handle DoP (DSD over PCM) or single- or double-rate DSD. The outputs provided are RCA (single-ended) and XLR (balanced). The level for the line signal appearing on both sets of output jacks can be set for low or high ranges, the latter suggested as appropriate for those who wish to bypass their preamplifier and directly drive their power amp(s).

Apart from a small indicator light, the DirectStream's clean-looking front panel has only an illuminated PS Audio logo and a 4" by 2.5" display—yet there was more to both than met the eye (or, at least, my eye): The logo is actually a soft-touch switch that toggles the powered-up DAC in and out of standby mode, while the display is a touchscreen from which the user can select (and give names to) source inputs, adjust volume, select output-level range, adjust screen brightness, and toggle between correct and inverted output-signal polarities. All of the display's functions are also accessible from the slender plastic remote handset (included).

Installation and setup

I removed the DirectStream from its very good packing, placed it in my system, and flipped its Power switch. The touchscreen informed me that the unit was *Initializing*. Precisely 11 seconds later, that message was replaced with the unit's clear and uncluttered default screen, which displays a volume scale near the bottom, a generously sized input-source indicator at the center, and other bits of data—plus two rows of dashes waiting to be replaced by numbers that would indicate the incoming signal's sampling rate and word length.

With the initialized DirectStream connected to my Apple iMac via a 1.5m WireWorld Revelation 2.0 USB cable, the correct device name appeared in the Sound subsection of my iMac's System Preferences window: "PS Audio USB 2.0 Audio Out." I assumed that all was well, but when I fired up my copy of the DSD-friendly Audirvana Plus playback software (v.1.5.12) and clicked on a song, my system remained resolutely silent—and no incoming data showed up on the screen.

As it turned out, the silence wasn't the result of a hardware or firmware flaw. Rather, it pointed to the need for greater care in optimizing my computer settings—greater, that is, than the level of care required by most PCM-only USB processors, the relative simplicity of which had lulled me into a false sense of expertise. During a conversation with Paul McGowan I learned that I needed to: open my iMac's AudioMIDI Setup window; highlight the left-column choice for the PS Audio DAC; change the source default sampling rate from 44.1 to 192kHz; and remove from the master-channel "Mute" box a check mark that, oddly, reappeared more than once during the review period.

MEASUREMENTS

I examined the PS Audio PerfectWave DirectStream's electrical performance with my Audio Precision SYS2722 system (see www.ap.com and the January 2008 "As We See It," http://tinyurl.com/4ffpve4). To test its USB input, I used my 2012 MacBook Pro running on battery power. Unless stated otherwise, all measurements were performed from the processor's balanced outputs. I don't yet have files of DSD-encoded test signals, so I assessed the DirectStream's measured performance with PCM-encoded files, with sample rates extending from 44.1 up to 352.8kHz. All testing was done with the DirectStream running on the newer v.1.1.4 firmware and the volume control was set to its maximum.

Apple's USB Prober utility identified the PS Audio as having the Product String "PS Audio USB Audio 2.0" and the Manufacturer String "PS Audio," and confirmed that the DirectStream processor operates in the optimal isochronous asynchronous mode. The USB input worked with data of sample rates from 44.1 to 352.8kHz, while the AES/EBU and S/PDIF inputs successfully locked to datastreams with sample rates up to 192kHz; as usual, the TosLink input was restricted to a maximum rate of 96kHz. The maximum output voltage at 1kHz was 2.85V balanced and 1.44V unbalanced.

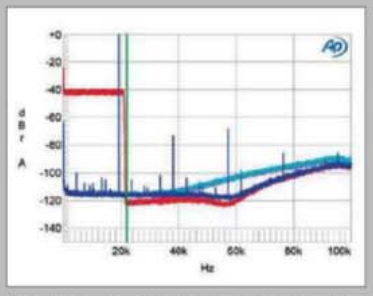

Fig.1 PS Audio DirectStream, wideband spectrum of white noise at –4dBFS (left channel magenta, right red) and 19.1kHz tone at 0dBFS (left cyan, right blue), with data sampled at 44.1kHz (20dB/vertical div.).

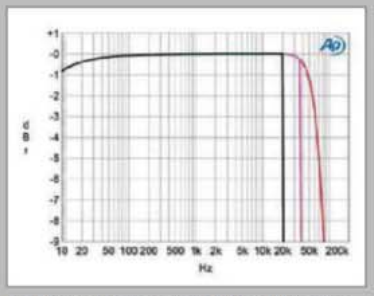

Fig.2 PS Audio DirectStream, balanced frequency response at –12dBFS into 100k ohms with data sampled at: 44.1kHz (left channel green, right gray), 96kHz (left cyan, right magenta), 192kHz (left blue, right red) (2dB/vertical div.).

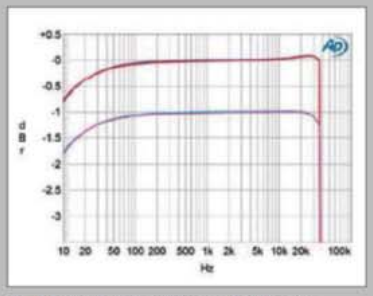

Fig.3 PS Audio DirectStream, unbalanced frequency response at –12dBFS into 100k ohms with data sampled at 96kHz (left channel blue, right red) (0.5dB/vertical div.).

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After that, I had to: call up the Audio System screen within Audirvana Plus's Preferences menu; change the Preferred Device to the PS Audio DAC (that option appeared automatically on hitting the Change button); and, most important, change "Native DSD Capability" to the option for "DSD over PCM Standard 1.0." (Per McGowan's suggestion, I also checked the option for Integer Mode.) After that, the system passed a bit-perfect throughput test. More to the point, it played music.

A final setup note: Given the choice, I always prefer the sound of my system with an active preamplifier—the passive approach seems to me sorely lacking in drive by comparison—so I didn't try using the DirectStream to directly drive any of my amps. That said, I found that the higher of the converter's two volume ranges best suited my system.

Both the front and rear panels of the DirectStream DAC appear clean and uncluttered.

The DirectStream distinguished itself as a superbly musical source component with a consistently smooth and slightly laid-back sound.

Listening

Arguably the most notable feature of the PS Audio DirectStream is its ability to convert everything to DSD, so that's just what I used to test it: *everything*—including downloaded DSD files, DSD files made from vinyl, high-resolution WAV files, CD-resolution AIFF files, even MP3 files. (The DirectStream did a fine job with the MP3 streams from the websites of WKCR and other stations.) With virtually all *programme*, as my favorite old-school British reviewers called it, the DirectStream distinguished itself as a superbly musical source component with excellent pacing, flow, correctness of pitch relationships, and the like, as well as a consistently smooth and slightly laid-back sound, especially when compared to competing high-end converters.

Unsurprisingly, DSD files sounded especially fine through the DirectStream DAC. "Tiny Dancer," from Elton John's *Madman Across the Water* (from MCA 2016), had clarity, color, and as much touch as one could expect from a 1971 studio rock recording in which virtually every instrument was subjected to generous levels of compression. Indeed,

measurements, continued

Switching in the output attenuator with the touchscreen reduced these levels by just over 20dB, to 273 and 106mV, respectively. Both outputs preserved absolute polarity (*ie*, were non-inverting). At low and midrange frequencies, the DirectStream's output impedance was a fairly low 296 ohms balanced and 124 ohms unbalanced. Both impedances rose slightly at the top of the audioband, to a respective 313 and 145 ohms, but this will be inconsequential.

The PS Audio's impulse response with 44.1kHz data was a standard linear-phase type, with symmetrical "ringing" before and after the single sample at 0dBFS (not shown). Fig.1 shows the results of a test suggested to me by Jürgen Reis of MBL, which characterizes the behavior of a digital device's reconstruction filter with FFT-derived spectral analysis up to 100kHz. The device under test decodes first 44.1kHz data representing white noise (magenta and red traces), then 44.1kHz data representing a full-scale tone at 19.1kHz (cyan, blue). With the tone, the second, third, and fourth harmonics, respectively at 38.2, 57.3, and 76.4kHz, can be seen, albeit at respectably low levels. But there is no trace of the aliasing product at 25kHz, this being completely suppressed by the reconstruction filter. The noise trace shows that the filter rolls off the processor's output sharply above 20kHz, and reaches the noise floor before the Nyquist frequency (half the sample rate; indicated by the vertical

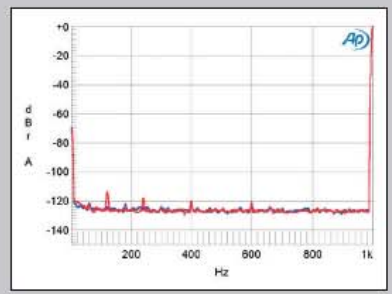

Fig.4 PS Audio DirectStream, spectrum of 1kHz sinewave, DC–1kHz, at 0dBFS into 100k ohms (left channel blue, right red; linear frequency scale).

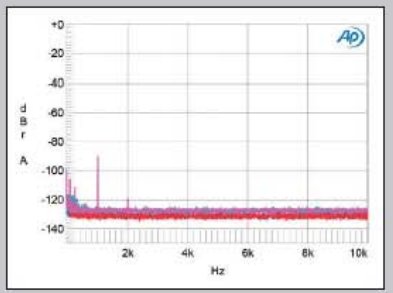

Fig.5 PS Audio DirectStream, spectrum with noise and spuriae of dithered 1kHz tone at –90dBFS with: 16-bit data (left channel cyan, right magenta), 24-bit data (left blue, right red) (20dB/vertical div.).

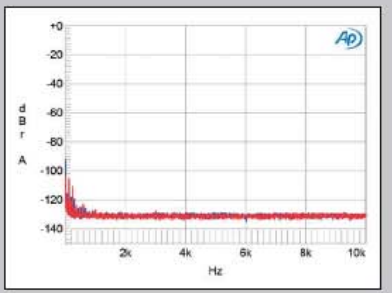

Fig.6 PS Audio DirectStream, spectrum with noise and spuriae of dithered 1kHz tone at –120dBFS with 24-bit data (left channel blue, right red) (20dB/vertical div.).

Caleb Quaye's consistently tasteful guitar embellishments popped nicely from the mix, while the pedal steel guitar of Cochise alum B.J. Cole shimmered and shone nicely behind the other instruments. John's lead vocal was realistically punchy and present, but lacked the excessive bite I've heard through other gear.

"St. Thomas," from Sonny Rollins's *Saxophone Colossus* (from Prestige 7079), also worked well, with good color—but slightly deficient texture—from the tenor sax and a fine drum sound, and with reasonably good touch. Good tactile qualities also characterized the DirectStream's way with Mahler's Symphony 1, played by the Budapest Festival Orchestra under the direction of Iván Fischer (from Channel Classics CCS SA 33112). The soft initial timpani strokes about 2:44 into the first movement had good startle factor, as did the even softer first taps on the bass drum a little after 9:00, and plucked strings and harp all had good touch and impact. The orchestra's first crescendo, at 7:26, was a little bloodless; the sound was considerably less forward than with the Luxman DA-06 DSD converter (which I reviewed in the July 2014 issue), enough that I often found myself inching up the volume control, hoping for just a bit more impact.

"Lonesome Tears," from Beck's *Sea Change* (from Geffen B0004372-01), was musically and emotionally compelling through the DirectStream. That said, the textures of the string samples were slightly smoothed over compared with the way they sounded through the Luxman converter, the latter also allowing more snap and impact in the drums and the glockenspiel-like electronic percussion. Similarly, the Luxman did a better job of getting across the breathy

Because AD couldn't pry open the review sample, PS Audio provided this photo.

quality of Sarah Watkins's voice in "Sabra Girl," from Nickel Creek's *This Side* (Sugar Hill)—although the DirectStream presented the music with an exceptionally fine and very analog-like sense of musical flow and momentum.

The same set of qualities—excellent musicality, clear and reasonably colorful if slightly reticent and overly smooth sound—followed the DirectStream to the realm of PCM files large and small. In conductor Daniel Myssyk's recording of Hindemith's *Escales Romantique* (from the Fidelio Musique sampler *Esales*), the chamber orchestra and piano both sounded just a bit distant and a shade soft through the DirectStream. My first impression was that the PS Audio

measurements, continued

green line). However, with both noise and tone data, the noise floor rises at ultrasonic frequencies, this presumably due to the PS Audio's DSD upsampling. Peculiarly, the two channels behave differently, the rise in the left channel's floor (cyan and magenta traces) starting at 40kHz, while the right channel's floor (blue, red) doesn't start to rise until 60kHz.

Fig.2 displays a more conventional representation of the DirectStream's frequency response, taken with data sampled at 44.1, 96, and 192kHz. In each case, the audioband response has a very slight rolloff in the low bass, reaching –0.8dB at 10Hz, but is otherwise flat up to 20kHz. The reconstruction filter rolls off the output just below the Nyquist frequency with the two lower sample rates, but the 192kHz response (blue and red traces) rolls off gently above 50kHz, reaching –3dB at 60kHz and –9dB at 80kHz. I also plotted the response with data sampled at 352.8kHz but haven't shown it, as it was identical to the 192kHz behavior. Fig.2 was taken from the DirectStream's balanced outputs. The cyan and magenta traces in fig.3 show the balanced output response at 96kHz, but plotted with a higher-resolution vertical scale and offset by –1dB for clarity. The blue and red traces in this graph were taken from the unbalanced output; it is slightly different from the balanced behavior in having a very slight rise in level above 12kHz, reaching +0.1dB at 25kHz. I doubt that this will have any audible consequences, but it is unusual.

Channel separation (not shown) was very good, at 95dB or greater across the audioband. Spectral analysis of the low-frequency noise floor while the PS Audio decoded 24-bit data representing a 1kHz tone at 0dBFS (fig.4) revealed that power-supply spuriae were extremely low in level, with the full-wave–rectified product at 120Hz present only in the right channel (red trace), but even so, at –114dB, this will be inconsequential. The DirectStream's circuit-board layout must have been done with a careful eye on grounding issues.

Things didn't look so good, how-

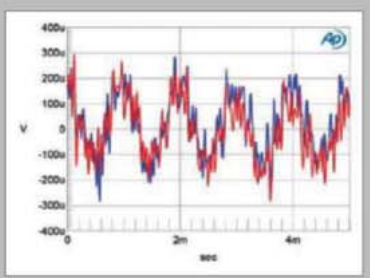

Fig.7 PS Audio DirectStream, waveform of undithered 1kHz sinewave at –90.31dBFS, 16-bit data (left channel blue, right red).

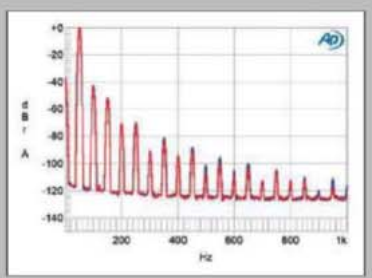

Fig.8 PS Audio DirectStream, spectrum of 50Hz sinewave, DC–1kHz, at 0dBFS into 100k ohms (left channel blue, right red; linear frequency scale).

was rounding off the attack components of notes to the detriment of their sonic physicality—yet there was excellent forcefulness in the plucked strings behind the piano in the second portion of the work's second movement, and I was impressed by the subtle and altogether lifelike manner in which the piano sound became bigger and more physically commanding as the intensity of the playing increased. This music was ultimately very satisfying through the DirectStream, even if it didn't sound quite as *forward* as I expected.

Solo piano music was also consistently involving through the DirectStream, as I found with the musically raw, live-in-the-studio recording by Jorge Bolet of Liszt's perversely fascinating arrangement of Wagner's *Tannhäuser Overture* (AIFF ripped from CD, RCA 63748-2). Here, again, the DirectStream seemed a bit rounded off and lacking the immediacy of, say, Bricasti's fine M1 DAC, which visited recently, and through which I could easily hear into the very blackness of the recording studio's natural reverb. Yet it was only when listening to the file through the DirectStream that I found myself physically responding to the music, nodding vigorously in response to the piece's many emotional peaks. And "Pharaoh's Dance," from the 40th-anniversary reissue of Miles Davis's *Bitches Brew* (AIFF from CD, Columbia/Legacy 88697 702742), was a delight: the most rhythmically insistent reproduction I've heard of this PCM file. The sound was free from digital edge, and offered not only great color in the trumpet and reeds, but excellent force and touch in Lenny White's and Jack DeJohnette's drumming and in Don Alias's congas. And Harvey Brooks's electric bass was

The DirectStream is an original and very forward-thinking product that is priced accordingly, but not unfairly.

ASSOCIATED EQUIPMENT

Analog Sources Garrard 301 turntable; EMT 997 tonearm; EMT OFD 25 & TSD 15 70th Anniversary pickup heads.
Digital Sources Halide Designs DAC HD USB D/A converter; Apple iMac G5 computer running Decibel v.1.2.11, Audirvana Plus v.1.5.12 playback software; Sony SCD-777ES SACD/CD player.
Preamplification Hommage T2 step-up transformer, Sutherland Engineering Insight phono preamplifier, Shindo Masseto preamplifier.
Power Amplifiers Shindo Corton-Charlemagne & Cortese (both monoblocks), Fi 421a.
Loudspeakers Altec Valencia, DeVore Fidelity Orangutan O/96.
Cables USB: WireWorld Revision 2.0. Interconnect (single-ended): Audio Note AN-Vx, Shindo Silver. Speaker; Auditorium 23.
Accessories Box Furniture Company D3S rack (source, amplification components); Keith Monks record-cleaning machine.—Art Dudley

measurements, continued

ever, when I performed a wider-band spectral analysis with the PS Audio processing dithered data representing a 1kHz tone at –90dBFS with 16-bit (fig.5, cyan and magenta traces) and 24-bit data (blue, red). With 16-bit data, the noise floor is dominated by the dither used to encode the signal, though a trace of second-harmonic distortion is visible. But when the bit depth was increased to 24, which was correctly indicated on the front-panel display, the noise floor dropped at most by 5dB, suggesting that the DirectStream DAC has only about 17 bits of resolution. This graph was taken with AES/EBU data; I got the same result with USB data, and though fig.5 suggests that the PS Audio DAC should just be able to resolve a 24-bit tone at –120dBFS, spectral analysis showed that it couldn't (fig.6). Its higher-than-expected noise floor meant that the PS Audio couldn't correctly resolve the waveform of an undithered 16-bit tone at exactly –90.31dBFS (fig.7). (For superb behavior on this test, see fig.6 in the review of the Antelope Zodiac Platinum elsewhere in this issue.)

While distortion on higher-frequency tones was acceptably low, even into 600 ohms—with a full-scale 1kHz tone, the second and third harmonics lay at –77dB (0.014%) and –71dB (0.029%), respectively—the DirectStream was less linear at low frequencies. Fig.8 was taken with a 50Hz tone into the kind load of 100k ohms. Even so, the second harmonic lay at –43dB (0.7%) and the third at –52dB (0.27%), with higher harmonics also visible. Dropping the signal level by 10dB (fig.9) reduced the level of the second harmonic by about 9dB with respect to the level of the fundamental tone, but the third harmonic dropped by just 1dB or so. At least this behavior didn't worsen into 600 ohms (not shown), and the DirectStream behaved very well when it came to high-frequency intermodulation distortion (fig.10). All the intermodulation products lay at –80dB (0.01%) and below, though some low-level spurious tones can be seen. These spuriae remained visible when I switched into circuit a brick-wall low-pass filter at 40kHz.

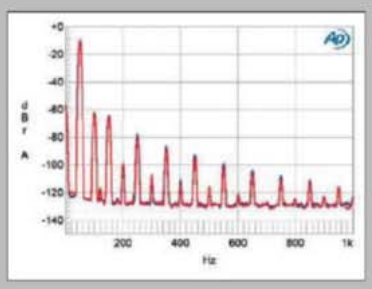

Fig.9 PS Audio DirectStream, spectrum of 50Hz sinewave, DC–1kHz, at –10dBFS into 100k ohms (left channel blue, right red; linear frequency scale).

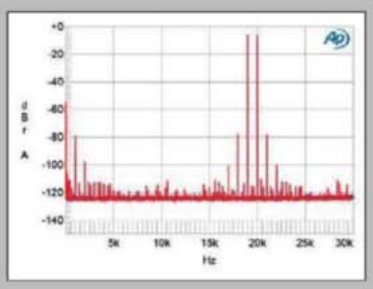

Fig.10 PS Audio DirectStream, HF intermodulation spectrum, DC–30kHz, 19+20kHz at 0dBFS into 100k ohms (left channel blue, right red; linear frequency scale).

colorful, impactful, and altogether badass.

Listening with new firmware

Apparently, my thoughts on the DirectStream's slightly distant, less-than-fully-textured sound were shared by someone at PS Audio: Unbidden, Paul McGowan contacted me in early June, alerting me to a user-installable firmware update aimed, he said, at "opening up" the sound—and, concomitantly, enabling the DAC to accept PCM files of sampling rates up to 352.8kHz.

The new firmware (v.1.1.4) arrived the next day on an SD card; installation was a simple matter of powering down the converter, inserting the card in the rear-panel slot, powering the unit back up with the card in place, and, after reinitialization, removing the card. *Anyone* could do it.

To get a handle on the update, I went back to Beck's "Lonesome Tears"—and was pleasantly surprised by a very audible increase in texture and touch. The PS Audio DirectStream maintained its slightly distant sound compared to that of the Luxman and other converters, but its excess smoothness had been replaced with a greater degree of textural nuance and detail. I was already impressed by the DirectStream's ability to play music more compellingly than most D/A converters of my experience; here was the refinement that put its sonic presentation in the first rank, as well.

I relistened to many of the selections cited above, and heard improvements in all of them. Across the board, attack components of notes were now more distinct—as a surprise bonus, I could more easily hear the differences between correct and incorrect output-signal polarity—and imaging "precision" was enhanced. As Beatrix Potter's Sally Henny Penny would say, "Something for everyone!"

The DirectStream presented the music with an exceptionally fine and very analog-like sense of musical flow and momentum.

Conclusions

Some digital products seem intended to stave off obsolescence as long as possible. And some digital products have a distinct point of view. PS Audio's PerfectWave DirectStream DAC is a little bit of both, and I find myself admiring the combination.

In these early days of DSD streaming, it should come as no surprise that the industry's digital-audio specialists are rolling out some rather large guns—and at prices often high enough that the target audience may, at first, be limited to only the most serious DSD and SACD stalwarts. So it goes here: The DirectStream is an original and very forward-thinking product that is priced accordingly, but not unfairly. It's beautifully made, insofar as I can see, and pleasant to use. Perhaps best of all, as I've already seen, it's very easily upgraded.

Time will tell if and when these levels of performance, flexibility, and *luxury* will become available for less than $6000. But today, for those who've waited for a computer-friendly DAC that offers, with *every* type of music file, the best musicality of which DSD is capable, the PerfectWave DirectStream may be in a class by itself. ■

measurements, continued

I obtained anomalous results when I tested the PS Audio DirectStream's rejection of wordclock jitter. Fig.11 shows a narrowband analysis of the processor's output while it decoded 16-bit J-Test data. While the central spike that represents the high-level tone at 11.025kHz is superbly well defined, the noise floor is closer to the 15- rather than the 16-bit level. In addition, while the odd-order harmonics of the low-frequency, LSB-level squarewave decay correctly with increasing frequency, they are all higher than their correct level (green line). With 24-bit J-Test data (fig.12), the noise floor remains too high in level, though no harmonics can now be seen.

It is important to note that figs. 11 and 12 are free from jitter-related artifacts; these graphs were taken with AES/EBU data. I got identical results with TosLink- and USB-sourced data—but something strange is going on.

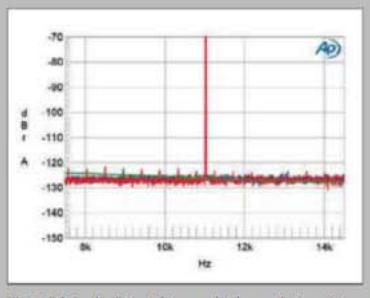

Fig.11 PS Audio DirectStream, high-resolution jitter spectrum of analog output signal, 11.025kHz at -6dBFS, sampled at 44.1kHz with LSB toggled at 229Hz: 16-bit data via AES/EBU from AP SYS2722 (left channel blue, right red). Center frequency of trace, 11.025kHz; frequency range, ±3.5kHz.

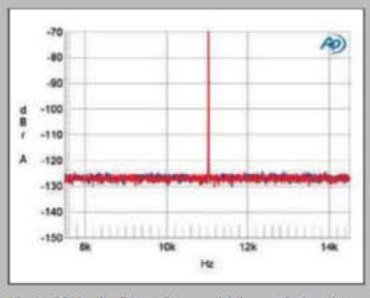

Fig.12 PS Audio DirectStream, high-resolution jitter spectrum of analog output signal, 11.025kHz at -6dBFS, sampled at 44.1kHz with LSB toggled at 229Hz: 24-bit data via AES/EBU from AP SYS2722 (left channel blue, right red). Center frequency of trace, 11.025kHz; frequency range, ±3.5kHz.

In many ways, PS Audio's DirectStream DAC measures superbly well. But I was somewhat bothered by its ultimate lack of resolution with data capable of higher-than-CD resolution, which I suspect lay behind AD's finding the processor to sound "a bit rounded off" and lacking in immediacy. Whether or not that will be an issue will depend on the listener's taste and the character of his or her other components. It is also fair to point out that the DirectStream's introduction of random noise at the 17-bit level will be sonically preferable to a processor whose errors consisted of enharmonic tones. But I was bothered by the PS Audio's poor linearity at low frequencies. Yes, some extra second- and third-harmonic content at low frequencies will add some "phatness" to the sounds of bass instruments; and as the nonlinear transfer function has been significantly improved in the midrange and above, that "phat" quality will not be accompanied by the high-frequency harshness of intermodulation. But the engineer in me doesn't like to see it.

—John Atkinson