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Reprints: Nick lademarco, Wright's Media, (877) 652-5295, (281) 419-5725, niademarco@wrightsmedia.com.
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Address letters to the editor: The Absolute Sound, 8868 Research Blvd., Suite 108 Austin, TX 78758 or email rharley@theabsolutesound.com

Newsstand Distribution and Local Dealers:
Contact IPD, 27500 Riverview Center Blvd., Suite 400, Bonita Springs, Florida 34134, (239) 949-4450
Publishing matters: contact Jim Hannon at the address below or e-mail jhannon@nextscreen.com

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Publications Mail Agreement 40600599
Return Undeliverable Canadian Addresses to:
Station A / P.O. Box 54 / Windsor, ON N9A 6J5
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Alpha DAC
Reference Series

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Reference, Indeed

Berkeley Audio Design Alpha DAC Reference Series

Robert Harley

Photography by Dennis Burnett

To understand Berkeley Audio Design's ambitious new Alpha DAC Reference, you need to know something about the company behind it. In its six years of existence Berkeley had produced just two products: the $4995 Alpha DAC and the $1895 Alpha USB, a USB-to-SPDIF converter. The hugely successful Alpha DAC established a new level of performance for digital products at anywhere near its price. I lived for several years with an Alpha DAC in front of some stellar electronics and loudspeakers, yet never felt it was the weak link in the chain despite its modest price relative to the rest of the system. Similarly, the Alpha USB was light years ahead of any other USB-to-SPDIF converter I'd heard. Given Berkeley's track record, I'd always wondered what this company could do if it aimed higher than the $5000 price point.

The answer has arrived in the new $16,000 Alpha DAC Reference Series, a vastly more ambitious effort than the venerable Alpha. Some potential purchasers will look at the Reference's lack of a USB input or its omission of DSD decoding, and consider the unit a non-starter. That would be shortsighted. Both a USB input and integral DSD compatibility were omitted by design, which speaks volumes about the ethos of Berkeley founders Michael Ritter and Michael "Pflash" Pflaumer. Their approach could be summed up as "no sonic compromises." If including a USB input in the same chassis as the DAC circuitry shaved off even a sliver of sound quality, it was ruled out. If performing DSD-to-PCM conversion brought performance down a notch, the decision was the same. Berkeley Audio, more than any other company I've encountered, is engineering and performance driven. A USB input and DSD decoding could easily have been included for marketing purposes, but that approach wouldn't have accorded with Ritter and Pflaumer's fundamental values.

The Alpha Reference is considerably more upscale in look and feel than the original Alpha. Although the Reference shares the Alpha's front-panel display and controls, the Reference's chassis is milled from a solid aluminum block, giving this 30-pound component a solid, brick-like feel. Front-panel switching includes input selection (two SPDIF, one AES/EBU, one TosLink), volume control, absolute-polarity inversion, filter choice, a button to change the display (volume, input sampling frequency, filter type, left/right gain), and a display dimmer. All these controls are duplicated on the handsome remote, along with a mute button and a balance control. LEDs indicate when the unit is locked to a source and if the input signal has been HDCD-encoded. The "Lock" LED glows amber when the Reference has established initial lock with the source, and then changes to green when the Reference locks to the source with a second, higher-precision clock. The Reference can drive a power amplifier directly with no need for a preamplifier in the signal path.


AES
SPDIF 1
SPDIF 2
TOSLINK
INPUT
LOCK
HDCD
INVERT
PHASE
192
STEREO
Alpha DAC
Reference Series

Both SPDIF inputs are on BNC jacks, not the typical RCAs. This is another example of Berkeley's "no sonic compromise" approach. BNC connectors are not only the correct impedance (75 ohms); they also form a much more secure mechanical connection between jack and plug. Berkeley recommends AES/EBU; it has ten times the voltage compared with SPDIF (5V vs. 0.5V), which reportedly confers a slight advantage in timing precision. Balanced analog output is on XLR jacks, unbalanced on RCAs.

Although you can't input DSD into the Alpha Reference, you can play DSD files by converting them to PCM in a Mac or Windows computer running the software playback engine JRiver Media Center. Buying an Alpha Reference gets you a license to JRiver. The rationale behind this approach is described in detail in the accompanying interview with Michael Ritter. If you want to drive the Reference with a USB output, you'll need Berkeley's Alpha USB.

Removing the heavy top panel and looking inside the chassis conjured up the image of a bank vault. The chassis' solid aluminum block has been milled out to create three separate isolated chambers—one for the power supply, one for the front-panel display and control electronics, and one for the DAC, DSP, and analog output stages. This design confers several advantages, including isolation from outside noise and vibration, isolation between subsystems, and temperature stability.

I enjoyed using the Reference on a daily basis. The front-panel layout, labeling, and display, and the remote control are sensible and well thought out. The circuit design is similar in many ways to the original Alpha DAC, but implemented with new parts and build techniques impossible in a $5000 DAC. After listening to the Alpha Reference and considering its design, I realized that this must be one of the most cleverly engineered products I've reviewed. By that I mean that every dollar of the parts budget was laser-focused on optimizing performance, with nothing wasted on superfluities. The Alpha Reference also upended several of my biases about what it takes to create a state-of-the-art DAC. As you'll see, the Alpha Reference sounds spectacular, and yet it realizes this unprecedented sound quality with what looks like a fairly conventional power supply (no outboard box filled with dozens of stages of cascaded discrete regulation), an off-the-shelf DAC chip (from Analog Devices), and an op-amp output stage. What you don't see are the extraordinary parts and the design techniques that have been applied to the subsystems that really matter, particularly the clocking and the hand-calibration of the analog filter. Berkeley has figured out exactly where to spend its parts budget—and where not to.

Listening

The playback system in which I evaluated the Alpha Reference is as good as it gets, in my experience. All the components are extraordinarily transparent, resolving, and dynamic, with these qualities in abundance over a very wide band. It turned out, however, that rather than the playback system telling me how the Alpha Reference sounded, this DAC revealed to me, for the first time, the playback system's full capabilities.

The highest praise that reviewers can heap on a DAC is to describe it as "analog-like." The Alpha Reference is certainly "analog-like," but not in the way that term has been used in the past. This accolade has described a DAC with a slightly softish treble, good space and bloom *for digital*, and an overall presentation that favors ease over resolution. The Alpha Reference transcends such comparison, overturning the idea that digital can merely aspire to mimic analog's best qualities. Rather, the Alpha Reference stakes out entirely new territory with a presentation all its own that sounds like neither analog nor digital, but rather like microphone feeds. The Alpha Reference is the first DAC in my experience to cross a threshold in which digital reproduction is no longer judged by how far it falls short of the analog benchmark. Make no mistake; the Alpha Reference is a watershed event in digital audio's long journey out of the Dark Ages. It's not just a little better than the best out there—it is significantly superior in every sonic criterion as well as in the musical involvement those sonic qualities engender. It's safe to say that no one has heard digital audio sound like this before.

The Reference's "un-digital" sound isn't achieved by masking digital shortcomings or by mitigating them with an overly smooth sound or by adding a bit of artificial bloom. Rather, the Reference presents a startling—and I mean startling—sense of tangible instruments existing in what is easily the most spacious and dimensional soundstage I've heard from digital media, from the best high-res files to older CDs. This vividness of timbre and image flows directly from the Reference's crystalline transparency. The Reference reveals that all previous DACs imposed a layer of opacity between source and listener, which diluted the sense of immediacy and realism. Hearing familiar recordings through the Reference is like taking several steps forward through the chain right to the microphone feed. As good as some digital has become, it has never quite engendered that same frisson of realism that comes so easily to analog—until the Reference.

This sense of hearing nothing between you and the instru-

ments is heightened by the Reference's unprecedented timbral truth. The slightly grayish patina overlaying tone colors, the shaving off of fine micro-details that dilute vividness, and the homogenization of images we've become inured to in digital are completely absent. The Reference has an uncanny ability to reveal much more information about how a sound was created, and consequently to produce a more lifelike impression of the real thing. I was struck by this quality while listening to *Skip, Hop, and Wobble*, a wonderful acoustic trio album by Jerry Douglas, Russ Barenberg, and Edgar Myer. Although I've heard this standard-issue CD on countless systems over the years, hearing it through the Alpha Reference was revelatory. The picking of the guitar and dobro, the way each note bursts forth for an instant, the resonant instrument bodies, the fine texture in the dobro's unique timbre, and the sounds of fingers on the strings all came together to create a more convincing illusion of hearing the instruments themselves rather than recreations of them.

> As you'd expect from this description, the Reference's reproduction of the human voice is startling in its naturalness.

As you'd expect from this description, the Reference's reproduction of the human voice is startling in its naturalness. Jane Monheit's gorgeous voice on the 96/24 version of *Come Dream With Me* has a palpability and immediacy that are downright eerie. The close miking and minimal reverb on her voice make the illusion of someone singing between the loudspeakers that much more credible. Although this file can sound wonderful through other great DACs, it never quite crossed that threshold into making me believe, if just for a few moments during the unaccompanied passages, that someone was actually standing in my listening room. The difference in the electrical waveforms output by the various DACs under consideration must be miniscule, but the musical effect is anything but. The Reference allows the music to create a sense of intimacy between listener and artist in a way that I've never before experienced from digital.

A large measure of the Alpha Reference's sense of realism comes also from the extraordinary spatial presentation. The Alpha Reference's soundstaging, dimensionality, and depth aren't merely spectacular "for digital"; they are spectacular, period. Instrumental images are tightly focused, but in a way different from other digital that has rendered a "sculptured" presentation. Rather, the image outlines are clearly delineated from the air around them in exactly the same way that real instruments sound in an acoustic space. There is no artificial edge to the outlines despite the tight focus. The way the sound expands around the image with each note—what Jonathan Valin calls "action"—is totally natural and lifelike. The spatial rendering is also extraordinary in the layering and bloom, with instruments positioned along the depth axis in a continuum rather than in discrete steps. I've described other DACs as exhibiting this depth-along-a-continuum phenomenon, but the Alpha Reference is clearly in a different league. The see-through transparency I mentioned previously combines with this spatial resolution to present even the lowest-level sounds at the rear of the hall with sensational vividness and clarity. I also enjoyed the manner in which the Alpha Reference "de-homogenizes" familiar music, presenting a collection of individual instruments, each distinct in tone color and space. The Reference is revelatory in the way it allows me to easily shift my attention between instruments or sections, and thereby to hear more of the composer's intent. I found myself experiencing familiar music from a different perspective as more and more musical information was unwoven by the Alpha Reference.

To hear all of these qualities at their zenith in a single musical example, look no further than Dick Hyman and the Swing All Stars at 176.4kHz/24-bit on the Reference Recordings HRx sampler disc. The distinct tone colors of the brass and woodwinds are richly portrayed, even during the unison phrases. The hi-hat "lights up" the acoustic in a completely natural way. The sense of transparent space is palpable. The piece includes an extended passage in which Frank Weiss plays a beautiful sax line that weaves in, around, and counter to the melody played by the brass and winds. The Alpha Reference, more than any digital I've heard, presents this playful counterpoint in all its glory—totally natural and unforced. I defy even the most diehard analog enthusiast to listen to this track through the Reference and detect the slightest trace of the flaws that have traditionally been assumed to be part-and-parcel of digital audio.

For all the Reference's vividness and resolution, it has

a completely non-aggressive, almost laid-back character. This may seem like a contradiction, but the Reference's lack of edge and glare allowed it to sound immediate yet relaxed—just like live music. The rapid-fire flamenco guitars on Paco de Lucia's *Live in America* are beautifully delineated with tremendous transient speed yet without the etch that makes you want to turn the music down. Orchestral crescendos at high playback levels don't create that sense of physical tension or "cringe factor" as your ears prepare for the glare. In fact, the Reference allows you to listen at louder levels, for longer sessions, without fatigue because of this smoothness and liquidity.

It almost goes without saying that the Alpha Reference's resolution is simply stunning. This DAC reaches down into the finest micro-details of timbre, transients, spatial cues, inflection, and dynamic shading. Everything is right there, laid out in a completely natural way that doesn't call attention to itself as detail. The treble is ultra-smooth, silky, and richly resolved. Even compared with other digital that could be considered as having a smooth treble, the Reference is lacking the metallic bite that has plagued digital audio since its inception. This combination of rich detailing, massive resolution, and timbral liquidity in the top end is simply unprecedented.

The way in which the Reference portrayed dynamics is also unlike any other digital playback. Instrumental attacks jump to life with stunning speed and immediacy, much like one hears from a horn loudspeaker. Listen, for example, to the brass entrance in *The Firebird*, again from the HRx sampler, which will nearly lift you out of your seat. This quality just increases the Reference's vivid realism, but again, without the slightest trace of etch or artificial edge.

As if this embarrassment of riches weren't enough, the Alpha Reference's bass reproduction is in a league of its own. Believe me, no one has ever heard bass like this from digital. For starters, the overall bass balance is weighty, warm, and rich, but without the caveats that typically accompany those descriptors. "Warm" and "rich" often describe a softish bottom end that is pleasant, but that lacks dynamic agility and pitch definition. The Alpha Reference's full-bodied bottom end not only provides a solid tonal foundation, it is also exquisitely textured and nuanced. The sound of plucked acoustic bass, for example, is infused with rich micro-texture and micro-dynamic details that, frankly, other digital simply smears. The attack of the string, the resonant body of the instrument, and the decay are all beautifully delineated in a way that sounds more like the instrument and less like a facsimile. I was surprised by how much more fine detail in the bottom end the Reference revealed. Despite the filigreed rendering, the bottom end has tremendous power and speed.

This synergy of muscular authority, resolution of textural detail, and dynamic agility is sensational on a wide range of music. Orchestral music is big and full-bodied in a way that you rarely hear from reproduced music. The "oomph" in the midbass, richness and density of tone color, and that thrilling visceral involvement you hear from live music are abundant through the Reference. The sense of rhythmic propulsion on rock, blues, and some jazz is nothing short of addicting. The track "Trans-Island Skyway" from the 96/24 version of Donald Fagan's *Kamakiriad* has an unusual meter that gives it a powerful propulsive groove. The Reference better resolved this track's amazing bottom-end dynamics, and not just in pure impact but also in the lack of smearing of the closely spaced kick-drum attacks. The Reference takes this track up several notches in that powerful ability of music to involve your entire body.

Perhaps not coincidentally, all the components in my current playback system share the specific quality of muscularity in the power range. The Magico Q7s, with their dual 12" woofers and 10" mid/woofer in a totally inert sealed enclosure, the mighty Soulution 701 monoblocks with their unprecedented bottom-end impact and resolution, and the MIT Oracle MA-X, known for its richly textured bass and midbass, teamed up to produce what is in my experience the most expressive presentation of what the British call pace and timing of any audio system I've heard. The Alpha Reference at the front end of these cost-no-object components revealed qualities in those components that had previously not been fully exploited.

I found myself astonished that these characteristics are apparent not just in super-high-resolution audiophile spectaculars, but across a wide range of music in my digital library. Standard CDs of my favorite recordings that I'd thought sounded hard, flat, and relatively low in resolution were "unwoven" by the Reference to reveal a rich panorama of musicality. That's a significant observation because it reveals that our CD libraries contain buried musical expression that can be released by improvements in digital-to-analog conversion technology.

Conclusion

The Berkeley Alpha DAC Reference Series is not only the absolute state of the art in digital-to-analog conversion, it also goes far beyond even this superlative to redefine what's possible in digital playback. This is a landmark product

in that it crosses a threshold of sound quality and musical expressiveness that renders moot the idea that digital can only aspire to mimic analog rather than offer its own set of virtues.

I won't reiterate the Alpha Reference's merits, but can guarantee that you've never heard digital audio sound like this. This is a product that you have to hear for yourself to believe just how far digital has traveled. I'm also heartened by the Reference's price. Although not inexpensive, $16,000 for the unquestioned state of the art in digital playback makes it seem like a bargain.

On a personal level, I can't tell you how thrilled I am to experience an entirely new and unexpected level of musical involvement from my library of standard-resolution CDs and files. After one particularly rewarding session, I reflected on how Berkeley Audio Design epitomizes the highest ideals of high-end audio.

Ritter and Pflaumer toiled for years, researching the finest minutia of design details that affect sound quality to create a product that has allowed me to experience a deeper level of musical involvement and appreciation. Their single-minded pursuit of performance above all else exemplifies the ethos behind the landmark breakthroughs in the history of high-end audio.

And breakthrough the Alpha Reference is. I'm confident in saying that the Alpha Reference will be remembered decades from now as a turning point in digital audio sound quality.

SET-UP NOTES

The Alpha Reference's balanced output fed a Constellation Audio Virgo II preamp throughout my listening sessions. Although I tried driving the Soulution 701 amplifiers directly from the Alpha Reference, the DAC's highish output level combined with the Soulution's high input sensitivity to require several tens of dBs of (digital-domain) attenuation in the Alpha Reference. Nonetheless, the Constellation Virgo II was more than up to the challenge, fully revealing the Reference's transparency, resolution, and dynamics.

I listened to the Alpha Reference fed by SPDIF from the extraordinary dCS Vivaldi transport via an AudioQuest Eagle Eye BNC cable (both units have BNC connectors), as well as from a MacBook Pro running Pure Music. Berkeley's Alpha USB converted the Mac's USB output (via a 1.5 meter Wireworld Platinum Starlight USB cable) to AES/EBU. The AES/EBU output was connected to the Alpha Reference through a 1.5 meter run of AudioQuest Wild digital cable. Analog output was balanced on MIT Oracle MA-X interconnects.

For comparisons with other DACs, I evaluated those DACs' sound when fed through their USB input as well as with the AES/EBU output from the Berkeley Alpha USB. This enabled me to isolate the sound of the DAC itself from its USB implementation. Incidentally, if you own a USB DAC, adding the Berkeley Alpha USB to bypass your DAC's USB input is likely to be a significant performance upgrade.

SPECS & PRICING

Input sampling rate: 32kHz-192kHz
Input word length: 24-bit
Inputs: AES/EBU, SPDIF on BNC (x2), TosLink
Outputs: Balanced on XLR jacks, unbalanced on RCA jacks
Output level: 6.15Vrms at 0dBFS (balanced); 3.25Vrms at 0dBFS (unbalanced)
Digital volume control and balance: 0.1dB steps, 0.05dB L/R balance, 60dB range
Remote control: Volume, balance, input selection, absolute polarity reversal
Digital filter: Custom, user selectable
THD+N: <-110dBFS at maximum output
Firmware: Upgradable through signal inputs
Warranty: Three years parts and labor
Dimensions: 17.5" x 3.5" x 12.5"
Weight: 30 lbs.
Price: $16,000

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ASSOCIATED COMPONENTS
Loudspeakers: Magico Q7
Preamplifier: Constellation Audio Virgo II
Power amplifiers: Soulution 701 monoblocks
Analog: Basis Inspiration turntable, Air Tight PC-1 Supreme cartridge
Phonostage: Simaudio 810LP
Interconnects: MIT Oracle MA-X, Transparent Reference XL, AudioQuest WEL Signature
Loudspeaker cables: MIT Oracle MA-X SHD
Digital cables: Wireworld Platinum Starlight, AudioQuest Eagle Eye (BNC), AudioQuest Wild (AES/EBU)
AC power: Four dedicated AC lines, Shunyata DPC-6, Triton, Talos, Cyclops, and Typhon conditioners, Audience aR-6TSS, aR2-TSS
AC cables: Shunyata Alpha Digital, Alpha HC, Anaconda; Audience Au24SE
Racks: Stillpoints Ultra
Amplifier stands: Critical Mass Systems MAXXUM
Isolation: Stillpoints Ultra 5, Ultra SS, and Ultra Mini; Critical Mass Systems Rize; Shunyata cable elevators
Acoustics: ASC 16" Full-Round Tube Traps, ASC Tower Trap, Stillpoints Aperture panels

I set the Reference's output level at 59 on the display, or 1dB of attenuation from full-scale. The digital filter apparently operates better when processing less than full-scale signals. Although the Reference offers several filter choices, the default filter is by far the best sounding.

In comparisons with other DACs I was careful not to use HDCD-encoded titles, which would give the Reference an unfair advantage because of its HDCD decoding. The Reference sat on four Stillpoints Ultra 5 isolation devices, which in turn were bolted into the Stillpoints grid within the Stillpoints rack. At this level of performance, every change in isolation is easily audible, and sonically significant.

Michael Ritter Discusses the Alpha Reference's Design

Robert Harley: Berkeley Audio Design has been in business for six years, yet you've introduced just two products before the Alpha Reference. Many other companies would have offered a range of products, including inexpensive portable USB DACs. Why have you taken this approach?

Michael Ritter Well, we're a reasonably atypical company. We're in business to be in business partly, but it really was a passion that led us to even start the company. The work we did at Pacific Microsonics *[the company that invented HDCD and built the professional analog-to-digital converters and HDCD encoders used in mastering studios]* was as close to a pure R&D effort as you'll find in audio, where the company's sole effort was directed at sound quality. The concept of HDCD was to create technologies that provided a much higher resolution signal in a standard Red Book recording that could be played back on any CD player. Obviously, to do that you need to start with a high-resolution recording, so we developed professional high-res A-to-D's, encoders, and D-to-A's that operated at 176.4kHz. We spent many millions of dollars and had the best test equipment available, including some built in-house. And we had excellent first-generation Keith Johnson analog mastertapes as reference source material. But the final design optimization was done in the field using Keith Johnson's live mike feeds since reproducing them represented the ultimate test of fidelity. These weren't mike feeds of a guy sitting in a room with a guitar, but of large choral groups and orchestras. Just tremendously big and difficult material to reproduce. We had a process where we could compare the mike feed to the entire A-to-D and D-to-A chain. We could hear instantly if we were listening to the mike feed or conventional digital or even 30ips analog tape, but at the end of the development process for the Pacific Microsonics Model Two sometimes we would confuse the A-D-A chain with the mike feed. That was a big emotional experience that I never thought would be possible.

You know the story of how Pacific Microsonics was bought by Microsoft, who didn't do much with it. So Michael Pflaumer and I *[Michael Pflaumer is the co-inventor of HDCD with Keith Johnson, and wrote the HDCD encoding and decoding DSP code—he also designed the clocking for the Pacific Microsonics Model One and Two]* realized that it just seemed wrong to have arrived at this potential for audio reproduction and let it disappear. We had some brilliant engineering expertise so we concentrated on building products with the best possible audio quality.

> We think of maintaining the clock's performance as similar to maintaining a vacuum, meaning that everything in the environment around the clock is trying to get in and degrade the clock's performance.

Going back to what you said about introducing only a few products, we didn't want to introduce products that offered only an incremental improvement, or feel compelled to change models for marketing reasons.

RH: Is the Alpha Reference a ground-up design effort or is it based on the original Alpha DAC?

MR Much of the technology we had already developed for the Alpha DAC Series 2, such as the data receiver and the digital filter, was pretty darn optimal. We knew there were areas we could do things better with certain parts, but those parts didn't exist. There were also areas where the implementation could be improved. The Alpha DAC Series 2 was the platform we started with.

RH: Why does the Alpha Reference lack a USB input?

MR There may be a time when it makes sense for us to introduce a lower-cost DAC with a USB input, but when you're shooting for the ultimate in performance, which is what we did with the Reference Series, not to mention the Alpha DAC before it, you absolutely don't want to connect the DAC directly to the computer or router. They have large amounts of electrical noise, and that noise gets injected into the DAC's ground, or the noise is capacitively coupled through the input. A separate isolation/reclocking device *[a USB-to-SPDIF converter]* for computer-audio playback is essential if you're going for the state of the art.

RH: Tell me about the DAC in the Reference and how it is clocked.

MR It's a highly optimized delta-sigma DAC, a topology we've used before. The DAC chip does nothing but D-to-A conversion; no other processing, no filtering, no DSD conversion. When you add other processing on the same piece of silicon while you're doing D-to-A conversion, it degrades performance.

The environment in which the DAC chip operates, and how it is clocked, is unique in the Reference. We use a clock with extremely low time-domain noise. We worked with a number of vendors before we found one that could deliver a part that met our requirements. The actual conversion clock in the Reference is very, very expensive but it's pretty stupendous. We're talking around 30 decibels superior to the competition. We're using really expensive analyzers like the Agilent to characterize each clock, but the clock has such low phase noise that when we measure it we're looking at the analyzer's performance as much as the clock's.

We think of maintaining the clock's performance as similar to maintaining a vacuum, meaning that everything in the

environment around the clock—the signal path, the power supply, the digital input stream, the temperature variations—is trying to get in and degrade the clock's performance. It's very difficult to maintain the clock's extreme integrity, which is why we devoted so much design effort and circuitry to isolating the clock. The clock's ultimate performance has to arrive at the DAC chip or it's wasted. The clock is quite close to the DAC and goes through impedance-controlled lines. The circuit board's dielectric characteristics are absolutely the state of the art—a ceramic aerospace material. It costs an arm and a leg, but it's worth it. The board material also pays dividends in the analog output section.

It's a big effort to A, have a phenomenal clock and B, isolate it from junk coming in and C, deliver it to where the payoff is at the DAC chip in pristine form. I don't understand those designs where the clock is some distance from the converter, or worse, in a separate enclosure so that the clock has to go through drivers, connectors, and cables. There's just no way that you can maintain the ultimate performance of a clock when it goes through a long-distance transmission system like that. The more advanced and extreme the clock's performance, the more difficult it is to maintain that performance at the DAC chip.

You'll have seen that when an input signal is present the front panel "Lock" light comes on amber and you can hear audio and it sounds fine. But then when the high-precision clock engages and the green LED illuminates, the precision clock is operating in isolation. That's when the magic really happens.

It's amazing what you hear when you pay this much attention to the clock—things you might not anticipate, such as bass performance. We've done a lot of work in this area since the late 1990s when we developed the Pacific Microsonics converters.

RH: Let's talk about the decision to offer DSD compatibility in software rather than building it into the Alpha Reference's hardware.

MR I have to confess that was the one feature that tested me a bit, for a number of reasons. By including DSD compatibility in the Alpha Reference we could advertise it as DSD-compatible without any complex explanations. We could have run DoP *[DoP stands for "DSD over PCM," a DSD interface standard]* into the Alpha Reference and the front panel would say "DSD" and you'd hear DSD. It's extremely inexpensive to implement—it approaches zero cost.

But while that would have made a good marketing story, it would have compromised the Alpha Reference's performance. If I'm hewing to my highest purpose as a manufacturer, it's to give customers the most musical, satisfying experience I can. And that's in direct conflict with the DoP approach, because you're doing the conversion from DSD to the multi-bit signal that drives the DAC within the DAC chip or adjacent to it. Virtually all manufacturers use DACs with multi-bit architecture. There are a few exceptions, but they are about 0.001 percent of all the converters out there. Almost every DAC that calls itself DSD-compatible, or even "native" DSD, is converting the DSD bitstream to multi-bit just before the D-to-A conversion.

Most DAC chips, including the one that we use, have a DSD input. Processing in the DAC chip converts it to multi-bit, but that's the worst possible approach because you're doing that processing and the digital-to-analog conversion simultaneously on the same piece of silicon. A step up from that is to do the multi-bit conversion with your own code in a separate DSP processor chip. And we could easily have done that. We have a lot of DSP processing power in the Reference Series—it would have been trivial. But then you've got the extra overhead of processing going on all the time in a chip that's contiguous to the DAC. And remember, we're being hyper-vigilant about the environment in which the DAC chip is operating in the Reference Series, because the intrinsic performance coming out of it, the way we operate it with those clocks and with everything else, is phenomenal. That processing noise would degrade that performance.

So, those are the two solutions for getting a front-panel DSD light to come on and make a DAC "DSD-compatible." We could have rationalized including DSD in that way, but Pflash *[Michael "Pflash" Pflaumer]* and I both agreed that our sense of integrity required us to follow the path of providing the best possible audio quality for both DSD and PCM.

Fortunately, there's another way to provide DSD reproduction that doesn't compromise performance, and that's to do the DSD-to-multi-bit conversion outside of the DAC. Because virtually all DSD sources that feed external DAC's are computers, we can do the conversion in software in the computer. We did a fair amount of research on it and considered writing our own software, but we found a product that did the math right, and that's JRiver Media Center for Mac or PC.

For the tweaky types, you can optimize the low-pass filtering for DSD conversion in JRiver depending on the spectrum of the supersonic noise, which varies between recordings. The resulting upconverted 176.4kHz/24-bit PCM format has sufficient resolution in the frequency and time domains to contain everything that's in the DSD signal, including supersonic noise if you want it there. You can play the DSD files on your computer and have JRiver perform the conversion on the fly. Or you can convert the DSD file to PCM ahead of time and then just play the PCM file. That shouldn't make a sonic difference in theory, but it does in practice. The processing overhead to perform that conversion in real-time makes it slightly less good sounding compared with converting ahead of time. The computer then isn't doing any processing, just outputting data pulled from memory. From a technical and audio quality point of view that's the best way to reproduce DSD recordings if you have a multi-bit DAC architecture. You're not only performing the conversion outside of the DAC box; you're also performing the conversion outside of the time domain as well. By the way, including a license to JRiver with the Alpha Reference is vastly more expensive for us than implementing DoP.

RH: There's also the potential of upgrading the DSD-to-PCM conversion algorithm with a software update, something you can't do if the conversion is performed inside the DAC.

MR That's exactly right.

RH: Tell me about the Alpha Reference's physical construction and how that affects the sound.

MR The physical design of the Reference is all about minimizing noise and time-domain noise. As you've seen, it's a very solid device physically, and the main reason for that is isolation and stability. The mechanical mass reduces microphonic effects as well as temperature gradients. Once it fully warms up, which takes about 12 hours, it will stabilize at that temperature, which is important.

The top cover is over a centimeter thick and each circuit board is in its own isolated chamber to reduce noise coupling. We have very tight RF shielding, and the top panel is machined to within a couple thousandths of an inch so that it forms a tight shield around the components inside. Everything about the design provides a quiet and stable environment for the DAC.

> If we tried to rush any aspect of the manufacturing or alignment process it would be just like putting a junk part in the device. Every aspect has to be done with full integrity or it's a wasted effort. We can build only two Alpha References per day.

RH: Tell me about the hand-calibration process.

MR [Laughs] It's really not the best kind of product to make if you want to make millions of them and go to the bank. But once again, this is a hyper-precise device and the manufacturing process takes a couple of weeks. After testing we burn in each unit for seven days, 24 hours a day, with a digital input signal and loads on the analog outputs. Then it's taken to another location where it's tested and thermally stabilized for another day. Then we do the final alignment process which involves both measurement and listening. I didn't mention it before, but the digital filter is our own propriety design with very precise performance parameters. To preserve that performance we model the analog output filter as a precision cascaded part of the overall digital/analog filter system. It's the analog filter that we hand-adjust to the tolerances we require—1/100th of 1 percent. To be able to make adjustments with that precision we use the very best trimmers available with precious-metal wipers and operate them over a very limited range. These devices are not normally used commercially—they're mil-spec. But for precision, stability, and repeatability, we had to use them. It's an iterative process of measuring and listening that takes three hours per unit.

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RH: That's pretty limited production capability.

MR It *is* pretty limited production. If the whole world falls in love with this product, we could increase production with a parallel production path, but this is not trivial because of the final alignment. We have a brilliant, degreed engineer with well over $100,000 worth of test equipment and about $100,000 worth of playback components performing the alignment. If we wanted to have another final alignment station operating in parallel, we couldn't just hire somebody and have them align it by measurement.

The important thing is that it has to be right. We don't ship it until it's fully optimized. From an integrity point of view, we're giving the customer the performance he's paying for. And it's also self-interest; our success is based on our audio quality and we're not going to do anything to jeopardize that. tas

THE IMPORTANCE OF CLOCKING

With so much discussion in this interview about the importance of a DAC's clock, I thought I'd offer a generic and simplified primer on what a DAC's clock does and why it's important.

In a typical multi-bit DAC, the DAC converts the 24-bit audio samples (called "words") at the DAC chip's input to an analog current at the output. The DAC chip performs this feat 352,800 times per second in a typical 8x oversampling DAC (352.8kHz is 8x the CD's sampling rate of 44.1kHz). The "word clock," a square wave with a frequency of 352.8kHz, tells the DAC *when* to convert each of those binary-encoded audio samples to an analog output. Each leading edge of that square wave triggers the DAC to perform the conversion of one audio sample to an analog current, and it does this 352,800 times per second.

If those clock pulses aren't perfectly uniform in time—the definition of jitter—the reconstructed analog waveform will be distorted. Specifically, timing variations in the clock become amplitude variations in the analog waveform. The converted sample's amplitude may be correct, but if it's shifted in time from where it should be, amplitude errors are introduced in the analog waveform. The right sample at the wrong time is the wrong sample.

It turns out that humans are exquisitely sensitive to the most miniscule timing variations, probably because the type of distortion jitter introduces never occurs in nature. Moreover, evolution has finely honed our hearing mechanism for instantly identifying a sound's location and determining what is creating the sound. It is these very characteristics—spatial cues and timbral recognition—that are obscured by jitter. Given that our survival depended on correctly identifying the "what and where" of a sound, it's not so surprising that we are so attuned to any mechanism that confuses these aural cues. **Robert Harley**