dCS Vivaldi Apex Digital-to-Analog Converter

Lord of the Ring

Jacob Heilbrunn

This past summer I had the good fortune to attend a performance at Washington's National Cathedral of Brahms' *German Requiem*, which was dedicated to the people of war-torn Ukraine. Where I was seated high up in the balcony, with a bird's-eye view of the orchestra and chorus, it was hard not to be wowed by the sheer grandeur of the cathedral. The sound effortlessly expanded into space, whether it was the soloists or the mighty brass section.

Listening to the dCS Vivaldi DAC with the new Apex upgrade vividly reminded me of this concert for a variety of reasons. Foremost among them was the ability of the Vivaldi Apex to reproduce the sense of air in concert halls or recording studios, allowing it to position an instrument or singer firmly in the soundstage and to capture a wealth of ambient detail (down to the degree of hall echo produced by a performer) with well-nigh uncanny accuracy. Until now, no digital system in my experience has succeeded in capturing this phenomenon as well as analog playback. The Vivaldi Apex does. Just listen to a Beethoven piano concerto—the DAC has the piano resounding so emphatically in the hall that it constitutes the very essence of sonic realism. In situating instruments so incisively in the actual venue, it takes a big step toward digital playback that is not simply improved but gobsmacking in both its precision and emotional power.

Believe it or not, even with the mighty TechDAS Air Force Zero 'table on hand, I listen to a lot of digital. Yes, siree! There's simply too much repertoire on digital that cannot be accessed on LPs or, if you prefer, tapes, to be a fuddy-duddy about it. Plus, digital often sounds first-rate—low noise floor, fortissimo dynamics. What's not to like? So, when John Giolas, the vice-president of sales and marketing for dCS, which is based in Cambridge, England, intimated that something swell was on the horizon, my ears perked up. It's been about a decade since dCS introduced the Vivaldi suite of digital source components (DAC, upsampler, CD/SACD transport, clock) to the Yanks at a demo at the audio retailer Ears Nova in Manhattan. Back then I was quite chuffed, as the Brits like to say, by the image stability of the four-box Vivaldi, which featured a superlative Esoteric VMK3 VRDS-Neo CD/SACD transport mechanism. I bought the whole stack. Since then, dCS has made some important software upgrades, but undertaken no major component upgrades until now to revivify the Vivaldi DAC. This Apex upgrade costs $9000 and is available for the Vivaldi DAC, Vivaldi One (one-box DAC, upsampler, transport), Rossini DAC, and Rossini CD/SACD player, regardless of vintage. The upgrade is handled through your dealer, who ships the unit to the dCS service center in Boston for North American customers (dCS has service centers around the world).

At the heart of dCS products is its innovative Ring DAC. The task of a digital-to-analog converter is implied in its name—to take a digital audio data stream and convert it to an analog signal. Optimally, this occurs without adding any new distortion to the signal. The folks at dCS note that the problem with transforming 1's and 0's into an analog wave is that it can do just that. The company explains that its Ring DAC architecture eliminates any correlation between the audio signal and errors introduced by the inevitable parts tolerances in even the most precise resistors: "Given that any combination of current sources can 'fire' any bit in the Ring DAC, the error generated is completely unrelated to the audio signal; it is decorrelated. This decorrelation means that any errors are randomized and converted to white noise." The aim, then, is to lower this distortion and preserve fine detail. To this end, dCS frowns upon the use of DAC chips, which it regards as a recipe for built-in obsolescence. Instead, it employs a Field Programmable Gate Array platform to ensure future software upgrades, something that it regularly offers to its customers. Now, dCS has taken further steps to attempt to improve the per-

Specs & Pricing

Vivaldi Apex DAC

Conversion: dCS proprietary Ring DAC topology
Analog outputs: One pair balanced outputs on XLR jacks; one pair unbalanced outputs on RCA jacks
Digital inputs: USB 2.0 interface on B-type connector, accepts 24-bit/44.1–384kS/s PCM, DSD64 & DSD128 in DoP format; 4x AES/EBU inputs on 3-pin female XLR connectors, accepts up to 32-bit/192kS/s PCM & DSD64 in DoP format; 2x dual AES pairs, accepts 24-bit/88.2–384kS/s PCM, DSD64 & DSD128 in DoP format; 2x SPDIF on RCA phono connectors, accepts 24-bit/32–192kS/s PCM & DSD64 in DoP format; 1x SPDIF on BNC connector, accepts 24-bit/32–192kS/s PCM & DSD64 in DoP format; 1x SPDIF on TosLink connector, accepts 24-bit/32–96kS/s PCM; 1x SDIF-2 interface on 2x BNC connectors, accepts 24-bit/32–96kS/s PCM or SDIF-2 DSD (auto selected)
Wordclock I/O: 3x Word Clock inputs on BNC connectors, accept standard Word Clock at 32, 44.1, 48, 88.2, 96, 176.4, or 192kHz (the data rate can be the same as the clock rate or an exact multiple of the clock rate); 1x Word Clock output on 1x BNC connector
Residual noise: Better than -113dB0 @ 20Hz-20kHz unweighted (6V setting)
Crosstalk: Better than -115dB0, 20-20kHz
Output levels: 0.2V, 0.6V, 2V, 6V rms for a full-scale input, set in the menu
Output impedance: 3 ohms
Maximum load: 600 ohms (10k–100k ohms is recommended)
Dimensions: 17.5" x 6" x 17.2"
Weight: 16.2 kg/35.65 lbs.
Price: $46,500 (upgrade for Vivaldi units, $9000)

DCS LIMITED
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dcsaudio.com

formance of the Ring DAC that include revamping the power supply, designing a new analog output stage, and reconfiguring the main Ring DAC circuit board. (See the sidebar on how the Ring DAC works.)

The changes were instantly audible the first time I had a chance to hear the new DAC. David and Steve Kennedy, who own a local store called JS Audio in Bethesda, Maryland, dropped by one evening, and we listened to several tunes through the unit. It was obvious that the Vivaldi Apex, which claims a 12dB improvement in its linearity, was noticeably smoother and richer in tonality than its predecessor. That demo whetted my appetite to hear the Apex fully warmed up and ready for battle. Enter Giolas, who sent me his burned-in unit from Salt Lake City, Utah.

I ran the Apex into both the darTZeel NHB-18NS preamp and the Gryphon Commander. It mated well with each preamp. With the darTZeel I used a 50-ohm BNC cable run off the RCA outputs of the Apex, and with the Commander I employed a balanced AudioQuest Mythical Creature interconnect. As I listened to the Apex for several months, I began to realize that the improvements to the DAC were more sweeping than I had initially realized. Part of this was probably because, when I first heard it, the unit was not warmed up. Another is that I've sometimes found that you start to perceive more intently when the critical apparatus gets switched off over time, and you just relax into the music. This hobby, after all, is supposed to be fun, a quality that can occasionally go by the boards in all our forensic examinations of everything from power cords to CD players.

Put simply, the Apex renders listening to music, classical or jazz, rap or rock, a lot more pleasurable. This nifty piece of gear has a salubrious effect on playback that manifests itself not only in the aforementioned enhanced sense of scale, but also in improved dynamics, clarity, imaging, and bass solidity. The bass region, as it happens, is a trouble spot for more than a few systems. Some of this can be chalked up to the challenges of simply creating linear bass in a home environment. But it's also the case that on digital jazz, as opposed to analog recordings, I've noticed bass reproduction can often sound somewhat murky. The Apex exerted a much firmer grip in the nether regions that was all to the good.

The bass line on Count Basie's celebrated Pablo album *88 Basie Street*, for example, sounded appreciably tauter. On tracks like "Sunday at the Savoy," the warmth of Cleveland Eaton's upright double bass could hardly have sounded more distinct and palpable. Then there was British pianist Rob Barron's elegant recording *From This Moment On* (on the Ubuntu label), which could sound a little woozy in the bass on the older Vivaldi unit. With the Apex in action matters were clarified considerably. In cleaning up the bass region, the DAC also displayed a lot more ferocity on drum passages. Just as fast piano runs were delivered with supernatural clarity, so drum rolls emerged with a lucidity that had to be heard to be believed. Once more, the low noise floor of the Apex came to the fore.

On the CD *Count Basie Remembered* by the New York All Stars, which features a live concert recorded in the Amerika Haus in Hamburg in 1996, Joe Ascione, who apparently started to play drums at age 2, belts it out on a number of cuts with a dynamism

and crispness that—at the risk of belaboring the comparison with the Vivaldi—simply were not apparent in the past. This is the kind of stuff, by the way, that the Wilson WAMM Master Chronosonic loudspeakers, which were designed by the late David Wilson, an aficionado of drums played at loud levels, revel in reproducing. Getting the bass region is a big part of why the Vivaldi Apex can produce such a cavernous soundstage. It also helps to explain the sheer dynamism, the sense of unbridled energy that the Vivaldi Apex can bring to the table. On Lynyrd Skynyrd's 1976 live album *One More from the Road*, it was a real pleasure to hear this travelin' band unleashed.

No compression here, folks. All that wealth of detail uncovered by the Vivaldi Apex coupled to real oomph delivered something akin to a sonic explosion. There is a latent sense of power and menace that permits the Apex to gradually ramp up the dynamic fireworks to dazzling levels. Put otherwise, it increased the sonic headroom, allowing the Wilson WAMM loudspeakers to perform in a relaxed fashion even at healthy output levels (not that the darTZeel NHB-468 amplifiers, no slouches they, weren't helping as well).

The upsides don't end here. The reduction in grain of the DAC means that it banishes a lot of the troublesome ills that have traditionally afflicted digital playback. The tonal purity of the Apex is remarkable. On vocals, it offers a beautiful mellifluity on Schubert art songs performed by the likes of the Austrian baritone Florian Boesch or the Dutch soprano Elly Ameling. But it can also bring on the ardor and brashness of Mick Jagger or John Lennon. Some of this can be ascribed, I think, to the DAC's excellent imaging, which ensures that there is no smearing of vocals with various instruments that are simultaneously playing. Everything is in its corner pocket, so to speak.

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Is this the last word in digital playback? Heaven forbid. The blunt truth is that digital engineers keep chasing down the audio gremlins to provide better and better playback, and I'm told that dCS itself has some developments up its sleeve that may further rock the audio world. But to hear what the Vivaldi Apex can provide is mesmerizing. The British are known for their stiff upper lips, but I would wager that if managing director David Steven and his trusty corps of engineers were to hear what the dCS delivers on a big system such as the Wilson WAMM, even theirs might start to quiver. This isn't a good DAC. It's a great one.

Robert Harley Explains the dCS Ring DAC

THE RING DAC, invented by dCS in 1987, is a brilliant solution to the challenge of converting digital data to an analog output signal. It is particularly well suited to high-resolution digital audio.

To understand the Ring DAC, let's first consider how a conventional multibit DAC works. You can think of a multibit DAC as a ladder, with as many rungs on that ladder as there are bits in a sample. A 24-bit DAC will have 24 "rungs," each one a resistor that corresponds to each bit in the digital sample. The resistors are connected to a voltage source through a series of switches; the digital data representing the audio signal open or close the switches to allow current to flow to the output or not. The currents of each rung are summed, with that summed value representing the audio signal's amplitude.

The arrangement of the resistors and the voltage source result in a "binary weighting." This means that each resistor lower down on the rung must effectively have double the resistance of the rung above it, and so forth, corresponding to the binary progression 1, 2, 4, 8, 16, and so on. In practice, only two resistor values are used; the resistor ladder forms a voltage divider that reduces the output voltage by a factor of two for each successive rung.

One problem with these so-called "R-2R ladder" DACs is that it's impossible to make resistors with the precision required for perfect binary weighting. The result is that the tolerances in resistor values introduce amplitude errors in the analog output. Moreover, those amplitude errors will occur in the same places on the audio waveform. Compounding the problem, the errors are a greater proportion of the signal at low levels.

This problem becomes more acute the greater the number of rungs on the ladder. In a 16-bit resistor-ladder DAC, the output voltage of the least-significant bit (LSB) should be exactly 0.0000152 the value of the most significant bit (MSB). In a 24-bit converter the LSB value should be precisely 0.000000119209289550781 the value of the MSB. It is obviously not possible to achieve anywhere near this level of precision in resistor manufacturing. Any deviation from the precise resistor values, in any resistor in the ladder, translates to amplitude errors in the analog output.

The now-defunct UltraAnalog company addressed this challenge by driving its 20-bit DACs (which were composed of two off-the-shelf 16-bit DACs ganged together) with 100,000 different digital codes, measuring the DAC output at each code value, calculating the degree of error in each specific resistor, and then having technicians hand-solder tiny precision metal-film resistors on the ladder rungs to bring them closer to the correct value. I visited the factory and saw this heroic (and expensive) approach in action.

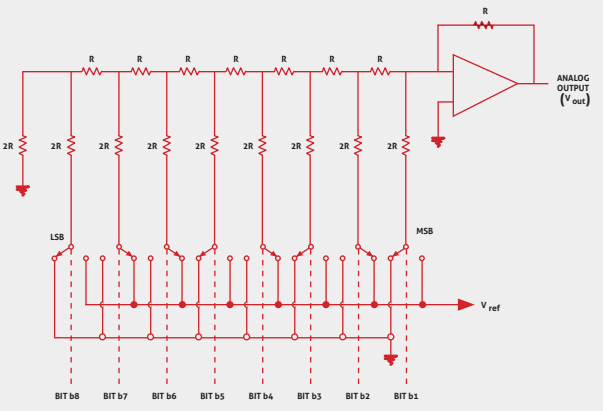
A DAC technology that doesn't rely on binary-weighted resistor ladders is the one-bit DAC. This device converts a multibit code into a single-bit datastream that has two values, one and zero. Unlike a multibit DAC, the one-bit DAC's amplitude precision is very high, but the one-bit DAC suffers from very high noise that must be "shaped" (shifted away from the audio band). One-bit DACs are also very susceptible to jitter.

dCS's solution is the Ring DAC, which can be considered a hybrid of the two approaches. It is based on a five-bit code that drives resistors of identical value. Because the resistors in dCS' Ring DAC are all the same nominal value, their actual values are very close to one another. The five-bit code has a much higher signal-to-noise ratio than a one-bit datastream and requires an order of magnitude less noise shaping.

Digital signal processing first "maps" whatever datastream is coming in (192kHz/24-bit or the 2.8224MHz 1-bit code of DSD, for examples) into a unique five-bit code. This five-bit code opens and closes one of 48 latches connected to a current source that drives one of five resistors of identical value. Because these resistors can never have *exactly* the same resistance, the Ring DAC employs an array of resistors and randomly shifts the audio signal between resistors in the array. The Ring DAC gets its name from this "passing around" of the signal from one resistor in the array to another, as in a ring. The effect is to convert what would be amplitude errors in the analog output into a very small amount of random white noise that is uncorrelated with the audio signal.

dCS's latest version of this evolving technology, the Apex, is based on the same principles, but with a more advanced implementation. The current source, the summing stage, the filter, and the output buffer have all been redesigned in the Apex. In addition, single transistors in the Ring DAC have been replaced by compound pairs in the Apex. The circuit board layout has been optimized. The result is a DAC that is quieter than previous generations with more than 12dB greater linearity.

The Ring DAC is brilliant in concept and is executed at its highest realization in the new Apex. The commonality in sonic character between all dCS products—the density of information, the resolution of fine detail, the unique spatial qualities—are probably attributable in large part to the Ring DAC. tas



An 8-bit R-2R ladder DAC.