ing was made with classically "natural" methods involving very few microphones.

The same traits shone through when I put on the San Francisco Symphony Orchestra's recording of Mahler's Symphony 9, conducted by Michael Tilson Thomas (SACD/CD, SFSO 821936-0007-2): the tremulous bowing of the violins, the brassy blaring of the horns in the distance, the swaying of the double basses. And when the music swelled in a crescendo, the Studio2s kept it all together: no breakup, no harshness, no mud.

But don't get the idea that the Ultima Studio2 was merely "analytical." At about 6:00 into the Górecki movement, when the high strings start bowing, they sounded as silky as they ever have. When I listened to Lorraine Hunt Lieberson singing "Ich habe genug," from her recording of J.S. Bach's Cantatas BWV 82 and 199 with Craig Smith conducting the Orchestra of Emmanuel Music (CD, Nonesuch 79692-2), my heart went pitter-patter, as usual. On Maria Schneider's *Sky Blue* (CD, ArtistShare AS0065), when her jazz orchestra begins to blow the opening passage of the first track, I couldn't help but sway along. The Studio2 was about as neutral a speaker as any I've heard in my system; if there's emotion on the disc and it hasn't been wiped out by the intervening components and cables, the Revel will pick it up and pass it along.

KR said that setting up the Ultima Studio2s wasn't all that delicate a task, but it was in my room. True, they weren't as persnickety as some speakers I've dealt with; I managed to find their sweet spots after just a few iterations, not a few dozen. But I found that changing the toe-in angle by 10° or even 5° made a big difference: If I toed them in too much, the midbass boomed a bit; if I toed them in too little, the upper midrange sounded thin, sometimes unpleasantly. In my room, the Revels sounded best when their tweeters were pointing to a spot just an inch or so outside my ears.

This setup narrowed the soundstage, though only a little. On "Jonah," from Paul Simon's *1964–1993* (3 CDs, Warner Bros. 45394-2), the hand drum was still well to the left of the left speaker; ditto for John Coltrane's tenor sax on side 1 of Miles Davis's *Kind of Blue* (LP, Columbia CS 8163). In either case, the Studio2s conveyed a palpable, layered depth—and if the recording was made in a concert hall, or a big studio such as the converted Greek Orthodox church that Columbia used in the 1950s and '60s, they also gave a convincing sense of the venue's dimensions and ambience.

Flaws and shortcomings? Well, a speaker of roughly similar design, but with more and larger woofers, would probably sound a bit warmer and heftier; I assume, though I've never heard it, that this is what one gets with Revel's own Ultima Salon2 ($20,999/pair). But, again, it would be way off the mark to call the Studio2 cold or bass-shy. When I put on Don Pullen's *Sacred Common Ground* (CD, Blue Note CDP 8 32800 2) to check how the Studio2 would handle pianist Pullen's slight darts and accents (very deftly, by the way), I was completely taken aback to hear how much more clear, woody, and thumpy Santi DeBriano's exquisite bass lines sounded; it was as if I'd never heard this part of the record before, though in fact I've listened to it dozens of times over the years. I should also note that, as clean and extended as the Studio2's highs sounded, thanks to its stiff, light beryllium tweeter, they don't quite match the stratospheric purity of a very good ribbon tweeter such as that in Verity Audio's Sarastro II ($40,000/pair).

Kal wasn't too thrilled with the Studio2's appearance, finding that its high-gloss piano-black finish looked too plastic. The units I reviewed were finished in mahogany, and looked both very attractive and genuine. (They also happened to go very nicely with the mahogany trim of my living room.)

All in all, I found the Revel Ultima Studio2 an involving, enticing, deeply pleasurable loudspeaker—among the best I've ever heard in my room.

—Fred Kaplan

FK'S ASSOCIATED EQUIPMENT

ANALOG SOURCE VPI Classic turntable & tonearm, Lyra Argo *i* cartridge.
DIGITAL SOURCE Krell Evolution 505 SACD/CD player with CAST outputs.
PREAMPLIFICATION Nagra BPS battery-powered phono preamplifier.
INTEGRATED AMPLIFIER Krell FBI.
CABLES Nordost CAST cables, Nirvana interconnects and loudspeaker cables.
ACCESSORIES Bybee Technologies Signature Power Purifier, Black Diamond Mk.4 Racing Cones, Mapleshade pucks, VPI HW-19 record-cleaning machine.
—Fred Kaplan

Musical Fidelity V-DAC D/A processor

Musical Fidelity V-DAC USB D/A processor

It was back in May 2009 that Sam Tellig wrote about Musical Fidelity's V-DAC D/A processor ($299), along with other products in the English company's bargain-basement–priced, blister-packed "V" series. "Frugality can be fun," cackled the inestimable Mr. T when he auditioned the V-DAC in his system, driven by Marantz CD63 Special Edition and Denon DCD-1650AR CD players used as transports. He said that the V-DAC sounded "extraordinarily quiet, as if I were hearing an *absence* of digital processing . . . the V-DAC's midrange was silky smooth, its treble sweetly extended." He concluded that "if you lust after a silken, sweet (but not oversweet) sound, you'll marvel at the Musical Fidelity V-DAC."

Intrigued by how Musical Fidelity achieves such excellent sound quality at the V-DAC's bargain price, I asked for a sample to be sent for measurement. Jon Iverson will be adding a second opinion on the V-DAC's sound quality in a future issue.

The V-DAC offers bare-bones construction. The power supply is a separate wall wart. A plain, black-painted box of extruded aluminum carries a single printed-circuit board, with the input jacks (TosLink, coaxial, USB) at one end and a single pair of RCA output jacks at the other. Other than three surface-mount LSI chips, the circuitry is based on traditional through-hole components, and local voltage regulation appears to be performed with the usual ±5V chips. The USB input feeds the ubiquitous Burr-Brown PCM2706 receiver chip, which is limited to 16-bit data and sample rates of up to 48kHz. The USB receiver operates in "adaptive" mode, where control of the data flow is subcontracted to the PC; it feeds the recovered audio data to a Burr-Brown SRC4392 sample-rate-converter chip, which also handles data up to 24-bit resolution and sample rates up to 96kHz from the TosLink and coaxial S/PDIF ports. Using this chip to upsample incoming data to 192kHz reduces the effect of datastream jitter.

The upsampled data are decoded to analog using yet another Burr-Brown chip, a DSD1792, which also does the necessary digital filtering. A high-speed quad–op-amp chip, a Motorola MCC33079, does the current-to-voltage conversion. This is followed by the output stage, based on a JRC 5532 dual–op-amp chip. While the 553*x* family of op-amps is now long in the tooth, Musical Fidelity uses them for the output stage of many of its products, due to their ability to drive low-impedance loads with very low distortion.

I examined the measured behavior of the Musical Fidelity V-DAC[3] using the Audio Precision SYS2722 system (see www.ap.com and "As We See It" in the January 2008 issue, www.stereophile.com/asweseeit/108awsi), as well as, for some tests, my Audio Precision System One Dual Domain and the Miller Audio Research Jitter Analyzer. Test data were sent to the V-DAC via TosLink from the AP systems or from the USB 2.0 output of my Intel MacBook running OS10.4.11 and playing back WAV files using Bias Peak 6.2. Unlike iTunes, Peak takes control of the OSX CoreAudio engine to ensure that audio at the correct sample rate is sent out through the computer's USB and FireWire ports. To avoid problems of noise contamination, I ran the MacBook on battery power for the testing, and used a premium USB cable from Belkin.

The V-DAC's maximum output was 2.08V and it preserved absolute polarity; *ie*, was non-inverting. The output impedance was a low 42 ohms at high and mid frequencies, rising slightly but inconsequentially to 78 ohms in the low bass. The S/PDIF inputs successfully locked to data with sample rates up to 96kHz. The USB input identified itself to the host computer as "USB Audio DAC" and was limited to sample rates at or below 48kHz. The audioband frequency response was the same at all sample rates, with a gentle droop evident above 10kHz (fig.1). Increasing the sample rate increased the frequency at which the ultrasonic brickwall filter cut in: with 44.1kHz data (fig.1, cyan and magenta traces), the response was –0.25dB at 19kHz; with 96kHz data (blue and red traces), the roll off continued to reach –1.1dB at 40kHz. Channel separation (not shown) was a superb 110dB in both directions in the midrange, decreasing to a still-excellent 100dB at 20kHz (due to capacitive coupling between the channels) and to 100dB in the bass (presumably due to increasing power-supply impedance).

For consistency with my two decades' worth of previously published tests of digital components, I first examine resolution by sweeping a ⅓-wide bandpass filter from 20kHz to 20Hz while the device under test decodes dithered data representing a 1kHz tone at –90dBFS. The top pair of traces in fig.2 show the result for the V-DAC decoding 16-bit data—the trace peaks at exactly –90dBFS, suggesting minimal linearity error, while the noise floor is free from harmonic- or power-supply–related spuriae. In fact, all the traces show is the spectrum of the dither used to encode the data, the V-DAC's own noise being much lower in level. Increasing the word length to 24 bits (using the S/PDIF input) gives the middle pair of traces in fig.2. The noise floor has dropped by 20dB, suggesting that the V-DAC has better than 19-bit resolution, which is competitive with D/A processors costing many times its price.

Dropping the signal level to –120dBFS gives the bottom pair of traces in fig.2; the tone is easily resolved, though a couple of dB of negative error are evi-

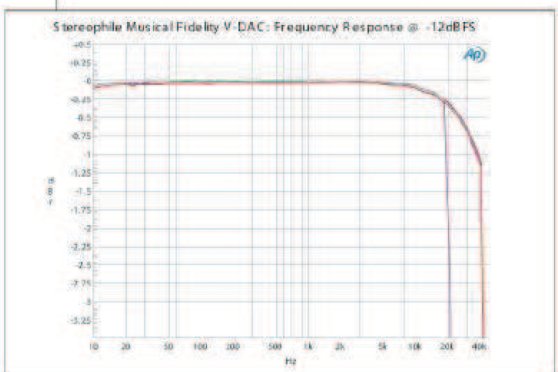

Fig.1 Musical Fidelity V-DAC, frequency response at –12dBFS into 100k ohms with 44.1kHz data (left channel cyan, right magenta) and data at 96kHz (left channel blue, right red; 0.25dB/vertical div.).

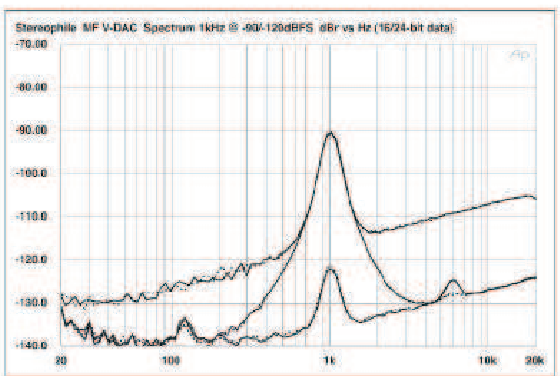

Fig.2 Musical Fidelity V-DAC, ⅓-octave spectrum with noise and spuriae of dithered 1kHz tone at –90dBFS with 16-bit data (top), 24-bit data (middle at 2kHz), and of dithered 1kHz tone at –120dBFS with 24-bit data (bottom at 1kHz). (Right channel dashed.)

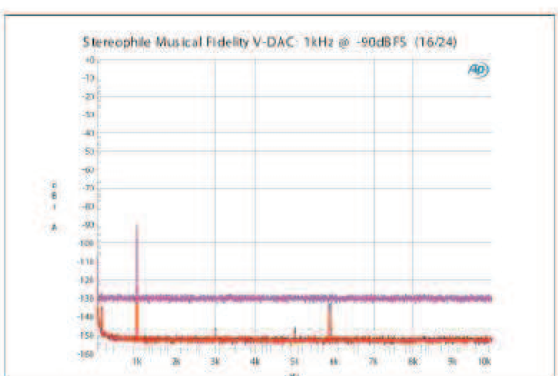

Fig.3 Musical Fidelity V-DAC, FFT-derived spectrum with noise and spuriae of dithered 1kHz tone at –90dBFS with 16-bit CD data (left channel cyan, right magenta) and 24-bit data (left channel blue, right red).

3 Musical Fidelity Ltd., 24/26 Fulton Road, Wembley, Middlesex HA9 0TF, England, UK. Tel: (44) (0)20-8900-2866. Fax: (44) (0)20-8900-2983. Web: www.musicalfidelity.com. Musical Fidelity lost its US distributor just before this issue went to press, but the V-DAC is still available from online retailers such as Amazon, Music Direct, and Audio Advisor.

dent. With all the 24-bit traces, a very small amount of power-supply hum at 120Hz is unmasked—at –135dB, this won't bother anyone—and a small spectral bump can be seen between 5 and 7kHz. Repeating the analysis using an FFT technique (fig.3), the bump is resolved to two spectral lines just below 6kHz, probably the result of a very slight DC offset being introduced into the data during its mathematical manipulation ahead of the D/A stage. Again, however, the V-DAC's very low noise floor is evident in this graph.

The plot of the Musical Fidelity's linearity error against absolute level with 16-bit data revealed only the effect of the recorded dither noise, so I haven't shown it. Fig.4 shows the waveform of an undithered 16-bit/1kHz tone at exactly –90.31dBFS: the three discrete DC voltage levels described by the data are clearly resolved, with excellent waveform symmetry. Increasing the data's depth to 24 bits gives rise to a well-defined sinewave (fig.5).

Only when it came to harmonic distortion did the V-DAC stumble, and then in only a very minor way. Fig.6 shows the spectrum of the DAC's output while it decoded a full-scale 1kHz tone into 600 ohms. (The result into the more benign 100k ohms was basically identical, so I haven't shown it.) A regular series of harmonic spuriae can be seen, as well as the idle tones just

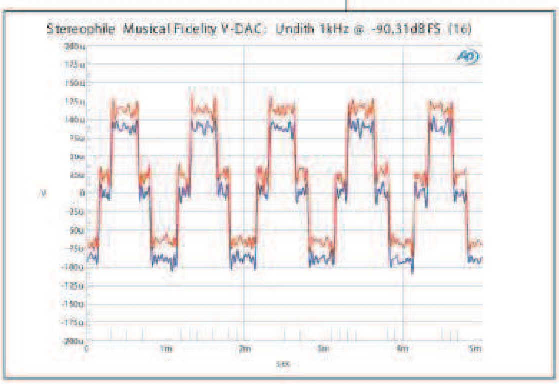

Fig.4 Musical Fidelity V-DAC, waveform of undithered 1kHz sinewave at –90.31dBFS, CD data (left channel blue, right red).

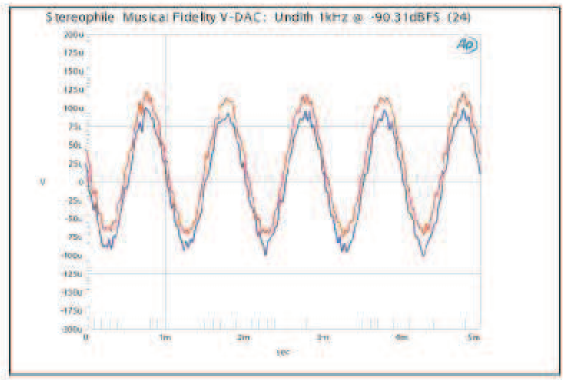

Fig.5 Musical Fidelity V-DAC, waveform of undithered 1kHz sinewave at –90.31dBFS, 24-bit data (left channel blue, right red).

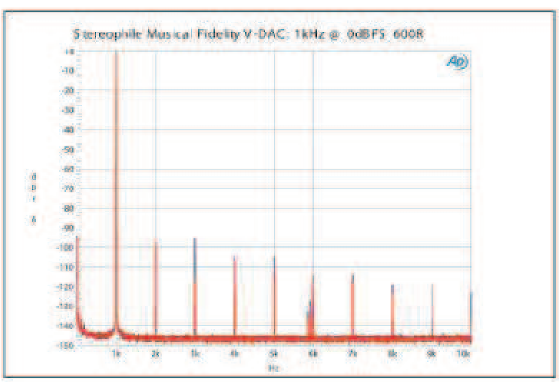

Fig.6 Musical Fidelity V-DAC, spectrum of 1kHz sinewave at 0dBFS into 600 ohms, 24-bit data (left channel blue, right red; linear frequency scale).

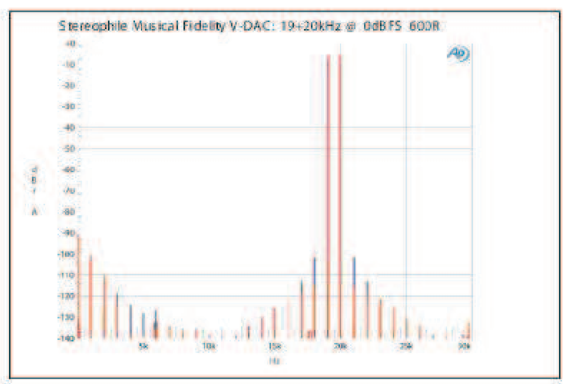

Fig.7 Musical Fidelity V-DAC, 19+20kHz at 0dBFS peak into 600 ohms, 24-bit data (left channel blue, right red; linear frequency scale).

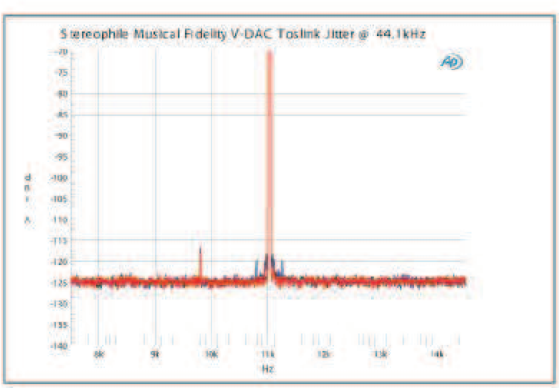

Fig.8 Musical Fidelity V-DAC, high-resolution jitter spectrum of analog output signal, 11.025kHz at –6dBFS, sampled at 44.1kHz with LSB toggled at 229Hz, 16-bit data via TosLink from AP SYS2722. Center frequency of trace, 11.025kHz; frequency range, ±3.5kHz (left channel blue, right red).

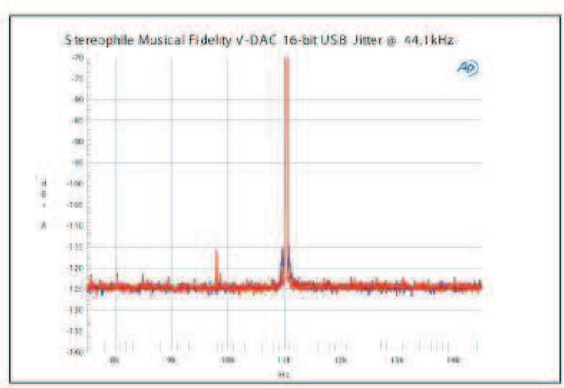

Fig.9 Musical Fidelity V-DAC, high-resolution jitter spectrum of analog output signal, 11.025kHz at –6dBFS, sampled at 44.1kHz with LSB toggled at 229Hz, 16-bit data via USB from MacBook. Center frequency of trace, 11.025kHz; frequency range, ±3.5kHz (left channel blue, right red).

below 6kHz, though it is fair to point out that all these lie at or below –96dB in the left channel, –100dB in the right. The left channel (blue trace) has more third and fifth harmonic content than the right (red). Intermodulation distortion was also very low (fig.7), and no aliasing products were visible. Again, the left channel was not quite as linear as the right, and the performance into the punishing 600 ohm load was no worse than into 100k ohms.

As with other products using the SRC4392 chip as an S/PDIF receiver—the Music Hall dac25.2 comes to mind—the V-DAC does not reject incoming jitter as well as I would wish, which is presumably why ST heard significant differences between the transports he tried with the V-DAC. The measured jitter level via both the TosLink and coaxial inputs was never high, but it varied considerably according to the source I used. Fed via 15' of TosLink cable from the RME soundcard mounted in one of my test-lab PCs, the measured jitter level was 444 picoseconds peak–peak, with most of the energy in the data-related sidebands at ±229.5Hz and ±689.5Hz. Changing the source to the AP SYS2722's TosLink output and using the same 15' of optical cable, the jitter halved in level, with now just the ±229.5Hz sidebands visible, and then only in the left channel (fig.8).

Feeding the V-DAC the same test signal via USB, these sidebands disappeared (fig.9) and the measured jitter level dropped below the resolution limit of the Miller Analyzer. Given that the V-DAC uses the PCM2706 chip in the jitter-prone adaptive mode, this result was surprising—until I remembered that the SRC4392 sample-rate–converts the incoming data, which will minimize the jitter. But then I don't understand why its doing so is less effective with S/PDIF data.

Yes, the D/A chips now coming from the foundries run by companies like Burr-Brown/Texas Instruments are capable of superb linearity and resolution, but the designer of a product like the Musical Fidelity V-DAC still has to be able not to compromise that performance with analog design and circuit layout. The V-DAC's generally superb measured performance indicates that compromise was avoided; it would not disgrace a much-higher-priced product, let alone one that costs just $299—half what our family spends on groceries each month. —John Atkinson