

Ayre Acoustics Codex USB DAC + Headphone Amp + Digital Preamp

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Device Type: Digital to Analog Converter, Headphone Amp, and Digital Preamp

Input: Asynchronous USB 2.0 (supports up to 24 bit/384kHz and DSD128)
Toslink optical input (supports up to 24 bit / 192kHz)

Output: 1 Pair Unbalanced RCA and 1 pair XLR. Headphone Outputs: ¼ inch phone jack, two 3.5mm mini-phone jacks that support the use of one single pair of balanced headphones or two pairs of conventional single-ended headphones.

Dimensions: 2.25" wide by 9" deep, by 5.25" high

Weight: 3 pounds

Availability: Authorized Dealers

Price: \$1795.00

Website: www.ayre.com



The Ayre Acoustics Codex is the newest DAC to be released from this well known high end manufacturer located in Boulder, Colorado. Some might initially conclude that the Codex is a stripped-down version of the more expensive Ayre QB-9 DSD DAC, but they would be wrong. The Codex was derived from the design of the audio circuitry for the PonoPlayer that utilized Ayre's best technology that would fit into a battery-operated device. But the Codex goes far beyond just being a DAC; it provides a first-class headphone amplifier that Ayre claims can drive most any headphone on the market. Also present is a front-panel volume control that operates in the digital domain and retains a full 24 bits of resolution (144 dB of dynamic range all the way down to an attenuation level of -60db).



The Design

The Codex has many design features not commonly found in a DAC that retails for \$1795. One is a pure analog, linear power supply instead of the more commonly found switching power supply. Another is a custom Ayre developed Minimum Phase Filter that was developed from 4 months of listening tests with a Burr-Brown DAC chip. A fully balanced signal path throughout the analog circuitry with zero feedback is also found in the Codex. There are so many unique internal features found in the Codex that I asked Charles Hansen, Founder and Designer of Ayre Acoustics, if he would describe the advanced design elements found in this DAC:

All of Ayre's technologies are built on a four-part foundation:

1. **Zero-feedback** - essential for the elimination of timing-related errors that make music sound "reproduced" instead of real. The late Allen Wright of Vacuum State Electronics called it "Real-Time Amplification". Instead of trying to go back in time and correct for an error that has already occurred, it is essential to always have the signal move forward with as little modification as possible.
2. **Power supplies** - every electronic circuit ever devised analog or digital, audio, video, RF or computing is nothing more than a modulated power supply. The better the power supply, the better the circuit will operate.

3. **Fully-complementary analog circuitry** - complementary circuitry is only possible with solid-state. There is no such thing (in this universe) as an "anti-tube" that emits anti-matter positrons instead of electrons. Only by using complementary solid-state circuits can coupling capacitors and/or coupling/output transformers be eliminated. All capacitors and transformers color the sound. "There is no capacitor as good as no capacitor".
4. **Fully-balanced analog circuitry** - there are many misconceptions surrounding balanced circuitry. It has been used in recording studios and other professional applications for nearly a century. Long runs of cables carrying low-level (eg, microphone) signals are prone to interference from external magnetic fields, such as the AC wiring present in all modern buildings.

That has next to zero relevance to high-performance audio home audio systems. The real reason all Ayre products use fully-balanced analog circuitry from input-to-output is because that circuit will reject imperfections from in the power supply in the same way that balanced circuits in a recording studio will reject hum pickup from external magnetic fields.

Please note that each of these last two foundational points doubles the parts count of the circuit. There are 4x as many transistors in a fully-complementary, fully-balanced circuit as in an equivalent non-complementary, single-ended circuit. Obviously this is 4x as expensive as conventional circuitry, which is why it is rarely used. In addition, it requires careful matching and selection of the devices, often by hand.

Also note that although there are 4x as many active devices in a complementary, balanced circuit which the signal does not have to go through all of those devices in series. Each "stage" of a circuit makes a more powerful copy of the input signal. The more stages, the more copies and the more chances for degradation - like taking a photograph of a photograph of a photograph of a photograph...

With Ayre's complementary, balanced circuitry, the additional devices are all in parallel with each other (like parallel processing in a computer), so there are no extra steps required as the signal makes its way from the input to the output. All four branches propagate simultaneously.

Built on this four-part foundation are three distinct innovations that comprise the Codex. In the chronological order in which they were introduced, they are:

- a. **EquiLock** - is Ayre proprietary way of stabilizing the operating conditions of the active amplification devices in the analog circuitry. It is a specific type of cascode (of which there are many), and implemented in a non-conventional way with all parameters fine-tuned via critical listening evaluations for the best possible sound quality.

b. **Diamond Output (line-level)** - the "diamond buffer" was conceptualized by Richard Baker (most famous for "the Baker clamp") of MIT in the 1950s before the required complementary devices were even available. He patented the circuit in 1967. A diamond buffer is a way of connection two pairs of complementary emitter-followers such that the first pair of devices provides the bias current for the second pair.

Doing so eliminates the need for a separate bias circuit. In our evaluations we have found it to sound better than the commonly-used alternatives. This is likely due to the fact that the two complementary halves are coupled together more tightly, creating a more faithful replica of the input - kind of like a single-ended triode. There are two disadvantages of a diamond buffer:

- i. It is more complex, requiring additional circuitry, PCB space, and expense.
- ii. If the current gain of two emitter-followers is required in a specific application, the first one is normally much smaller than the second one, with smaller, less-expensive parts required. The diamond buffer demands that all four devices be operated with identical currents. This leads to a near doubling of the power requirements and heat dissipation.

In the Codex, we have found that our carefully optimized, proprietary variation of Baker's diamond buffer (called the "Diamond Output") sounds better than any other output stage we have tried. The extra power and heat required for a line-level device is why the Codex runs warm.

c. **AyreLock** - Ayre has always used discrete, zero-feedback regulators for all analog circuitry and critical digital circuitry. In contrast, conventional products use so-called "three-pin" regulators that are very high gain, very high feedback ICs with extremely limited bandwidths that distinctly colors the product's sound.

The (current) culmination of this technology is called the "**AyreLock**" because the regulator "locks" the output voltage in a radical new way. Conventional regulators add an adjustable resistance in series with the audio circuit (load for the power supply). If the audio circuit draws more current, the regulator's resistance is lowered to keep a constant voltage at the output of the regulator.

Please note that a conventional regulator can only pull the output voltage "up" (higher). It cannot pull it "down" (lower). This type of regulator is called a series regulator and is found at least 99% of the time. A few designs use a shunt regulator that essentially has the opposite set of virtues. It can pull the output voltage of the regulator "down" (lower), but not "up" (higher). Furthermore it is less efficient and creates waste heat.

NB - Switching power supplies are invariably series regulators that simply operate at very high frequencies using pulse-width modulation. Again, they can only pull the output "up" (higher), and not down.

The **AyreLock** regulator has a push-pull output stage that can both pull the output "up" (higher) when the audio circuit draws more current, and also "down" (lower) when the audio circuit draws less current. This dual action regulator is a radical breakthrough in power supplies and moves the performance mark forward greatly.

Operating the Codex

I found that the operation of the Codex was highly intuitive and quite simple with its three-digit display. A volume control is found on the front panel with ranges from 0 to 100 in 1.0 dB steps with a built-in mute and setup menu that is activated by pressing the knob. Pressing the volume control for 3 seconds will enter the setup menu of the

Codex allowing Input Mode selection of USB or Toslink. Output Mode has a Preamplifier selection that activates the volume control and a DAC Mode that bypasses the volume control. Mute is activated by a quick pressing of the knob.

Display Brightness can be controlled in 3 steps as well as an Off selection.

When headphones are plugged into the 3.5mm mini-plugs, the Codex will ask you to select either Shared Mode for two headphones or Balanced Mode for balanced headphones by rotating the knob and then pressing the knob for your selection.

The Firmware Version can also be displayed.

An LED is illuminated on the front panel to indicate if the Codex is running in balanced operation.

Associated Components Used in This Evaluation

I did most of my listening using a MacBook Pro 2.3 GHz, 16 GB RAM with Samsung SSD that was used with 2 GRAID Thunderbolt drives for the music libraries; one for PCM and the other for DSD files. OSX El Capitan was the operating system. For music software, I used Channel D's excellent Pure Music 3.03 that did a wonderful job revealing the acoustic properties of the Codex.

The GRAID Thunderbolt drives were powered by HDPLEX linear power supplies. One component that has made a big difference in the performance of my system was the Shunyata Research Hydra DPC-6 ver 2 Power Center. The DPC-6 filters the digital noise placed back on the AC line from the computer by effectively firewalling it. This allowed me to get a truer impression of the Codex's true sound. The MacBook Pro and the hard drives were plugged into the DPC-6. The Codex was plugged into a Shunyata Hydra Triton ver 2. Shunyata Sigma and Alpha AC cables were utilized in this evaluation.

The primary USB cable employed was the AudioQuest Diamond. I also did listening with the Synergistic Research Galileo LE and Kubala-Sosna Realization USB cables.



Impressions of the Sound of the Codex

My initial listening was done with the Codex connected to my Ayre KX-R preamp with balanced cables. I did find that the use of balanced outputs sounded a little better than with the single-ended outputs. As I listened to the Codex for an extended period of time, I began to realize that I was totally engaged in the music and not concentrating on picking the sound apart. This DAC drew me into the music unlike any other DAC in its price range, or for that matter, DACs costing far more. But let's take a closer look at the particulars of how this DAC sounded in my system.

The general sonic balance from top to bottom was as neutral as I've heard on a DAC. There was no particular emphasis to the sound or midrange / high end brightness. Bass was very well defined and controlled with good visceral grip delivery when called upon. The Codex was able to reproduce a realistic soundstage when provided with well recorded music. Besides having good sided-to-side dimensionality, it also had good front-to-back depth; something that is often found lacking in DACs of this price range.

Good dynamic reproduction is important and necessary for engaging playback. The Codex had no problem reproducing macro and micro dynamic changes. Vocalists and instruments were well portrayed in the soundstage with the presence of the recording venue's acoustic space. Background silence was also very good allowing one to hear the finer soundstage qualities of recordings.

There was a sense of richness to the sound without digital hardness or coolness. The Codex was able to unravel and reproduce complex musical passages with an ease often found in far more costly DACs. Music simply flowed from the Codex in a relaxed manner that encouraged long term listening sessions.

The Codex was equally at home playing PCM or DSD. Going from one format to another was silent with no extraneous noises. Not only was the PCM playback very good, but I was equally pleased with the sound of DSD 64 and DSD 128 files.

While the Codex gets quite warm to the touch when playing, I never encountered shut down or other faults even with long continuous playback for break-in purposes.

The Codex Soared with the AudioQuest NightHawk

AudioQuest was kind enough to loan me a pair of their NightHawk headphones for use with the Codex. Given that the Codex offers a pair of balanced 3.5mm mini-phone jack outputs, I was able to take full advantage of the Codex's output capabilities with the balanced cables provided from AudioQuest.

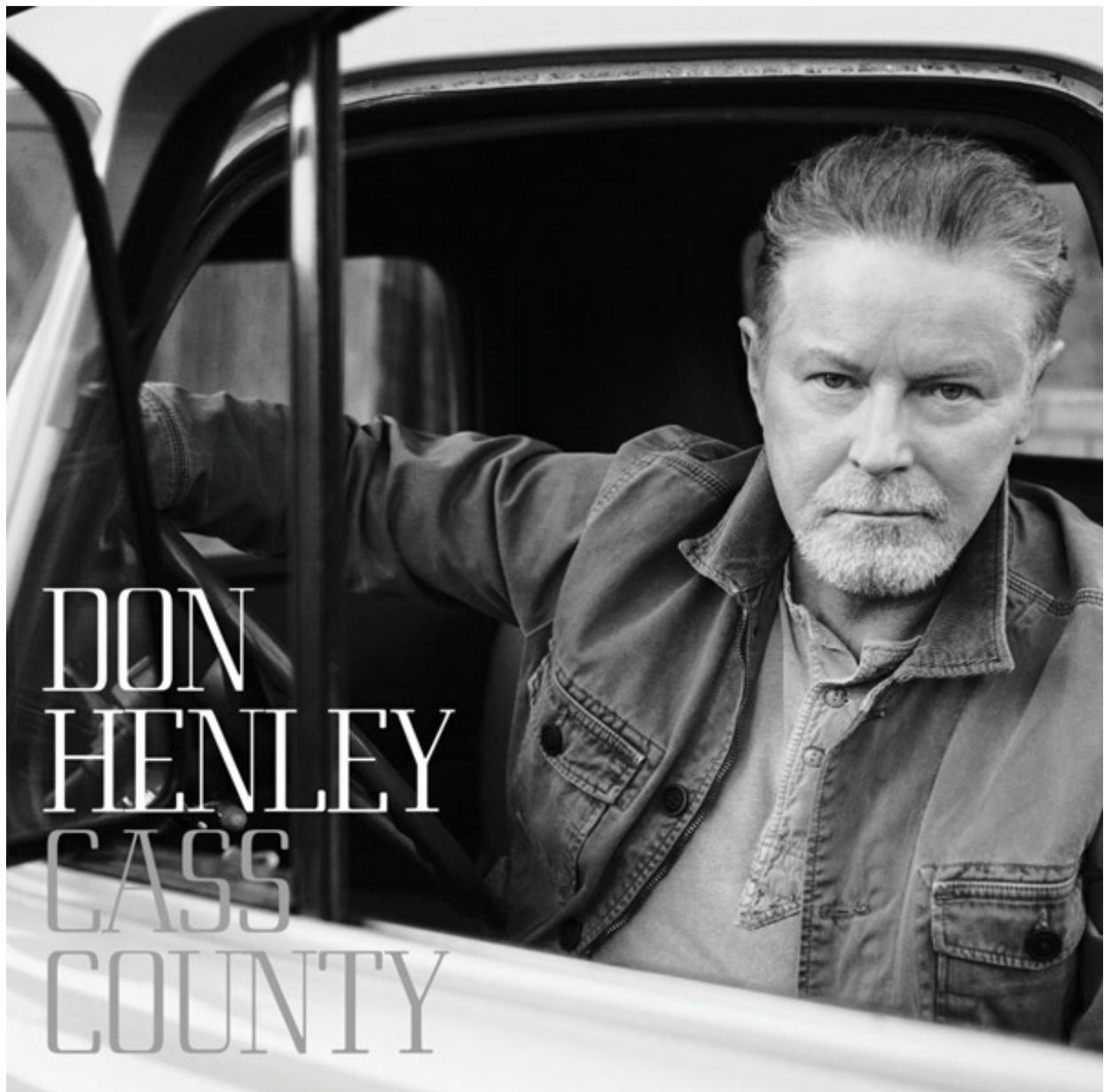
The Codex sounded superb driving the NightHawks. The wonderful balanced sound I previously mentioned allowed the NightHawks to sound neutral with no increased warmth or overemphasis of high end definition. The Codex displayed very good focus and soundstaging with the NightHawks.

The NightHawks are the most comfortable headphones I have yet experienced allowing long, non-fatiguing listening sessions with the Codex. The Codex had no trouble driving these \$599.00 headphones to satisfying volume levels for this listener. I did try the NightHawks with single-ended cables; but I found the balance, definition, and soundstaging were superior with the balanced cables. Also, the NightHawk needs a great deal of break-in to reach its full sonic potential. AudioQuest recommends up to 150 hours. Without this break-in period, the NightHawk sounds somewhat closed down at the high end, warm, and dynamically constricted.

Given a good set of headphones like the AudioQuest NightHawks, the Codex will provide an outstanding audiophile headphone experience.

The Codex's Digital Preamp

I connected the balanced outputs of the Codex directly to my Ayre MX-R amps. I was surprised at just how good the Codex sounded with direct amp playback. Even though I preferred listening with my Ayre preamp, I found the sound with the Codex volume control to be very nice; as good as or better than any other DAC I have heard with a digital volume control. I heard no obvious degradation of music playback with the direct balanced connection.



A Satisfying Musical Experience

I enjoyed listening to Don Henley's new release *Cass County* (24/96). Eagle fans will probably love this album as much I did. The Codex provided a relaxed presentation that complemented the country music on this album. There was an immediacy and palpability to the sound with good reproduction of instrument textures.



I loved what I heard with David Benoit's new album featuring vocalist Jane Monheit. This 24/96 recording was cut live in the studio resulting in an exciting performance with great sound. The Codex was able to capture every inflection and nuance of Jane's vocals. I heard good image solidity with a life-like sense of instrumental body and weight with the Codex.



Manfred Honeck conducting the Pittsburgh Symphony Orchestra (Reference Recordings DSD 64) of the Bruckner: Symphony No. 4 allowed the Codex to reproduce a large soundstage with a wonderful sense of bloom around the instruments. The Codex was able to resolve low level information, but yet had no difficulty reproducing the full authority and weight of the orchestra. The ambience of the Heinz Hall for the Performing Arts was captured and reproduced by the Codex with a richly layered soundstage. The Codex was superb in its ability to play back complex orchestral passages without a trace of hardness.



An Unexpected Sonic Result

When I first began reviewing the Codex, I thought that I would be experiencing a fine headphone amp with a DAC included as an extra feature. What I discovered was that the Codex is a first-rate DAC that sounds as good as or better than DACs costing far more in price. The Codex can easily form the basis of a first-rate high end system. I now view the excellent headphone amp and digital volume control as bonus features that match the sound quality of the Codex. I feel that Ayre has accomplished something very special in the design of the Codex that will force other DAC manufacturers to improve their products or fall behind. Given the price, performance, and features found in the Codex, I feel it is the most significant product I have reviewed in 2015.

[Associated Equipment](#)