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From the Editor

Bits Is Bits?

The Wadax Reference Server I review in this issue raises some fascinating questions about the fundamental nature of digital audio. Unique for a server, the Wadax has three front-panel controls that allow the user to adjust the amplitude and shape of the digital waveform that represents the music. These controls don't change the digital ones and zeros, but rather introduce an analog-like variability to the digital bitstream—a radical concept.

Digital audio was supposed to work perfectly or not at all; *removing* analog-like variability was its *raison d'être*. Yet early on in digital audio it became apparent that identical bitstreams could sound different if the digital samples were put back together with even the most miniscule timing errors—jitter. Although 30 years later this mechanism is fully understood, it came as a shock to a mindset that viewed digital-audio data as just another form of digital information that could be transmitted or copied endlessly without error. However, unlike other forms of digitally represented data, the end of a digital-audio system is an analog signal that is analyzed by our exquisitely sensitive hearing mechanism.

Yet for all we've learned about digital audio, there's much that remains a mystery. One such mystery is precisely how adjusting the waveshape's steepness with the Wadax server's "Speed" control changes the music's sense of pace and rhythm.

The analog-like variability of digital signals has long fascinated me. When I was working in a CD mastering lab in the late 1980s, one of my jobs was investigating technical problems with mastertapes that could lead to issues with replicated discs. One day I learned that a customer, a small, independent music label, was unhappy with the sound of the replicated discs we had made. I spoke with someone in the band, who described how the replicated disc sounded different from the mastertape. This was the first time a customer had complained about the sound quality of a replicated disc.

The sonic differences he described could not be the result of data errors on the disc. For starters, our QC department would have rejected any discs that had uncorrectable errors. CD error correction is extremely robust; it can completely and perfectly correct—not conceal through interpolation—up to 4000 consecutive missing or corrupted bits. Second, such errors would show up as audible glitches, not as, for example, a reduction in soundstage dimensionality.

The first thing I did was compare the data on the customer's ¾" U-Matic CD mastertape with the data on the replicated disc, using a CD-ROM pre-mastering system. As expected, the data on the mastertape and the data on the replicated CD were identical.

To the engineers I worked with, that was the end of the story. "Bits is bits," they said, dismissing the musician's claims. Because the replicated discs contained data identical to the mastertape, they reasoned, our company had done its job, and any sonic differences were figments of someone's imagination. These guys were brilliant engineers. They had designed and built, from scratch, the two custom CD mastering machines in our factory—no mean feat. Yet, the audiophile in me was compelled to explore the question, so I cut a new glass master from the customer's CD mastertape on our second, newly designed mastering machine and had discs replicated. This would enable me to listen to the two discs through the same CD player, something I couldn't do with the CD mastertape and the replicated disc (the mastertape could be decoded only by a Sony PCM-1630 processor). After verifying that the second disc contained the same data as the mastertape and the first disc, I listened to both discs on my home system. The two discs did, indeed, sound different—the second disc sounded smoother and more dimensional. Without telling the customer what I heard (or about the different mastering machine), he reported that the second disc sounded like what he created in the studio.

Now, I was *really* curious. I rented an analyzer that would measure the time periods of the pit and land structures on the CD. The analyzer graphically plotted the precise period of each of the nine discrete pit and land lengths that encode information. The first disc that sounded inferior had a much wider frequency distribution of the signals generated by the pits. The second, better-sounding disc, had a much narrower frequency distribution, indicating that the pit and land lengths were more precise. Moreover, looking at the raw signal from the CD player's photodetector revealed that the pit-to-land and land-to-pit transitions were cleaner and sharper on the second disc. In essence, jitter was embedded in the disc itself in the physical pit and land structures. It wasn't surprising that the second CD mastering machine produced less timing variation; its turntable was controlled by a vastly more sophisticated and precise rotational-servo system.

Although this exercise was illuminating, it still didn't answer the question of how those timing variations on the disc made their way through an enormous amount of complex signal processing (the error-correction decoding alone is mind-boggling) to somehow affect the CD player's analog output signal.

That question remains unanswered to this day. Although our knowledge of digital audio has advanced enormously in the last 35 years, there's still much to be discovered. The conundrum presented by the Wadax Reference Server is simply the latest example. It shows us the limits of our understanding by raising more questions than it answers.

Robert Harley

Wadax Atlantis Reference Music Server

Remastering Machine

Robert Harley

Most of us have experienced the thrill of hearing a favorite album in a fabulous remastering. The best remastering jobs are transformative. You hear a newfound clarity; each instrument or voice is distinct and sonically separate; the bass suddenly has depth, texture, pitch, and nuance; the treble is smooth and liquid rather than hard and metallic; a murky haze gives way to crystalline clarity; and there's an ease and warmth that draw you into the music. As a result, you experience the music in a different and more profound way.

Unfortunately, we don't have the ability to conjure up any album we choose for the remastered experience; we must rely on whatever titles the reissue companies provide. But I have discovered a device that performs the astonishing feat of making any digital file sound almost like it had undergone a high-quality remastering. I would not have believed such a thing were possible unless I heard it for myself.

That device is the Wadax Atlantis Reference Music Server when driving the Wadax Atlantis Reference DAC. Quite apart from the Reference Server's revelatory performance is the surprising and happy realization that many of digital's sonic limitations are the result of decoding on playback rather than flaws permanently embedded in the music files. To say that this bodes well for the future of digital audio is an understatement.

The unfortunate news is that, at $221,495, the Wadax duo is astronomically expensive. That's a breathtaking number for a digital front end by any measure. Nonetheless, it took a device of the Wadax's sophistication to reveal the true sound quality hidden within our digital files. The Spanish company spent four years researching the techniques for extracting this musicality and for making even standard-resolution files vastly more enjoyable. Although it took a $200k+ pair of devices to prove the concept, it is my fervent hope—and Wadax's intention—that the company will apply its technology to lower-priced products accessible to a wider range of music lovers. For those of you who object to the very existence of a such an expensive digital front end, consider that those wealthy customers who can afford the Wadax pair are subsidizing the R&D for the rest of us.

The Wadax Reference DAC, which I reviewed in Issue 312 and named our Overall Product of the Year Award-winner in 2020, set a new benchmark in digital sound quality in my experience. But it turns out that the $145,000 Reference DAC is only half of the equation; Wadax has been developing proprietary new music-server technologies that go hand-in-hand with the DAC to elevate the sound of digital audio to unprecedented heights.

Enter the Wadax Reference Server reviewed here. Housed in a chassis nearly identical to that of the Reference DAC (but without the DAC's two outboard power supplies), the Reference Server is virtually the Reference DAC's visual twin. A front-panel, color touchscreen display provides for setup and control, and shows the album art of the music playing. The displays and front-panel controls differ slightly between the server and DAC, but you must look closely to see the differences. The Server runs Roon Core internally, and is controlled by that state-of-the-art music-management app. Choosing Roon as the music-management app is a good move; it's unlikely that a hardware manufacturer can develop a custom app that comes close to Roon's tremendous power and fabulous user interface. The Server has 2TB of internal SSD memory, with four expansion slots in the rear panel for

adding drives. No dealer or factory support is required for adding drives; you simply insert them into the bays and initialize them from the Server's touchscreen. Wadax recommends against using an external NAS, preferring that solid-state storage is added via the rear-panel slots.

Most music servers offer a wide range of output connectors, but no front-panel controls or adjustments. The Reference Server inverts that convention; the rear panel offers *only* USB output, while the front panel has six intriguing adjustment knobs (marked "Speed," "Input Gain," and "Output Gain") that hint at the radically different technology inside. There is one set of three controls for the USB interface and one set for Wadax's custom optical interface. The rear panel has an IEC AC power jack, an Ethernet port for connecting to the Internet, a USB service port, and a port for an external power supply. The latter accommodates a future upgrade of an outboard supply in a separate chassis, called the Reference Power Supply. Finally, blank panels cover unused slots in the modular chassis, again to allow the Reference Server's hardware to be updated in the field. One of these panels can be fitted with an optional module that adds AES/EBU, SPDIF on RCA, and SPDIF on BNC jacks.

There's one more jack on the Reference Server's rear panel, one that is essentially the device's *raison d'être*: a custom optical interface, called Akasa, for connecting the Reference Server to the Reference DAC. To use the Akasa optical interface, the Reference DAC must be retrofitted with an optical-input module. The module simply slides into the Reference DAC's rear panel, an example of the wisdom of building digital products with modular architecture. The Reference Server is fitted with a USB output as well as the Akasa optical output. In this configuration, the price is $59,000. The cost of an optical-input module for the Reference DAC along with the optical cable is $17,495, making the Reference Server in essence a $76,495 product. The ability to connect the Reference Server to the Reference DAC through the Akasa optical interface is the compelling reason for buying the Reference Server. Indeed, it's this interface that transforms the Reference pair's performance from fabulous to transcendental.

Back to those unique front-panel adjustments. The first of the three, Output Gain, adjusts the voltage of the signal at the Server's output. The second, Input Gain, adjusts the amplitude of the incoming clock and control signals from the DAC. Unlike most interfaces, the Akasa offers two-way communication between Server and DAC, which allows the DAC to become the system's master clock and system controller. The third adjustment, Speed, controls the rise time of the Server's output signal. The adjustment settings are displayed graphically on the front panel. You can program three different combinations of these adjustments for quick recall. Note that none of these adjustments changes the data; they simply affect the level and shape of the bitstream. I discuss these adjustments, the Akasa interface, and other details of the Reference Server's technology, in the sidebar.

Sound

I started this review by comparing the sound of the Reference Server to the improvements rendered by a high-quality remastering. On the face of it, that sounds far-fetched. How can a device that simply takes incoming data from an Ethernet port or internal storage, reformats it, and sends it to a DAC be so transformative? That was my thought upon first hearing about a music server that costs $76,495, but such skepticism vanished when listening to the astounding revolution the Server renders. I should qualify this statement: When driving the Reference DAC through the USB port, the Server is outstanding—the best I've heard. But the transformation happens when listening through the Akasa optical interface. My comments about the Server's ability to make digital files sound almost like high-quality remasterings, and my description below, are based on listening to the Akasa interface driving the Reference DAC.

The Reference Server's overall sound is one of greatly increased clarity, dimensionality, resolution, lifelikeness, rhythmic drive, and musical vividness. These qualities were so elevated by the Reference Server that I'm going to say that the Server is an even more significant product than the Reference DAC. Just as the Reference DAC sounds fundamentally different from other DACs, so too does the Server sound fundamentally different from other music servers. I'm not talking about marginal improvements to the status quo, but rather a qualitative difference in the sound of digital audio.

I'll start with the bass. The Reference DAC's bass was already state of the art but driving it with the Server resulted in a metamorphosis in ways that are very important musically. The Server snapped the bass into sharp focus to reveal a level of pitch resolution, dynamic articulation, and harmonic texture that I have not heard before from any format, analog or digital. Recordings that I've listened to countless times over many decades were transformed. I could suddenly hear every nuance of the bass line, in pitch, dynamics, and timbre. What had been a mush, relatively speaking, was instantly clarified into individual notes. Consequently, and more importantly, the bass player's contribution to the ensemble took on a different and more prominent role. This was particularly true of dynamics, whether from bass guitar or stand-up acoustic bass. The bass player's dynamic emphases on certain notes were rendered with powerful clarity, profoundly affecting the music's rhythmic flow. The bass became much more of a rhythm instrument, emphasizing dynamic accents and thus the feeling of propulsive energy.

The Wadax Server at the front end revealed bass as a distinct and powerful voice that added to the music in entirely new ways. A perfect example of this, and one that suggested my comparison of the Wadax with remasterings, is Dave Holland's acoustic bass on *Like Minds*. This outstanding album, with Chick Corea, Gary Burton, Holland, and Roy Haynes, features some beautiful and inspired solos as well as empathetic ensemble playing. Unfortunately, Holland's bass is poorly recorded, sounding muffled and lacking articulation. His bass lines just get lost much of the time. I've listened to this album countless times on digital, as well as on a Pure Audiophile LP release. Hearing it through the Wadax, Holland's bass, while still not the paragon of clarity, is much more intelligible. I could suddenly discern individual notes, pitches, and textures rather than a blur. I heard another dimension to this treasured favorite, such as the way Holland anticipates Corea's phrasing in the solos, particularly on the Corea composition "Windows."

The optical interface seemed to provide an octave of deeper extension, with greater solidity and power below 40Hz. The 16Hz organ pedal tones on the Rutter Requiem, or Virgil Fox's *The Bach Gamut*, or the Saint-Saëns Third Symphony ("Organ"), had a majestic, center-of-the-earth solidity. The Reference Server rendered the bass with greater fullness and

Specs & Pricing

Standard output: USB and Akasa optical (Akasa requires connection to Wadax Reference DAC)
Optional outputs: SPDIF on RCA, SPDIF on BNC, AES/EBU with optional Digital Output Board
Service port: USB
User interface: 5" capacitive color touchscreen
Music-management: Roon (lifetime subscription optional)
Storage: 2TB internal PCI-E M.2
Storage expansion: Four 2.5" bays
Dimensions: 18.9" x 10.62" x 18.58"
Weight: 105.8 lbs.
Price: $59,000; $76,495 with Akasa optical cable and optical input module for Reference DAC

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Associated Equipment
Analog source: Basis Audio A.J. Conti Transcendence turntable with SuperArm 12.5 tonearm; Air Tight Opus cartridge; CH Precision P1 phonostage with X1 power supply; DS Audio ST-50 stylus cleaner, Levin record brush, Degritter ultrasonic LP cleaner
Digital source: Wadax Reference DAC, UpTone Audio EtherREGEN Ethernet switch
Amplification: CH Precision L10 Dual Monaural linestage; CH Precision M10 Dual Monaural power amplifiers
AC Power: Shunyata Everest 8000 conditioner, Omega and Sigma NR V2 power cords; Shunyata AC outlets, five dedicated 20A lines wired with identical length 10AWG
Support: Critical Mass Systems Olympus equipment racks and Olympus amplifier stands; CenterStage2 isolation, Ayra Audio RevOpods isolation
Cables: AudioQuest WEL Signature interconnects and AudioQuest Dragon Zero and Dragon Bass loudspeaker cables
Accessories: The Chord Company GroundArray noise reduction
Acoustics: Acoustic Geometry Pro Room Pack 12, ASC 16** Round Tube Traps
Room: Purpose-built; Acoustic Sciences Corporation Iso-Wall System

weight, yet simultaneously made it tighter with greater dynamic agility. This quality created a more powerful visceral listening experience, one that tends to involve the whole body and not just the mind.

The Server's greater resolution of micro- and macro-dynamics, and the more precise and powerful sense of rhythm it conveyed, was apparent across all types of music. I'll give you two examples at opposite ends of the rhythmic spectrum. The first is "Worried Life Blues" from *Riding with the King* with Eric Clapton and B.B. King (Tidal MQA). This track has a slow, loping beat with a very simple drum part. The drummer is Steve Gadd, who is best known for his virtuoso, high-energy power drumming (that's him on Steely Dan's "Aja," for example). His skills would seem to be wasted on such a pedestrian part, but the Reference Server reveals, with exquisite detail, Gadd's nuances of timing and accented beats that underpin the song's languid flow, conveying the resignation expressed in the lyrics of this blues classic. Far from Gadd's prodigious skills being wasted, the Reference Server shows how essential his precise timing and rhythmic feel are to this song. Or try listening to the whole-body experience of Talking Heads *Speaking in Tongues*, the powerful and steady beat of the kick drum and bass guitar behind the polyrhythms of percussion instruments, and the guitar that's used as a rhythm, rather than melodic, instrument. (I'm reminded of James Brown's admonition to his band in the biopic *Get On Up*: "Every instrument is a drum.") The Wadax has an incredibly precise sense of rhythmic timing, power, and propulsion. This aspect of the music was most affected by the Server's three front-panel controls that adjust the amplitude waveshape of the digital signal. The Speed control subjectively seemed to affect the timing of the bass guitar and kick drum; when ideally set, the two instruments combined synergistically, almost as though they were one pulse driving the rhythm. Moving the control out of its optimum setting (which you set by ear) seems to make the bass lag, with a less precise sound and diluted propulsive drive. Of course, the adjustment to the waveshape has no objective effect on the timing of the bass, but that is the subjective impression rendered by the Speed control.

Another area in which the Wadax pair delivered unprecedented performance is in dimensionality, sense of space, separation of individual instruments from the whole, and the three-dimensional quality of the images themselves. Ever since high-end designers started modifying early CD players, and then building separate DACs, one of the greatest challenges has been to bring the dimensionality of analog to digital audio. Digital has tended to sound flat and dry, with homogenized images in which instruments sound fused together with the surrounding acoustic rather than emerging as distinct objects separated from each other. The best of today's DACs are much better in this regard than those of a decade ago, but they still don't have the openness and tangible presentation of images that come so naturally to analog. This character not only distorts the music's spatial qualities, but it also diminishes the immediacy of images and thus musical realism.

Before I received the Reference Server, I thought that the Wadax Reference DAC produced unrivaled dimensionality, but driving it with the Reference Server through the optical interface took the spatial performance into an entirely different realm. If you have the opportunity to audition the Wadax pair, ask to hear a comparison of the Server's USB output with the optical connection. The difference is readily audible with any music, but particularly with naturally miked recordings in a large hall—try the Arnold *Overtures* on Reference Recordings, for example. With the optical interface, the wall behind the speakers vanishes, replaced by a tremendous sense of distance. The apparent space between instruments in the front of the orchestra and the back deepens. The big

low-brass tuttis "light up" the hall, revealing the size of the recording venue. The decays from those tuttis hang in the air longer, further explicating the hall's scale. The air in the hall sounds "charged" and alive rather than flat and airless. Instruments or sections of the orchestra are separated from each other by tangible, three-dimensional air and space. Moreover, the way the instruments project their energy into the space around them is thrillingly vivid and realistic. As a result of these sonic characteristics, the sound becomes much more like live music and less like an electromechanical recreation. The music is more organic, natural, and free of the artifacts that remind us that we're listening to an illusion.

The most revealing track of all these qualities—dynamic and harmonic resolution in the bass, transient fidelity, and the fabulous spatial presentation—is from a recording I made in 1989 live to DAT of a straight-ahead jazz group in a high-end 24-track studio (I bypassed the multitrack machine and mixed it live to two channels). The ensemble included Jay Migliore (a founding member of Supersax), Conti Condoli on trumpet and flugelhorn (Stan Kenton, Woody Herman, Benny Goodman, Dizzy Gillespie, and longtime member of *The Tonight Show* band), Isla Eckinger on acoustic bass, Joe Letteri on piano, and the group's leader, drummer Chiz Harris. I've listened to this CD, or rips from the CD, on just about every product I've reviewed over the past 32 years. But hearing it through the Reference Server was a qualitatively different experience. Each instrument was now clearly separate from the others, laid out across the soundstage just as I had panned them (the drums were miked in stereo with an overhead pair of Neumann U-87s in an X/Y configuration). More importantly, I heard and felt the energy of the individual players and the group, as they worked out on extended versions of bop classics such as "Confirmation" and "Speak Low." It brought back vivid memories of hearing the microphone feed and thrilling at the opportunity to record such consummate musicianship. It wasn't a subtle sonic difference such as I hear when comparing other digital sources, but rather a gestalt reaction that brought the music vividly to life. (This CD, *Confirmation* by the Chiz Harris Quartet, is out of print but you can read a review of the album, and sample short segments, at AllMusic.)

The Wadax represents yet another advance in digital playback—in reproducing the smoothness and liquidity of instrumental timbre. Designers have for decades struggled with the balance between smoothness and reproducing a full measure of upper-midrange and treble energy. I've heard countless DACs that prioritized detail and an open and extended top end at the expense of sounding hard, bright, and fatiguing. I've also heard many DACs that smooth over these digital nasties by making the sound soft, euphonic, and lower in resolution. Both approaches are a recipe for long-term dissatisfaction. The Wadax, more than any other digital front end I've heard, achieves the perfect balance between these extremes. It has an unmatched beauty and liquidity of timbre, yet is highly detailed, vibrant, open, and extended in the treble, The Wadax doesn't realize this smoothness by softening the sound. Well-recorded cymbals are revelatory through the Wadax, infused with detail, life, air, shimmer, and rich in treble energy without sounding bright or harsh. The Server revealed more texture and inner detail in cymbals and hi-hat. Digital has improved in this area, with the first DACs making cymbals sound like bursts of noise from a spray can. Although digital has come a long way, and there are some superb-sounding DACs on the market, the Wadax simply has no peer in its ability to sound simultaneously richly detailed in the top octaves and smooth and unfatiguing.

I was once in a Mexican restaurant with the great turntable designer and deep audio thinker Basis Audio founder A.J. Conti when a roving mariachi band approached our table. The four-piece band played right in front of us, the trumpet's bell a few feet away and pointed at us. After the musicians left, A.J. commented on the very high level of high-frequency energy the instrument produced, noting that it didn't offend the ears the way that amount of high-frequency energy would from any reproduced music. It's the lack of distortion in the live instruments that allows us to experience that sound-pressure level without wincing. The Wadax's ability to present a full measure of treble energy without glare, hardness, or fatigue reminded me of A.J.'s astute observation.

Conclusion

I've been following the evolution of digital audio since 1989 and have reviewed many of the industry's most ambitious efforts. There's been a slow and steady climb in the technical sophistication and sound quality of digital sources, punctuated by occasional leaps in performance. But the Wadax Reference Server represents a qualitative advance in sound quality that is unlike the improvements I've heard in a single product. It's not an incremental advance in sound quality—more of the same but better. Rather, the Wadax pair sounds different in kind rather than in degree. The qualities that the Wadax embodies are so important musically. The Wadax conveys a feeling of spontaneity, vitality, and contemporaneous music-making that is the antithesis of canned and sterile. I heard this vivid life and immediacy on recordings I've been listening to for decades and know intimately. It was surprising—and sensational—to discover that these treasured recordings held greater musical expression than I had realized.

Yes, the Wadax Reference pair are crazy-expensive and will be owned by very few music lovers. But it's impossible to put a price on the value of having an instant remastering machine in your own listening room. tas

Technology

The Reference Server project began four years ago when Wadax began testing its Atlantis Transport with disc-ripping features and discovered that the length and type of USB cable made a significant sonic difference. The sound changed even though the bits representing the audio signal were identical. Wadax also discovered that the software processing the audio made a difference, specifically the Linux compiler, and even the settings within a specific compiler. During this work, it also discovered other mechanisms by which bit-perfect datastreams were sonically compromised, including the influence of power supplies, grounding, and noise coupling. After two years of R&D, Wadax identified a specific combination of hardware platform, compiler, and compiler settings that produced the best sound. It then addressed other sources of sonic degradation that included power supplies, grounding, isolation, and airborne and structural vibration.

Once the software and hardware issues had been addressed didn't mean the job was done. Wadax discovered that a significant source of sonic degradation was the interface between the server and the DAC, specifically a phenomenon Wadax calls "bit waveform distortion." This is a change in the shape of the digital signal's waveform, a change that doesn't alter the data but nonetheless corrupts the audio performance. The USB interface was particularly prone to this distortion mechanism, so for an attempt at the state of the art in music servers, the USB interface wasn't even a consideration. Although the Server offers a USB output for compatibility, Wadax wanted an interface that didn't suffer from USB's limitations.

Wadax recognized that any physical electrical ("galvanic") connection between the DAC and transport degraded fidelity, largely through noise coupling and ground loops. The solution was an optical interface. To create a custom optical interface from a blank sheet of paper, Wadax turned to three outside companies that had specific expertise in state-of-the-art fiber-optic encoding and transmission. The result was the Akasa optical interface—high-end audio's first optical interface that's not a stock technology simply rebranded (such as the AT&T ST-Type interface popular in the 1990s).

For starters, the Akasa optical interface provides complete galvanic isolation between the Server and DAC, meaning that there's no path for electrical noise. This galvanic isolation also means no noise modulation of the ground plane, no ground loops, and no noise crosstalk. Second, a signal traveling down an optical interface is subjected to less dispersion than a signal traveling down an electrical conductor. Dispersion is a phenomenon in which the energy of a signal is spread out in time—a contributor to the "bit waveform distortion" mentioned earlier. Think of a perfect square wave at the transmission end of a cable; at the receiving end the square wave's edges are rounded, and the rise time is slower, causing the leading edge of the square wave to become slightly slanted. The square wave's shape is altered because the cable's transmission speed isn't infinite. It's this leading edge of the square wave that represents a binary transition from one to zero, or from zero to one. If that edge is slanted, the precise timing of that transition is indeterminate; it could occur at different points along the slope.

Although an optical interface greatly reduces these effects, it doesn't eliminate them. This is where the Server's three unusual front-panel controls come into play. They change the waveshape in a specific way that counteracts the change in the waveshape introduced by the cable. Wadax calls this technique of reversing bit-waveform distortion Digital Feed-Forward Waveform Control. It essentially compensates for changes in the waveshape that occur in the interface. To reiterate, the three front-panel adjustments are Speed (rise time), Output Gain (digital bitstream voltage), and Input Gain (voltage of the clock and control signals from the DAC to the Server). More specifically, the Output Gain control determines the voltage at which the Server considers a binary "one" to be "one" or binary "zero" to be "zero." As mentioned, you can store three settings of these controls as presets, called up from the front-panel touchscreen. Note that these adjustments don't change the data, only the *shape* of the data. (For more on how the shape of data affects the sound, see this issue's From The Editor.)

The audio data transmitted through the Akasa interface are not formatted in the conventional SPDIF format. Rather, Wadax developed a proprietary data-transfer protocol in which the DAC controls the flow of data in blocks from the Server. The transfer speed is many times faster than that required by the audio data and remains constant regardless of the audio signal's native data rate, i.e., 44.1kHz/16-bit, 192kHz/24-bit, or any DSD frequency. When carrying higher data rates, the DAC simply commands the server to transmit blocks more frequently.

The interface between the electrical signal and the optical interface was critical. To avoid degradation at this junction, Wadax developed a circuit built around a Neutrik connector and a 25-element CNC-machined part that performs these optical-to-electrical and electrical-to-optical conversions. The part minimizes optical reflections as well as damps resonances. It is a massive, futuristic-looking device that is unlike any audio termination I've seen.

What started out four years ago as a research project into mechanisms by which bit-perfect datastreams sounded different became a product-development effort aimed at realizing a state-of-the-art music server. Although Wadax is a very measurement-oriented company, the firm says it achieved 80% of the Reference Server's performance through scientific testing, with the remaining 20% realized through critical listening.