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**PS Audio
DirectStream DAC
DSD Done Right**

EQUIPMENT REPORT



PS Audio PerfectWave DirectStream DAC

Not Just Another DAC

Vade Forrester

In 2012, a group of Direct Stream Digital (DSD) enthusiasts within the audio industry (led by dCS) released the DSD-over-PCM (DoP) standard, providing a way to “trick” traditional PCM audio circuits into playing native DSD files on suitably-equipped servers and DACs without first converting them to PCM. Today, few new DACs dare venture into the marketplace without DSD capability. Designing a DSD DAC has become almost routine; just order up some DAC chips capable of handling DoP inputs and use them in standard digital and analog circuits.

There is, however, always someone who wants to toss conventional practices over the side and start from scratch. In the case of PS Audio’s new DirectStream DAC, the original thinker is a computer scientist/audiophile named Ted Smith. A strong admirer of DSD recordings, Ted felt that the ideal DAC should work entirely in the DSD domain, so he set out to build a DAC which was entirely DSD-based. Of course, it had to accept PCM files; there are too many of those (e. g., CDs) to ignore, but they would be internally converted to DSD upon input. On his own, Ted took seven years to design a working example of his DSD DAC. Almost by chance, his design came to the attention of PS Audio’s CEO Paul McGowan, who liked what he heard (a lot), ultimately resulting in the subject of this review.

What’s so great about DSD anyhow? Here are some of the advantages PS Audio cites for DSD playback:

- DSD is simple to convert to analog; just run it through a low-pass filter. It doesn’t need a brick-wall filter like PCM, which can affect the sound. The DirectStream DAC uses a 24dB-per-octave low-pass filter, the same as you’ll find in many loudspeaker crossover networks. *[In theory, a DSD bitstream can be converted to analog with a single capacitor.—RH]*

- DSD is inherently linear; it’s hard to build a PCM DAC that always takes the same-sized step in the output for any possible unit increment of the representative PCM voltage value.

- DSD soft clips when overdriven, more like magnetic tape.
- All bits in a DSD stream have the same weight; a single-bit error anywhere is barely measurable, let alone audible.

PS Audio describes the DirectStream DAC’s circuit as follows:

All incoming data, PCM and DSD, are upsampled to 30 bits running at ten times the standard DSD rate and then back down again to double DSD for noise-shaping. The ten-times DSD sampling rate was the lowest common rate attainable through integer upsampling of 176.4 and 192kHz PCM files. An internal volume control maintains complete precision. Except for the sigma-delta modulation process itself there is no rounding; a full 50 bits are used. Consequently, there is no degradation from using the digital volume control. After the volume control, the signal is converted to DSD and downsampled to double-speed DSD (often referred to as DSD128). The double-speed DSD rate allows the low-pass filter to begin rolling off at 80kHz. A higher output rate would have increased jitter.

There is no conventional analog output stage. The output of the DSD engine is fed directly into high-speed, high-voltage, high-current symmetrical video amplifiers and from there into the passive output filter. Rather than use an active output section, a balanced wideband transformer (which is part of the low-pass filter) drives either balanced or unbalanced interconnect cables. The output impedance is 100 ohms (unbalanced)/200 ohms (balanced), which should drive any reasonable load.

Off-the-shelf DAC chips can’t perform the functions described above, so Ted used a Xilinx Spartan 6 field-programmable gate array (FPGA) chip instead. An FPGA is a computer chip that’s a blank slate; you can program it to do whatever you want, and that’s what Ted did. A single master clock is used, but it’s unrelated to the input sampling rate.

I don’t usually spend this much space describing the design and functions of gear I review, but since the DirectStream DAC is such an innovative design I thought it would be worthwhile; if you’re interested in learning more about it, I highly recommend a visit to PS Audio’s Web site. Suffice it to say that Ted Smith has completely rethought how a DAC should operate and has designed a unique and innovative DAC.

The \$5995 DirectStream DAC replaces PS Audio’s PerfectWave DAC. The two DACs are virtually identical, and that’s not an accident; PS Audio has a program for updating existing PerfectWave DACs by converting them to DirectStream

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DACs. One of the options for doing that involves gutting the PerfectWave DAC and replacing it with the DirectStream DAC's interior parts. Apparently that's easy enough that an owner can do it, but since some owners won't feel inclined to take on that project, PS Audio has other options for updating the PerfectWave DAC. See the PS Audio Web site for details and pricing.

Like the PerfectWave DAC, a DirectStream DAC is a black or silver-gray box that measures 17" x 4" x 14" and weighs 19 pounds. Its fine-grained metallic chassis has rounded corners, a color touchscreen towards the right end of the front panel, and a high-density fiberboard top panel finished in piano-gloss black. Its elegant and refined styling would look right at home alongside the fanciest components. In a nutshell, I'd describe its looks as classy. A plastic remote control is included. Some manufacturers provide remote controls hewn from ingots of solid metal, but the first time you drop one of those on your coffee table (or your foot), you'll really appreciate a light plastic remote—don't ask me how I know this. The PerfectWave Media Bridge, an optional expansion card that plugs into the PerfectWave DAC and enables you to connect it to a network, also works with the DirectStream DAC. The PerfectWave Transport, an advanced optical drive in an enclosure stylistically and dimensionally identical to the DirectStream DAC, is still available and makes a natural match with the DirectStream DAC. In other words, PS Audio has bent over backwards to protect the investment its customers have made in other PS Audio equipment.

Like the PerfectWave DAC, the new DirectStream DAC provides a wide variety of digital inputs: SPDIF on coaxial RCA and TosLink inputs, USB, AES/EBU on an XLR connector, and two I²S inputs on HDMI connectors. Although HDMI connectors are used for I²S inputs, these inputs don't carry HDMI video signals. Interestingly, while all the inputs will accept DoP-encoded signals, the I²S inputs will accept raw DSD signals direct, without DoP encoding. One raw DSD source is PS Audio's NuWave Phono Converter, which combines a phono preamp with a high-resolution PCM and DSD analog-to-digital recorder.

The color touchscreen on the front of the DirectStream DAC allows you to control most of its functions, duplicating the remote control; however, the remote control operates other items PS Audio manufactures, like the PerfectWave Transport, so it has a lot of buttons unrelated to the DAC. If, like me, you're suffering from remote control overload, it's quite convenient to be able to control all your PS Audio gear with a single remote.

Starting at the left end of the rear panel, there's the IEC input for AC power and the on/off switch. To the right, towards the bottom of the panel, is the horizontal slot for the PerfectWave Bridge expansion card and an opening for an SD memory card. About halfway across, the rear panel is divided into two sections: input and output. The bottom section is the output section, where the XLR and RCA output jacks are located. In the top section, you'll find the input jacks.

Setting Up and Using the DirectStream DAC

Although the DirectStream DAC can drive an amplifier directly, PS Audio recommends you not use both output jacks simultaneously. Because I use a subwoofer with my main speakers, I plugged the DAC's output into my Audio Research

SP20 preamp, which will drive my main speakers and subwoofer. Digital sources plugged into the DirectStream DAC included my HP laptop computer running Windows 7 and J. River Media Center 19, an Auraliti PK100 PCM and DSD File Player with its optional linear power supply, and a Meridian 500 CD transport. Hold on, a transport? Isn't that kind of Stone Age? Well, I still use a transport to play CDs inappropriate to rip, like those borrowed from my local library or from visitors. I also had the use of a PS Audio NuWave Phono Converter (reviewed by Anthony Cordesman in Issue 241), which when connected to the DirectStream DAC via the I²S connection, passes raw DSD formatted music converted from an LP. Music files used by both J. River and the Auraliti were stored on a NetGear ReadyNAS network-attached storage drive connected by an Ethernet cable through my home router to either server. The HP laptop was connected to the DirectStream DAC by Wireworld Platinum Starlight USB and AudioQuest Diamond USB cables (not at the same time), the Auraliti server used a Wireworld Gold Starlight 6 SPDIF cable, while the Meridian transport used a Wireworld Gold Starlight 5 AES/EBU cable. PS Audio includes a heavy-duty power cord, but a better cord should produce better sound, so I used an Audience Power Chord e cord. Clarity Cables Organic balanced interconnects connected the DirectStream DAC to my preamp. The manual recommended plugging the DirectStream DAC into one of PS Audio's Power Plant power centers, but lacking one of those, I plugged it into an Audience aR6-T power conditioner.

It was easy to install the driver software necessary for the DirectStream DAC to work with Windows. However, as with any driver installation, a few basic computer skills are required: extracting files from a ZIP file and running the SETUP.EXE file.

SPECS & PRICING

Converter type: Field Programmable Gate Array custom-programmed to serve as DAC

Sample rate (PCM): 44.1kHz, 48.0kHz, 88.2kHz, 96.0kHz, 176.4kHz, 192kHz

Word length (PCM): 16, 18, 20, 24 bits

Data rate (DSD): Standard (2.8MHz) or Double (5.6MHz) DSD on PCM on all inputs as well as raw DSD on I²S inputs

Synchronous upsampling, all inputs: 28.224MHz

Analog conversion method: Delta-Sigma, double-rate DSD

Output levels: "Low" setting, 140mV RMS unbalanced/280mV RMS

balanced; "High" setting, 1.4V RMS unbalanced/2.8V RMS

Digital inputs: I²S(2), coax, XLR, TosLink, USB, Network Bridge slot

Balanced outputs: One stereo pair on XLR connector

Unbalanced outputs: One stereo pair on RCA connector

Dimensions: 17" x 4" x 14"

Weight: 22 lbs.

Price: \$5995; \$3995 with trade-in of PerfectWave DAC

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Once the driver was installed, I had to adjust the settings on my music server program J. River, so it would use the new driver. That too, was simple—if you're comfortable with J. River. My Auraliti server, being a Linux computer, didn't require a driver for USB, and no drivers are required for SPDIF connections.

PS Audio suggested breaking in the DirectStream DAC for two weeks. That's a good starting point, but actually, the DAC continued to break in for two months, running almost 24/7. I noticed that the highs, which were initially a little edgy, became smoother and sweeter, the bass more extended, and the overall sound more spacious. If you audition a DirectStream DAC, be sure it's well broken-in.

Sound

PS Audio claims the DirectStream DAC “uncovers all the missing information hiding in your digital audio media for all these years.” That's a pretty tall claim; is it for real, or just hype? I'll let my listening buddy Carl answer that. When he entered the listening room where the DirectStream DAC was playing, he stopped, listened intently, and said, “That's a lot of detail!” And that was before I introduced him to the DAC. Carl is pretty familiar with my system and room, so the fact that he noticed the increased detail before I even pointed out the DAC is a genuine testament to the validity of PS Audio's claim.

I had wondered if the additional information the DirectStream DAC claims to retrieve from a digital recording would be easy to hear, or would be subtle low-level information that I'd have to strain to discern. Well, the answer was: both. The first thing I noticed about the DirectStream DAC's sonic characteristics was its ability to capture a sense of space. Even recordings that had seemed a bit flat had some air around them, and those with already well-defined soundstages had those soundstages more precisely defined, with more information about the recording venue.

The DirectStream DAC also captured more mechanical detail, more information about the physical process of playing back music. That includes a variety of things, for example, the noises a guitar makes when it's playing music. And I could hear more clearly how a vocalist articulated words and phrases. In addition to the physical details, the DirectStream DAC captured a ton of harmonic detail that made instruments and voices seem more realistic, instead of cardboard imitations of instruments. If the recording contained lots of harmonic details, I could hear those reproduced in accurate proportions. Indeed, after the DAC was broken in, I'd describe its sound as sweet and relaxed, so there's no need to worry that you'll hear unpleasant threadbare sound. But wait, there's more: The DirectStream DAC also captured lots of information about dynamic contrasts—both macrodynamic and microdynamic. Finally, if the recording permitted, the DirectStream DAC put all the musical information into context, so it was easy to hear how the all those parameters—detail, harmonics, dynamics, and space—related to each other to portray a coherent musical event. It didn't just tell you how a violin sounded; it also told you how it sounded relative to the rest of the orchestra. The DAC was able to organize the information it retrieved to make its presentation more like a musical performance.

Does this sound like more insane reviewer ravings? I can certainly see how it might, so let me cite a few musical examples

that led me to these conclusions. I made an effort to listen to old favorite recordings ripped from CDs, as well as newer high-resolution releases. I queued up Chris Jones' “God Moves on the Water” from his CD *Roadhouses and Automobiles* [Stockfish] ripped to an AIFF file. The first thing I noticed was the subterranean bass this track is noted for, presented with lots of detail and power. Then I observed that I heard more extraneous guitar sounds. Guitar harmonics were abundant. Jones' gravelly voice seemed unusually well fleshed-out harmonically. A visiting audiophile (not Carl) remarked that this track sounded like a high-resolution recording—not a bad start for a listening session.

Another demonstration of how much information the DirectStream DAC could retrieve came when I queued up the cut “Folia Rodrigo Martinez” from Jordi Savall's CD *La Folia 1490-1701* [Alia Vox] ripped to an AIFF file. The percussion instruments are quite vivid when played loudly, but often tend to fade into a background noise when played quietly. Or at least that's what I used to think; the DirectStream DAC raised them above the noise level and made them audible at all times. The clack of the wood blocks was clearly audible throughout the entire piece, as was the clatter of the castanets. The DirectStream DAC also generated a wider, more stable soundstage than I usually hear from this piece. The dynamic level is constantly changing, and the DirectStream DAC made it clear how band leader/viola da gamba player Savall was driving those changes. There was unusually precise placement of instruments in the soundstage, as well. The DirectStream DAC gave my subwoofer a good workout as it delivered a deep extension of the bass drum, with lots of power and impact I could feel as well as hear.

The Tallis Scholars' recording *Allegri's Miserere & Palestrina's Missa Papae Marcelli* [Gimell] was recorded in a spacious church. On the cut “Miserere,” a main choral group is up front in the soundstage, while a small solo group is further back in the room. A good system makes it obvious that the two groups are spatially separate, and decent DACs will give the impression of how far they are apart. The DirectStream DAC revealed not only that, but also gave a spatial picture of the recording venue. Likewise, while singers in the main choral group weren't exactly pinpointed, due to reverberation, their relative location was well-defined, as were their vocal characteristics. The vocalists weren't portrayed as a homogeneous blob, as they sometimes are with other DACs.

I think there's an unwritten rule that reviewers have to mention at least one female vocal performance in every review. So up next was Rebecca Pigeon's audiophile fave “Spanish Harlem,” from her album *The Raven*. I had two recorded versions of the cut, an 88.2/24 FLAC and a 176.4/24 FLAC which had been remastered by Bob Katz. The DirectStream DAC made the differences between the two recordings easy to distinguish—the 176.4kHz recording sounded less mechanical and edgy, making Pigeon's voice quite human-sounding. I felt like I could hear how she vocalized each word.

Okay, we've established that the DirectStream DAC plays CDs and PCM material quite well, but does it do as well on DSD recordings? To find out, I switched to a DSD recording: Alex de Grassi's album *Special Event 19* [Blue Coast Records]. Playing the cut “St. James Infirmary,” the DirectStream DAC captured more detail about guitar than I thought was possible. Starting with initial transients, the DAC reproduced the pluck of the

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strings sharply but with the resolution that told me when each string had been plucked. In the sustain part of the note, each note displayed its full harmonic characteristics, and then decayed off into silence, quivering in space for several seconds. The DAC caught de Grassi's phrasing perfectly, giving the piece a bluesy tinge. While each note was individually captured in textbook fashion, they all blended together to form an organic musical whole, a song with a touch of swing. I don't think I've ever heard a better rendition of someone playing a guitar. I've never heard a DSD DAC play the cut with such abundant musical detail, either.

To see if the DirectStream DAC would fall apart playing a recording of a full orchestra, I queued up Michael Tilson Thomas conducting the San Francisco Symphony in Mahler's Third Symphony [SFS Media/Downloads NOW!]. The SFS Media DSD recordings of the Mahler symphonies may well be the most realistic orchestral recordings I've ever heard. The result: rich, accurate harmonics, well-defined spatial environment, dynamic changes ranging from barely perceptible to hammering blows that threatened my speakers' well-being—and the breathtaking performance didn't hurt, either. Instruments sounded spookily realistic and were scaled to create a believable impression of a large symphony orchestra. The DirectStream DAC played the recording effortlessly; the passive output stage never sounded strained or congested. After we'd listened to the Mahler Third, another audiophile buddy commented: "It really doesn't sound digital anymore." He's never said that about any other DAC.

The above impressions were derived using a preamp between the DirectStream DAC and my power amp and subwoofer, for reasons I've explained. But I wanted to test PS Audio's claim that the DirectStream DAC will drive amplifiers directly, so I disconnected my subwoofer and used the DirectStream DAC to drive the power amplifier only. As I expected, the direct-drive mode yielded a slightly cleaner, more delicate sound, with even more spaciousness. Of course, absent a subwoofer, bass didn't extend as deeply. But if you only have one power amplifier to drive, I'd go with the direct-drive connection.

Comparison

My Audio Research DAC8 is a PCM-only DAC, so I could only compare it to the DirectStream DAC using PCM files. It's still in Audio Research's product line, selling for \$4995, not far from the price of the DirectStream DAC. I acquired the DAC8 back in 2010, but although I've reviewed several excellent-sounding DACs, I haven't yet been motivated to replace it. Or have I?

On "Folia Rodrigo Martinez," instrumental detail was less distinct, and the percussion instruments tended to blend together in the background a bit. However, the dynamic contrasts and shifts which are so important to this performance were as forceful as with the DirectStream DAC. Instruments were well fleshed out harmonically, although they sounded just a tiny bit raw compared to the DirectStream DAC. As is usual, bass was very extended and powerful, one of the characteristics the DAC8 is known for. The DirectStream DAC's bass power and extension seemed every bit as powerful as the Audio Research DAC8. No other DAC has ever achieved that.

The "Miserere" cut sounded very spacious, but the details of the soundstage, the reverberant space, seemed a bit less distinct than through the DirectStream DAC. The tenor soloist in the

main choral group sounded a bit grainier than through the DirectStream DAC. The DAC8's rendition was still well-defined and enjoyable, but the DirectStream DAC's version was better focused and smoother by a tiny margin.

Rebecca Pigeon sounded very good through both DACs. In "Spanish Harlem," the differences between the 88.2kHz and 176.4kHz versions were still discernible, but a bit easier to recognize through the DirectStream DAC.

Audio Research's DAC8 is obviously blessed with a very good analog section; however, the DirectStream DAC's passive output section was a bit more refined—something I wasn't expecting.

Bottom Line

In this review, I've explored the performance of the DirectStream DAC and compared it to another DAC of roughly similar price. Now it's time to answer three important questions: 1) Does the DirectStream DAC live up to its claim of revealing hitherto hidden details in your CDs; 2) if the answer to the first question is yes, how much of an improvement in sound does the DirectStream DAC make; and 3) is it worth its price? Answer No. 1: Based on my listening sessions, I'd have to say that the DirectStream DAC does indeed retrieve more information from my recordings, from CD to the highest-resolution recordings, than I had heard from other DACs. Answer No. 2: The differences in sound were perceptible, and contrary to my expectations, not really subtle. The effect of a lot of previously unheard information being added to previously audible information was often surprising. On the other hand, I wasn't surprised to learn that extracting more information from a recording is not always the same as making the recording sound better. Several times during the review period, I discovered that sometimes the DirectStream DAC made some recordings sound more obviously mediocre. As an audiophile, I suppose that's good; but as a music lover, sometimes less detail may actually be a benefit. An unexpected advantage, though, was that I learned that quite a few CDs and rips sounded better than I realized; so for well-recorded material, it elevated the playback quality quite noticeably. I guess that's all you could reasonably expect. Now for the hardest question—answer No. 3: This answer depends to some extent on personal preference. Although my memory of other DACs has faded with time, I can't remember any DAC that impressed me as much with its overall sound quality as the DirectStream DAC. So my answer to third answer would be yes. Of course, your mileage may vary. Obviously, any purchasing recommendation must take into account your financial situation. A price of \$5995 is pretty substantial, but I don't know of another DAC at or below that price that sounds as good.

Whether you're a rabid DSD fan, or have strong convictions that PCM is the only way to go, PS Audio's goal for the DirectStream DAC was to make both types of recordings sound as good as possible. My personal take is that it substantially realizes that goal. I highly recommend putting the PS Audio DirectStream DAC on your must-audition list if you're considering purchasing a DAC in its price range—or even if you're willing to spend more, even a lot more. It's easily the best DAC I've heard in my system, making digitally-recorded music sound better than I've ever heard it.

Bravo, Ted and Paul. **tas**

MANUFACTURER Comments

PS Audio DirectStream

Thanks to Vade Forrester for a thorough and comprehensive review of our DirectStream.

It's clear that Mr. Forrester understands not just the unique aspects of the design, but the actual philosophy driving that architecture as well.

From our first listen to Ted Smith's prototype, it was clear to us this was a design that would challenge a lot of the commonly held ideas about digital audio, in particular the magnitude of benefits offered by high-resolution files. This is a controversial subject, and our claim that the product brings new life to old music libraries of plain ol' Red Book CDs was a stretch to many, until verified by Mr. Forrester.

One would expect DirectStream's DSD and hi-res playback to be excellent, but its unique ability to reveal detail and ambient cues in familiar discs, even those Goodwill and yard sale specials, is something new, and we appreciate the courage of Mr. Forrester and the editorial staff at TAS for writing openly and honestly about the subject.

Paul McGowan
Ted Smith