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DIGITAL PROCESSOR REVIEWS

Aurender Flow D/A headphone amplifier

By John Atkinson • Posted: Jun 11, 2015

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Aurender was a name new to me when I encountered the company at the 2015 Consumer Electronics Show, where they displayed a range of music servers designed in California and manufactured in South Korea. But what caught my attention in Aurender's suite was their Flow portable D/A headphone amplifier ($1295). This handsome, battery-powered device, housed in a

machined aluminum case about twice the size of a pack of playing cards, offers optical S/PDIF and USB 2.0/3.0 input ports and a single ¼" stereo headphone jack. Two features distinguish the Flow from the pack: Its USB input can be used with iOS (iPhone/iPad) and Android smartphone sources, and it can accept an mSATA drive (not included in price) of up to 1TB capacity for internal storage of audio files. Visually, the Flow's distinguishing feature is its round LCD display, which stands proud of the faceplate; the bezel encircling the display acts as a velocity-sensitive volume control operating in 0.5dB steps.

Internally, the Flow is powered by a 3.8V, 4450mAh Li-ion rechargeable battery claimed to provide more than seven hours of playing time. The USB interface chip is an XMOS XS1-U8A-64-FB96, while the DAC chip is the popular ESS9018K2M, which supports PCM playback at resolutions up to 32 bits and 384kHz, as well as DSD64 and DSD128.

Five pushbuttons along the Flow's right edge allow power on/off, access to the setup menu (one press for the most frequently used functions, a long press for other functions), and three transport functions. The last three buttons—Play/Pause, Forward, Backward (on my review sample, the last two operated the opposite of their icons' indications)—control playback with USB-connected devices, and allow menu items to be changed.

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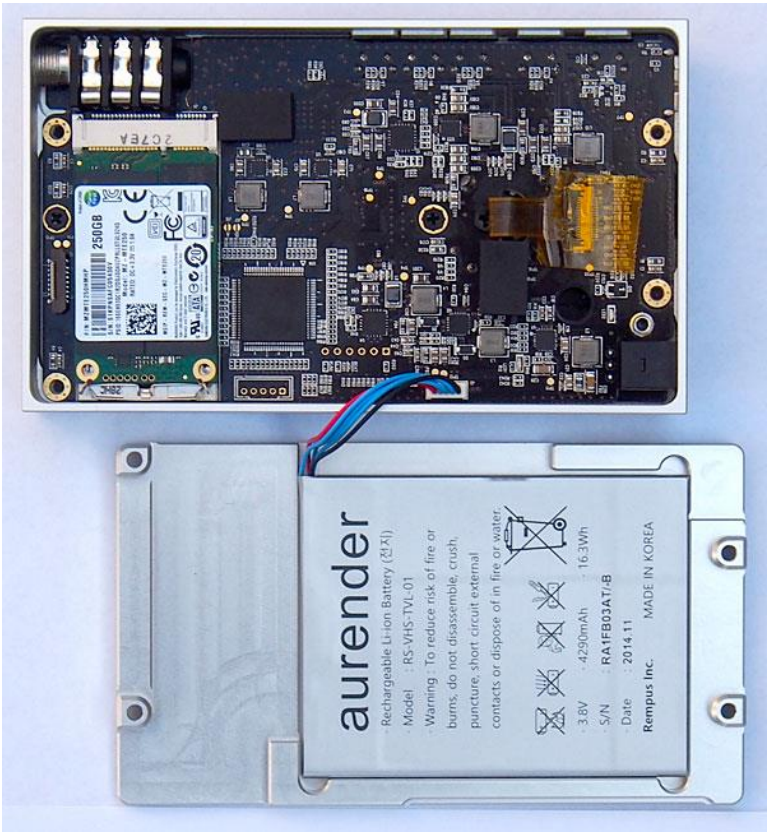

Some functions can be accessed with headphones or a source connected; others require ancillaries to be unplugged. For example, while the Flow gives users three analog output options—Fixed at 2V or 5V, and Variable (with the maximum output level set to whatever had

been set as the Fixed output)—this setting can be changed only with the headphones unplugged. Usefully, there are several different reconstruction filters, accessible via a long press of the Menu button. To play PCM files of up to 384kHz, there is a conventional fast-rolloff filter, a slow-rolloff filter with optimal time-domain behavior, and a minimum-phase filter. For DSD playback (using the DoP protocol), four filters are available, with bandwidths of 47.4, 50, 60, and 70kHz.

The Aurender Flow comes in classy packaging; included are a faux-leather carrying case, a charger, a magnetized screwdriver to remove the rear panel screws to install storage, and a complete set of cables and adapters (see "Specifications").

Listening

The review sample came fitted with 250GB of solid-state storage (approximate value $150), which I loaded up with PCM and DSD files. (This drive appears on the computer's desktop when the Flow is connected via USB, and files can be dragged'n'dropped on the drive's icon in the conventional manner.) However, it appears that playing files stored on the Flow's internal drive requires that the Flow be connected to a host computer and used with an audio playback program. I used the Flow with three main sources: my laptop connected with TosLink or USB 2.0 to play files from the laptop's drive using Pure Music (PCM) and Audirvana (DSD); the same two programs on my laptop, to play files from the Flow's internal storage via USB 2.0; and the Music app on my iPad 2 via Apple's camera connection kit.

The Flow got warm after a couple of hours' use. For listening at home, my headphones were the Audeze LCD-Xes, which I reviewed in March 2014, and the Sennheiser HD650s; for music during my commute, and during the flights to and from Denver for last April's Music Matters events, I used Ultimate Ears 18 Pro in-ear monitors. My comments are an amalgam of my experiences with all sources and headphones.

Low frequencies sounded a little thin with the Sennheisers, more fleshed out with the Audezes. This was very noticeable with Marc Johnson's double-bass solo in the Bill Evans Trio's performance of "Nardis (2nd Set)," from *Turn Out the Stars: The Final Village Vanguard Recordings June 1980*, which I streamed in true CD quality (Nonesuch/Tidal). The high frequencies were clean and clear, though very slightly less so when playing files from the Flow's internal drive compared with the same files played from the laptop's hard drive. Though playing from the Flow's storage means the USB port is operating simultaneously in both directions, doubling the rate of data flow, I heard no dropouts or other problems.

However, the absolute quality of both the treble and midrange depended on which PCM filter I used. Evans's rather clangy piano sounded a touch more palpable with pcm1, though Vaughan Williams's *Variants of "Dives and Lazarus,"* with Bryden Thomson conducting the LPO (ALAC file ripped from CD, Chandos), sounded more natural with pcm2. The pcm2 filter also smoothed over Phil Collins's voice in "Tearing and Breaking Down," from *Johnny Boy Would Love This . . . A Tribute to . . . John Martyn* (256kbps AAC file, Liaison), and made it easier for me to distinguish among the instruments in the complex of "Paraphernalia," from *Miles at the Fillmore—Miles Davis 1970: The Bootleg Series Vol.3* (Columbia/Legacy, Tidal stream).

image: http://cdn.stereophile.com/images/615aurender.close.jpg

DSD playback was initially a little confusing: Although Audirvana identified the Flow as being capable of playing DSD64 and DSD128 files, "176.4kHz" appeared on the Flow's screen with DSD64 files, which implied PCM rather than DSD. Then I noticed that a small "DSD" icon was illuminated, and below it an even smaller "64." The sound with DSD was indeed excellent, especially with DSD Filter 3. Iván Fischer and the Budapest Festival Orchestra performing Rachmaninoff's Symphony 2 (DSD64, Channel Classics) was reproduced with a smooth, natural midrange and clean, clear highs. Delicate treble detail, such as the snare drum and cymbals around 5:00 in the Rachmaninoff's second movement, were readily apparent without being spotlit.

Most of my listening to the Flow was done using the iPad. When I initially connected the Flow, I got a warning that the "accessory requires too much current," and the Flow shut itself down. This turned out to be because the Flow needs to be set to iOS mode, then powered down, before being connected to the iPad. (The Flow remembers which mode it's set to.) The Flow then powers up when it's connected to the iPad, and will play music selected using the iPad's Music menu.

Streaming music from Tidal with the iPad was the killer app for this setup, but I also wanted to play hi-rez files of 88.2 and 96kHz sample rates on the iPad. This turned out to be a nonintuitive process. While iTunes on the host computer *will* transfer 24-bit files when the iPad is synchronized with the host, iTunes gives an error message for files with sample rates greater than 48kHz: "[Filename] was not copied to the iPad [serial number] because it cannot be played on this iPad." The solution was to set iTunes to manual management of the iPad's music library, and drag'n'drop the hi-rez files from their folders to iTunes' Music Library screen. I selected

various WAV, AIFF, and ALAC files; all were then copied to the iPad without any problem, and played at full resolution (see "Measurements") and at the correct sample rate, as indicated on the Flow's display. The sound was identical to that with the Flow playing the same hi-rez files from my laptop.

Comparisons

I don't have a USB headphone amplifier that competes directly on price with the Flow, but I still have the review sample of the Meridian Prime ($2000 without optional power supply), which I reviewed last October. The Prime has become one of my headphone references while I wait for a firmware upgrade to allow it to play MQA-encoded files.

With levels matched by ear, the Flow had a lighter balance than the Meridian Prime on my 24/88.2 master files for April's "Recording of the Month": Sasha Matson's *Cooperstown: Jazz Opera in Nine Innings* (Albany). Rod Gilfry's baritone voice in the big tune in the Sixth Inning lacked a little chest tone compared with the Meridian, but the two tenors, Daniel Favela and Daniel Montenegro, were better differentiated through the Flow. The two headphone amplifiers sounded identical, however, when it came to decoding the subtle reverberation around soprano Julie Adams's high notes at the end of the Seventh Inning.

My final comparison was with the Pono Music PonoPlayer ($400), which I reviewed in April. Using the Audeze headphones with the Pono in single-ended mode (see Follow-Up in this issue for my thoughts on balanced operation), I listened to "Stairway to Heaven (Sunset Sound Mix)," from the *Deluxe Edition* of Led Zeppelin's remastered *IV* (24/96 FLAC, PonoMusic World/Atlantic). The sound was as described in my review: full, detailed, and dynamic, with what Art Dudley refers to as "flow" well in evidence. Through the Flow, John Bonham's kick drum had more kick (for want of a better word), and the high frequencies sounded slightly clearer than through the Pono. Though this made Robert Plant's voice a touch too strident at the top of his range, the Flow slightly better differentiated Jimmy Page's multiple acoustic and electric guitar lines.

Summing Up

The Aurender Flow is a beautifully made, beautiful-looking, beautiful-sounding, and beautifully versatile audio component. Its different digital filters allow its sonic character to be optimized for different types of music. Its light tonal balance will be a better match with relatively dark-sounding headphones like the Audeze LCD-Xes than with headphones, such as Sennheiser's HD-800s, that have a similar character in the treble. Recommended.

Sidebar 1: Specifications

Description: Portable D/A headphone amplifier with LCD screen. Inputs: USB 3.0/2.0 (Audio Class 2.0), S/PDIF optical. Output: &#188l" (6.35mm) stereo headphone jack. Compatible sample rates: up to 96kHz via S/PDIF, up to 384kHz and DSD128 via USB. Compatible bit depths: 16–24 (S/PDIF), 16–32 (USB). Internal storage: up to 1TB total via mSATA bus. Output impedance: 0.06 ohm. Output power (0.1% THD): 43mW/600 ohms, 87mW/300 ohms, 384mW/56 ohms, 570mW/32 ohms. THD+N: –114dB. IMD (SMPTE): –112dB. THD (1kHz, 5.1V RMS output): 0.0002%. Dynamic range: 122dB. Damping factor: >130: Power supply: 4450mAh

Li-ion rechargeable battery. Supplied adapters: AC universal (100–240V), 6.35mm headphone plug to 3.5mm headphone jack, 6.35mm headphone plug to stereo RCA jacks cable, TosLink to mini-optical cable, mini-USB to mini-USB cable, short USB-A to USB 3.0 cable, long USB-A to USB 3.0 cable. Also supplied: screwdriver for installing optional internal storage.
Dimensions: 5.4" (137mm) H by 3.1" (80mm) W by 1.1" (28mm) D. Weight: 1 lb (450gm).
Finish: Matte brushed aluminum.
Serial number of unit reviewed: V1000N0278. Firmware: v.027.
Price: $1295 without mSATA drive. Approximate number of dealers: 19 (US), 3 (Canada).
Manufacturer: Aurender, SmartAudio Division of TVLogic Co., Ltd., 100 Baekhyun-ro, 2802 Jeongja I-Park, Bungdang-gu, Seongnam, Korea. US: TVLogic America, 209 N. Victory Boulevard, Burbank, CA 91502. Web: www.aurender.com.

Sidebar 2: Associated Equipment

Digital Sources: Apple MacBook Pro running OS10.7.6, iTunes 11, Pure Music 2.0, Audirvana Plus 1.5.12; AudioQuest JitterBug; iPad 2 with camera connection kit; PonoPlayer.
Headphone Amplifier: Meridian Prime.
Headphones: Audeze LCD-X, Sennheiser HD650, Ultimate Ears 18 Pro in-ear monitors.—**John Atkinson**

Sidebar 3: Measurements

With the Aurender Flow's battery fully charged, I measured it with my Audio Precision SYS2722 system (see www.ap.com and the January 2008 "As We See It"). Sources were TosLink from the SYS2722, USB from my 2012 MacBook Pro (running on battery power), or USB from my iPad 2 via the camera connection kit. Macintosh's USB Prober utility reported the Flow's product string as "Aurender-FLOW-6027 Output" and the manufacturer string as "XMOS." USB Prober also confirmed that the Flow's USB port operated in the optimal isochronous asynchronous mode. The TosLink input locked to datastreams with sample rates up to 96kHz, the USB input up to 384kHz. The iPad was restricted to sample rates of 96kHz and below.

The maximum output level at 1kHz was 5.19V or 2.07V for both the fixed output setting and the variable output with the volume control set to "0.0dB." (The output level was set to 5V for all testing.) The volume control operated in accurate 0.5dB steps. The output preserved absolute polarity and the output impedance was very low, at 0.4 ohm across the audioband (including 6' of cable). The impulse response with 44.1kHz data depended on the reconstruction filter in use. The default, pcm0, is a conventional FIR type with a time-symmetrical impulse response (fig.1), while pcm1 (fig.2) is a short type that, as the Flow's manual states, "virtually eliminates ringing from signals." However, the manual also states that this is a "minimum phase" filter, which the impulse response shows not to be correct (footnote 1). However, pcm2 is indeed a minimum-phase type, as revealed by its impulse response (fig.3), where all the ringing occurs after the initial transient.

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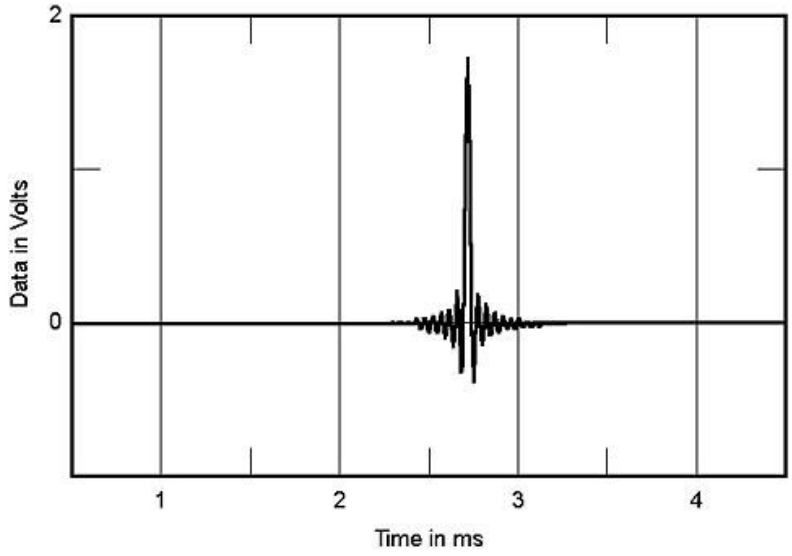

Fig.1 Aurender Flow, pcm0 filter, impulse response at 44.1kHz (4ms time window).

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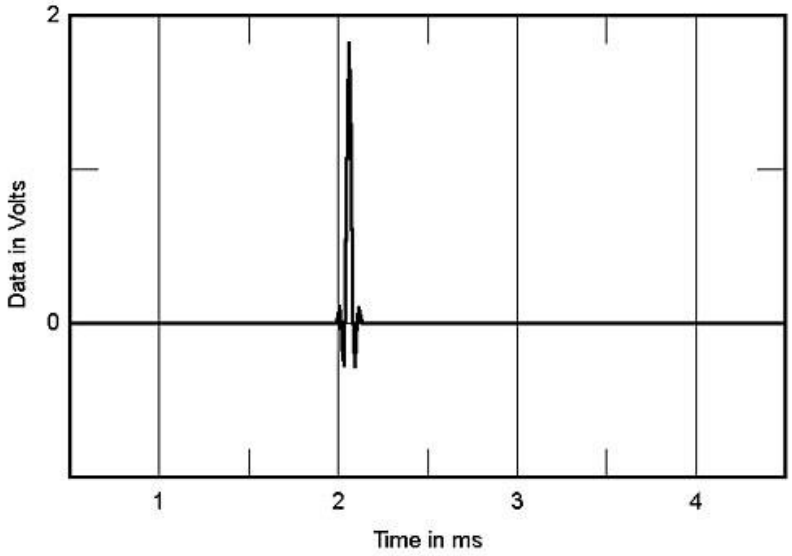

Fig.2 Aurender Flow, pcm1 filter, impulse response at 44.1kHz (4ms time window).

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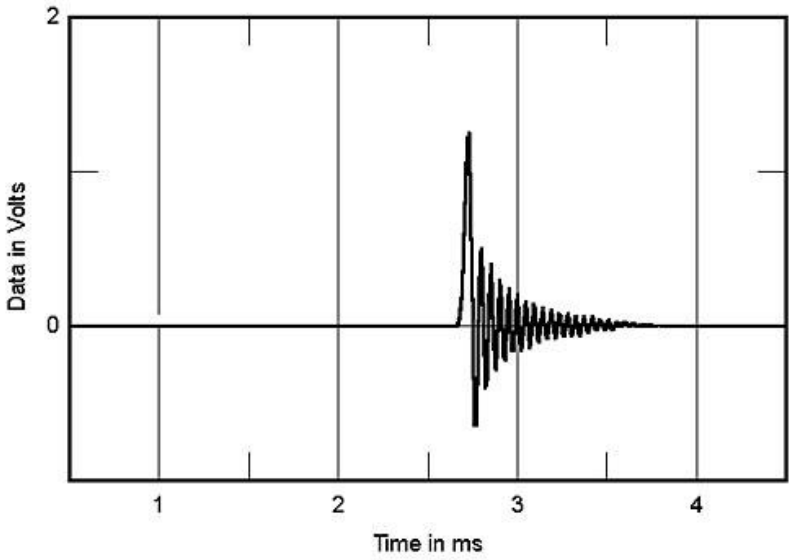

Fig.3 Aurender Flow, pcm2 filter impulse response at 44.1kHz (4ms time window).

Although pcm2 is described in the manual as "a slow roll-off PCM filter" by means of which the output signal "will be slightly attenuated," the red and magenta traces in fig.4 indicate that this is not the case, the 44.1kHz-sampled white noise rolling off sharply above 22.05kHz (green vertical line) to reach the stopband noise floor by 24kHz (footnote 2). It is the pcm1 filter that offers the slow and early rolloff (fig.5), correlating with the short filter length, and allowing the image of the full-scale tone at 19.1kHz in the graph (blue and cyan traces) to lie just 10dB below the level of the fundamental tone. But note the very low levels of the distortion harmonics in figs.4 and 5.

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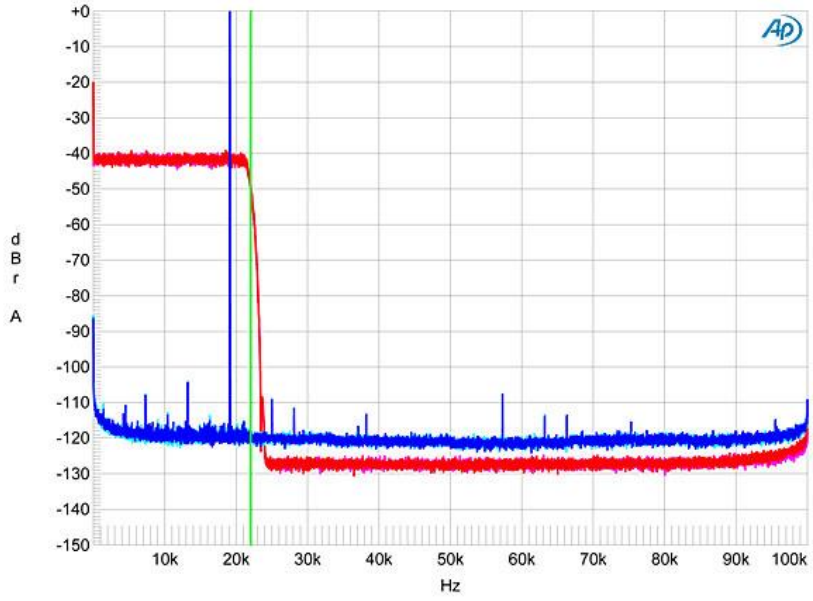

Fig.4 Aurender Flow, pcm2 filter, wideband spectrum of white noise at –4dBFS (left channel red, right magenta) and 19.1kHz tone at 0dBFS (left blue, right cyan), with data sampled at 44.1kHz (20dB/vertical div.).

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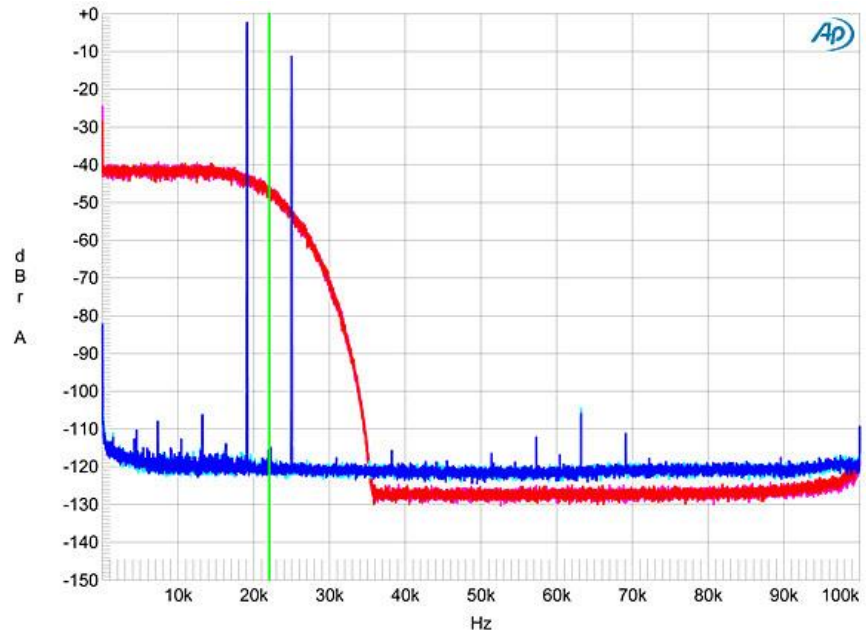

Fig.5 Aurender Flow, pcm1 filter, wideband spectrum of white noise at –4dBFS (left channel red, right magenta) and 19.1kHz tone at 0dBFS (left blue, right cyan), with data sampled at 44.1kHz (20dB/vertical div.).

This early rolloff with pcm1 can be seen in fig.6, which plots the Flow's frequency response at sample rates of 44.1, 96, 192, and 384kHz. With the lowest sample rate, the signal is down by 2dB at 20kHz. Filters pcm0 and pcm2 behaved identically, offering flat response almost up to the Nyquist frequency for the lower sample rates, but an earlier, slower rolloff for data sampled at 384kHz (fig.7 red trace). Channel separation (not shown) was superb, at >120dB below 3kHz, while the Aurender's noise floor was free from idle tones and other spuriae (fig.8).

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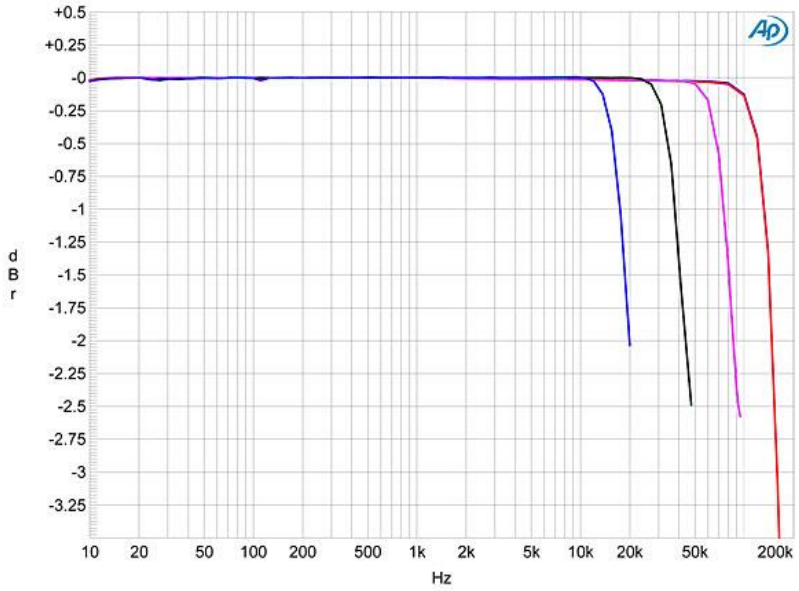

Fig.6 Aurender Flow, pcm1 filter, frequency response at –12dBFS into 100k ohms with data sampled at: 44.1kHz (left channel blue, right red), 96kHz (left green, right gray), 192kHz (left cyan, right magenta), 384kHz (left blue, right red) (0.5dB/vertical div.).

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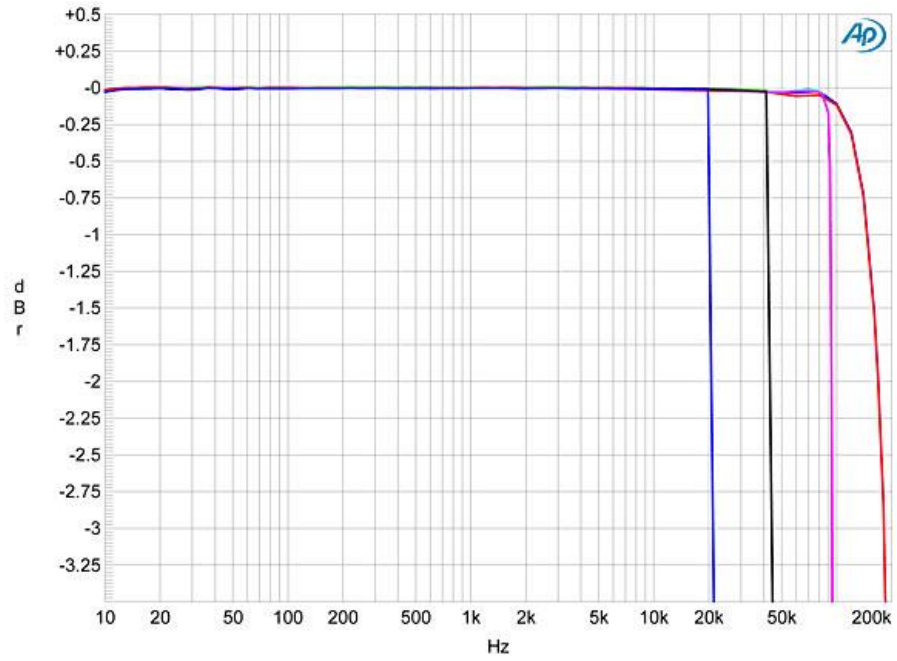

Fig.7 Aurender Flow, pcm0 filter, frequency response at –12dBFS into 100k ohms with data sampled at: 44.1kHz (left channel blue, right red), 96kHz (left green, right gray), 192kHz (left cyan, right magenta), 384kHz (left blue, right red) (0.5dB/vertical div.).

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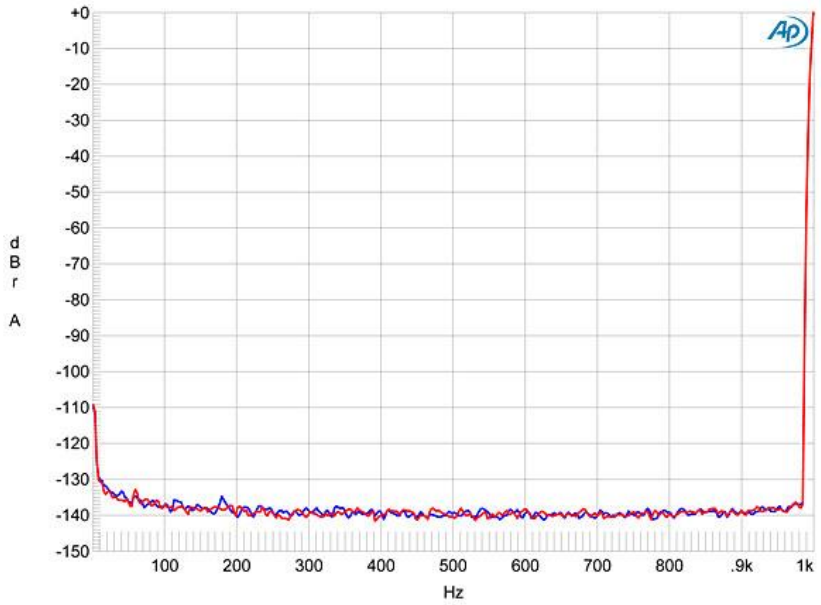

Fig.8 Aurender Flow, spectrum of 1kHz sinewave, DC–1kHz, at 0dBFS into 100k ohms (left channel blue, right red; linear frequency scale).

The drop in the noise floor of >12dB in fig.9 when the bit depth is increased from 16 to 24 suggests that the Flow has at least 18-bit resolution, which is excellent. This graph was taken with S/PDIF data; I obtained identical results with both USB and iOS sources. (An iPad will indeed output 24-bit data via the camera connection kit, fig.10.) The Aurender's reproduction of an undithered 16-bit signal at exactly –90.31dBFS was excellent (fig.11), with the three DC voltage levels clearly and symmetrically resolved. With a 24-bit representation of the same signal, the Flow output a nice sinewave (fig.12).

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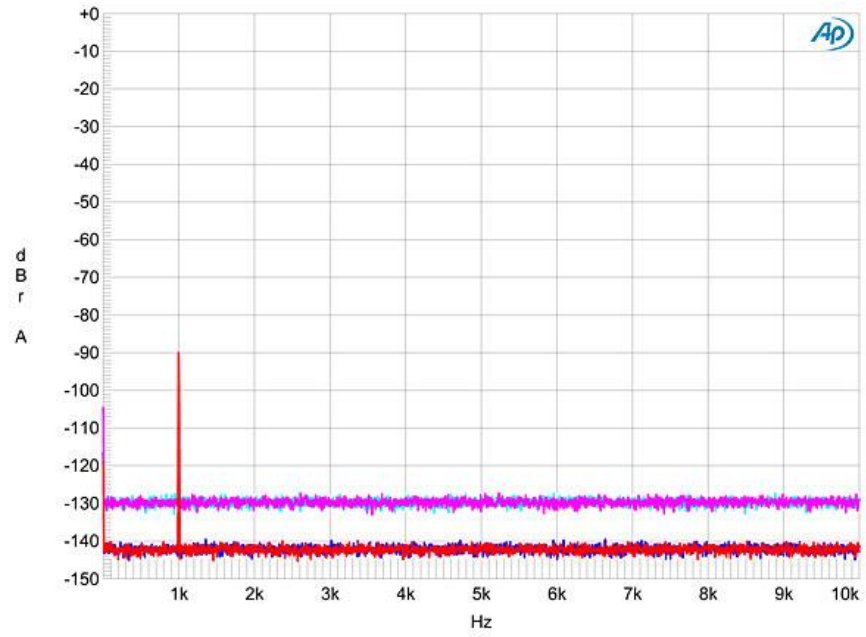

Fig.9 Aurender Flow, spectrum with noise and spuriae of dithered 1kHz tone at –90dBFS with: 16-bit data (left channel cyan, right magenta), 24-bit data (left blue, right red) (20dB/vertical div.).

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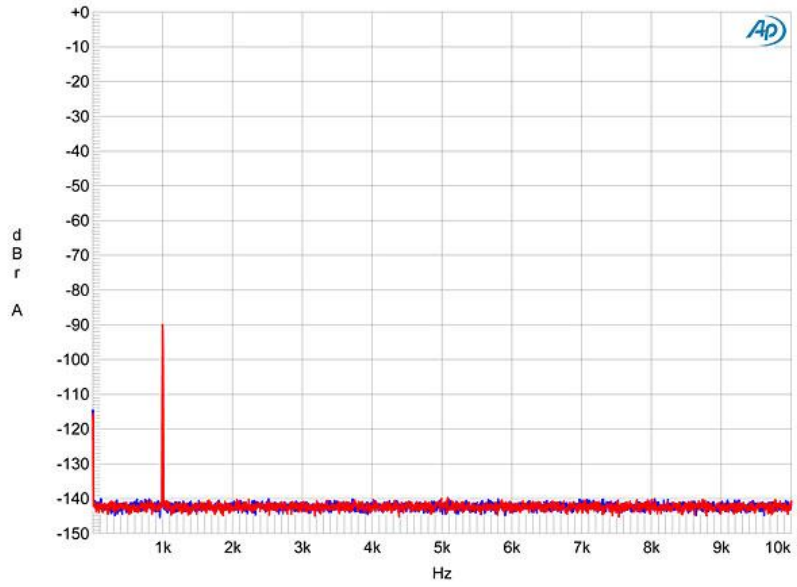

Fig.10 Aurender Flow, spectrum with noise and spuriae of dithered 1kHz tone at –90dBFS with 24-bit iPad data (left blue, right red) (20dB/vertical div.).

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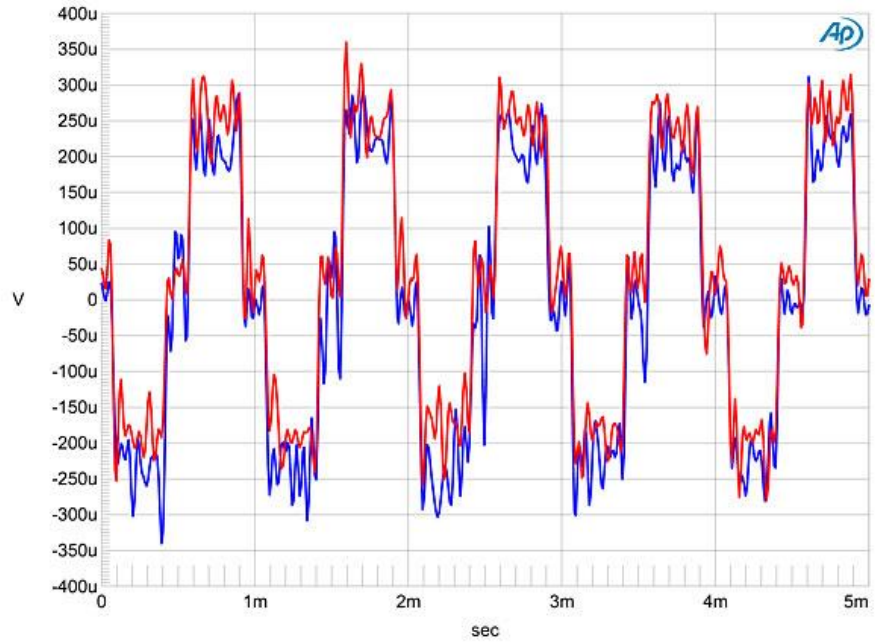

Fig.11 Aurender Flow, waveform of undithered 1kHz sinewave at –90.31dBFS, 16-bit data (left channel blue, right red).

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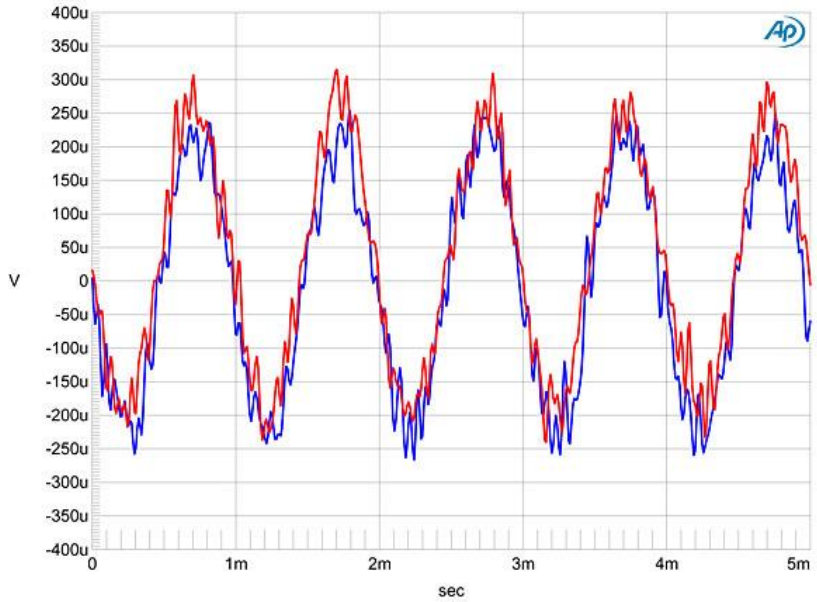

Fig.12 Aurender Flow, waveform of undithered 1kHz sinewave at –90.31dBFS, 24-bit data (left channel blue, right red).

As hinted in figs. 3 and 4, the Flow is superbly linear, a full-scale 50Hz tone into 300 ohms (fig.13) giving rise to third-harmonic distortion at –114dB (0.0002%) and an even lower level of second harmonic. With an equal mix of 19 and 20kHz tones, the sum peaking at 0dBFS, filters pcm0 and pcm2 gave a negligible amount of intermodulation distortion (fig.14), although, as expected, the

slow rolloff of pcm1 gave rise to high-level ultrasonic images of the two fundamental tones (fig.15). But actual intermodulation distortion is still extremely low with this filter.

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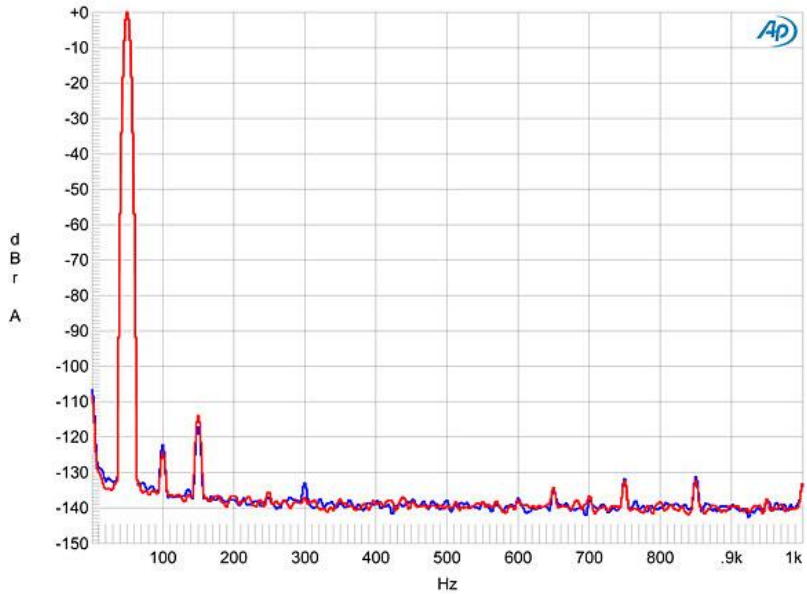

Fig.13 Aurender Flow, spectrum of 50Hz sinewave, DC–1kHz, at 0dBFS into 300 ohms (left channel blue, right red; linear frequency scale).

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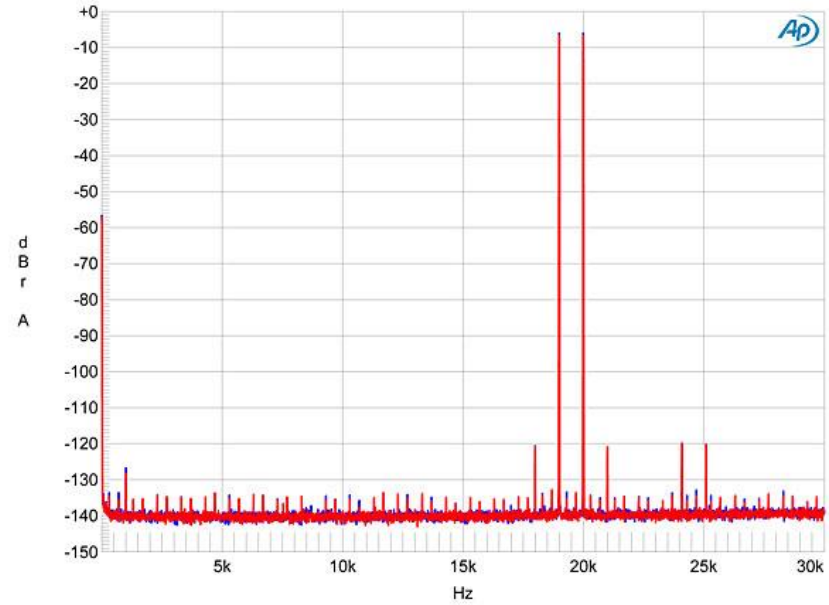

Fig.14 Aurender Flow, pcm2 filter, HF intermodulation spectrum, DC–30kHz, 19+20kHz at 0dBFS into 300 ohms, 44.1kHz data (left channel blue, right red; linear frequency scale).

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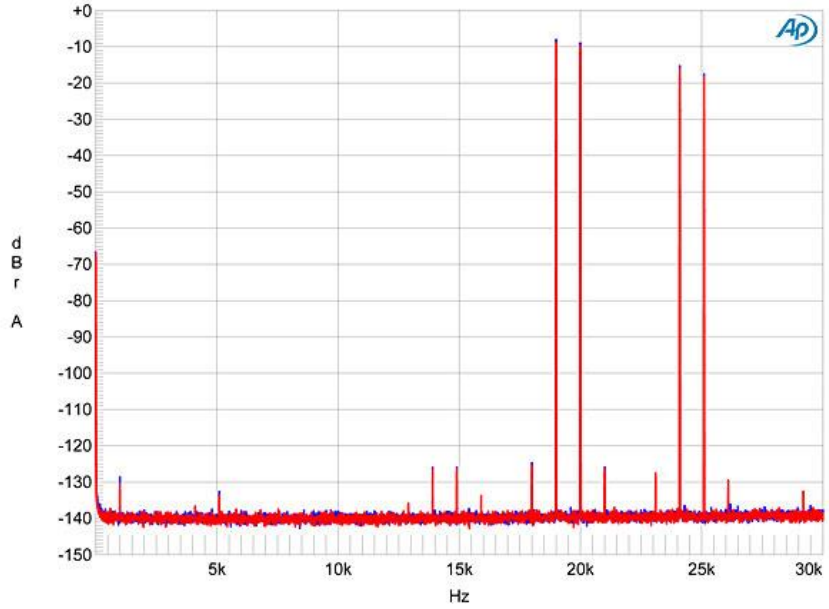

Fig.15 Aurender Flow, pcm1 filter, HF intermodulation spectrum, DC–30kHz, 19+20kHz at 0dBFS into 300 ohms, 44.1kHz data (left channel blue, right red; linear frequency scale).

All three sources—S/PDIF, USB, iOS—gave identical results when it came to rejection of jitter. Fig.16 is a narrowband spectral analysis of the Flow's analog output when fed 16-bit/44.1kHz S/PDIF data representing the Miller-Dunn J-Test signal. All the odd-order harmonics of the LSB-level low-frequency squarewave are very close to their correct levels (green line), and there are virtually no sidebands around the high-level 11.025kHz tone. There were no sidebands with 24-bit data (fig.17), though the noise floor looked more ragged than is usually the case with state-of-the-art digital processors.

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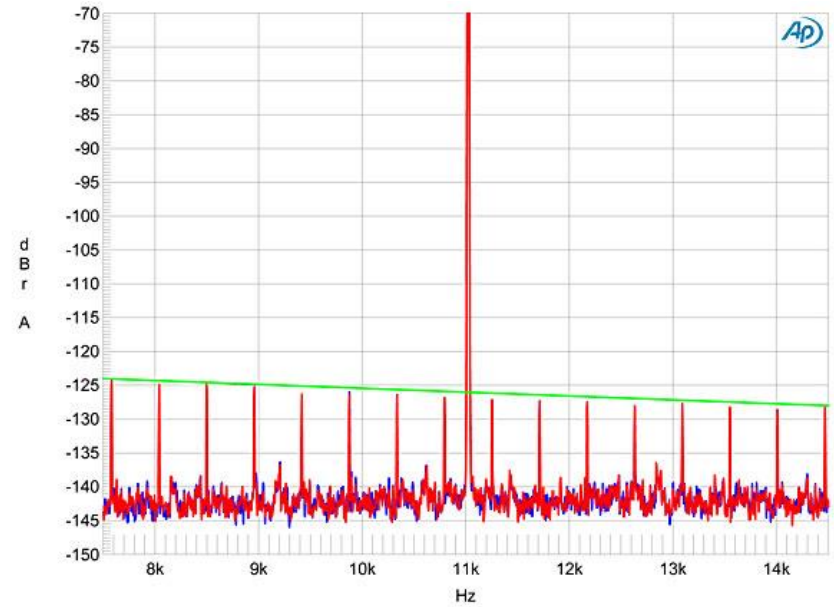

Fig.16 Aurender Flow, high-resolution jitter spectrum of analog output signal, 11.025kHz at –6dBFS, sampled at 44.1kHz with LSB toggled at 229Hz: 16-bit data via S/PDIF (left channel blue, right red). Center frequency of trace, 11.025kHz; frequency range, ±3.5kHz.

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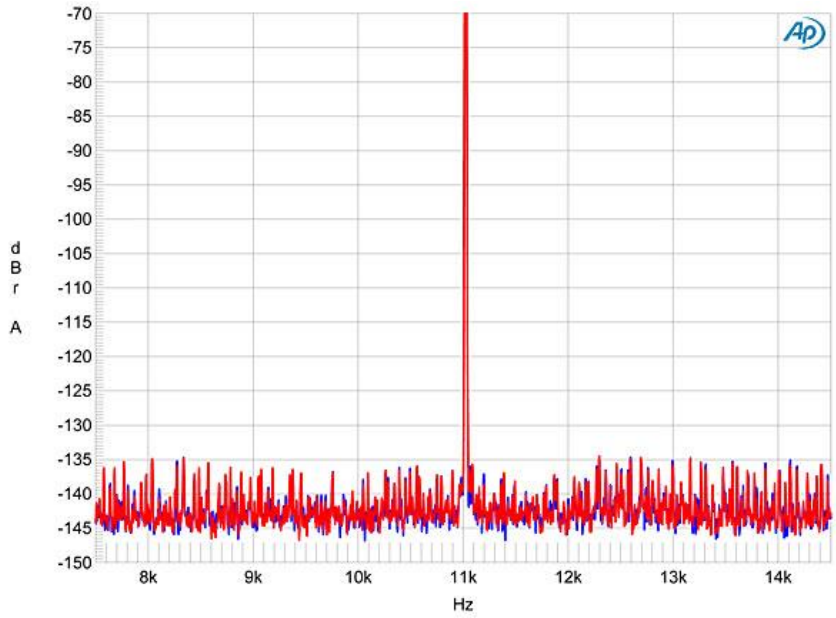

Fig.17 Aurender Flow, high-resolution jitter spectrum of analog output signal, 11.025kHz at –6dBFS, sampled at 44.1kHz with LSB toggled at 229Hz: 24-bit data via S/PDIF (left channel blue, right red). Center frequency of trace, 11.025kHz; frequency range, ±3.5kHz.

Overall, the Aurender Flow offers superb measured performance.**—John Atkinson**