AUDIO ENGINEERING HI FI TECHNOLOGY

Engineering Excellence in High-Fidelity Audio: A Technical Analysis of the Cambridge Audio Azur 851 Series and Digital Signal Processing

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The landscape of high-fidelity (Hi-Fi) audio engineering is defined by a constant pursuit of signal purity and the elimination of harmonic distortion. Since its inception in 1968, **Cambridge Audio** has maintained a pivotal role in this pursuit, evolving from the legendary P40 integrated amplifier to the sophisticated **Azur 851 series**. This flagship range represents a culmination of decades of research into Class XD amplification, adaptive time filtering (ATF2) upsampling, and robust power delivery systems. Understanding the technical architecture of these components is essential for audiophiles and systems engineers seeking to optimize sonic performance in high-resolution environments.

The Evolution of the 'Great British Sound' Philosophy

To analyze the **Azur 851 series**, one must first understand the foundational philosophy of the 'Great British Sound.' Unlike the 'American sound,' which often emphasizes bass extension and high-energy dynamics, or the 'Japanese sound,' which historically focused on clinical precision, the British approach prioritizes mid-range transparency and a natural, uncolored representation of the original recording. Cambridge Audio has refined this approach by integrating modern **Digital-to-Analogue Converter (DAC)** technologies with traditional analog amplification circuits.

The transition of manufacturing processes—moving from local UK production to high-quality facilities in China—marked a significant shift in the industry. As noted in technical assessments of the global audio market, China has emerged as a primary hub for precision audio manufacturing. This shift allowed Cambridge Audio to implement high-grade components, such as **toroidal transformers** and **dual-differential DAC configurations**, at scale without compromising the engineering integrity established in their London-based research and development center.

Core Concepts: Class XD Amplification and Crossover Displacement

The hallmark of the **Azur 851A** and **851W** is the proprietary **Class XD (Crossover Displacement)**amplification system. To appreciate this technology, we must evaluate the traditional trade-offs between Class A and Class AB topologies.

- Class A: Known for zero crossover distortion, but suffers from extreme thermal inefficiency and low power output.
- Class AB: Offers high efficiency but introduces crossover distortion at the point where the waveform transitions between the positive and negative output transistors.

Technical Mechanism of Class XD

Class XD is not simply a marketing term; it is a unique circuit design that applies a controlled displacement current to the output stage. By shifting the crossover point away from the zero-crossing of the audio signal, the system ensures that the transistors do not switch states at the point where the signal is most sensitive to distortion. This results in the sonic purity of Class A operation during low-level signals, while maintaining the efficiency and thermal

management of Class AB at higher volumes. The mathematical model for this involves a constant current source that biases the output stage, effectively moving the 'non-linear' switching region to a point where the signal voltage is significantly higher, thereby masking the distortion within the signal's own energy.

Digital Signal Processing: ATF2 Upsampling and Jitter Suppression

In the digital domain, represented by the **Azur 851N Network Player** and the **DacMagic 200M**, the primary challenge is temporal accuracy. Digital audio is susceptible to **jitter**—timing errors in the sampling clock that manifest as harshness and a loss of spatial imaging in the analog output.

The ATF2 (Adaptive Time Filtering) Algorithm

Developed in collaboration with Anagram Technologies, the ATF2 system upsamples all incoming digital data to **24-bit/384kHz**. This process utilizes a polynomial curve-fitting model to interpolate new data points between existing samples. The technical benefits include:

1. Harmonic Jitter Suppression: By using a high-performance 32-bit Analog Devices Blackfin DSP (Digital Signal Processor), the system effectively removes timing errors from the input signal.
2. Noise Floor Reduction: Upsampling moves the quantization noise significantly higher in the frequency spectrum, allowing for a shallower, more linear analog filter that does not introduce phase shift in the audible range.
3. Bit-Perfect Playback: Ensuring that the integrity of the source file is maintained while providing the DAC with the highest possible resolution data stream.

Component Analysis: Comparison of the Azur 851 and Mid-Range Series

The following table provides a comparative matrix of key technical specifications across the Cambridge Audio spectrum, including the **Azur 851 series** and the mid-tier **Azur 550A/651A** models.

Feature/Model	Azur 851A (Integrated)	Azur 851W (Power Amp)	Azur 651A (Legacy)	DacMagic 200M
Amplifier Class	Class XD	Class XD (Dual Mono)	Class AB	N/A (Pre-amp/DAC)
Power Output (8:'•	120W per channel	200W per channel	75W per channel	N/A
DAC Chipset	None (Analog)	None (Analog)	Burr-Brown PCM1791	Dual ESS ES9028Q2M
THD (unweighted)	< 0.001% @ 1kHz	< 0.001% @ 1kHz	< 0.002% @ 1kHz	< 0.0005%
Input Structure	XLR Balanced / RCA	XLR Balanced / RCA	RCA / USB Audio	USB, Coax, Optical

The Architecture of the Azur 851N Network Player

The **Azur 851N** serves as the digital pre-amplifier hub. Its architecture is designed to handle a wide array of digital inputs, from high-resolution NAS (Network Attached Storage) drives to streaming services via the **StreamMagic** platform. The internal signal path is fully balanced, which is crucial for minimizing electromagnetic interference (EMI) in a device that contains both high-frequency digital processors and sensitive analog output stages.

Inside the 851N, the **Dual Differential DAC**configuration uses two separate DAC chips—one for the left channel and one for the right. This increases the dynamic range and improves the Signal-to-Noise Ratio (SNR) by 3dB. When signals are processed in a dual-differential mode, common-mode noise is cancelled out at the summation stage, leading to an exceptionally black background (low noise floor), which is vital for resolving micro-dynamics in classical and acoustic recordings.

Mechanical Design and Thermal Management

High-power amplifiers like the **Azur 851W** generate significant heat due to the bias current required for Class XD operation. The chassis design utilizes an **Acoustically Damped Metal (ADM)** framework. This involves a heavy-duty, multi-layered metal structure that resists mechanical resonance. High-fidelity audio components are susceptible to **microphony**, where mechanical vibrations are converted into electrical noise by capacitors and other components. By using an ultra-rigid chassis and dampened feet, the 851 series minimizes this risk.

Furthermore, the **CAP5 protection system**is integrated into the 851A and 851W. This is a non-invasive protection circuit that monitors the following parameters without placing components in the direct signal path:

- DC Detection: Prevents damage to speakers from direct current leaks.
- Over-Temperature: Shuts down the unit if ventilation is obstructed.
- Over-Voltage/Current: Protects against short circuits at the speaker terminals.
- Clipping Detection: Alerts the user if the amplifier is driven beyond its linear limits.

Practical Implementation: Integrating the SX-50 and Legacy Systems

While the 851 series represents the high-end, it is often paired with different tiers of transducers, such as the **Cambridge Audio SX-50** bookshelf speakers. In a technical implementation scenario, matching the output impedance of the amplifier to the sensitivity of the speaker is critical. The SX-50, with its matte black finish and

compact form factor, is designed for near-field listening. When driven by a high-current source like the **Azur 550A** or 851A, the importance of the **damping factor**becomes evident. A high damping factor ensures the amplifier can control the motion of the woofer cone, preventing 'overhang' and ensuring tight, articulate bass response.

Step-by-Step System Optimization Procedure

1. Signal Path Verification: Ensure balanced (XLR) cables are used between the 851N and 851W to leverage the common-mode rejection benefits of the balanced circuitry.
2. Phase Alignment: Verify that the positive and negative terminals on the amplifier match those on the SX-50 speakers precisely to prevent phase cancellation.
3. Digital Source Configuration: Set the computer or streamer output to 'Bit-Perfect' or 'Exclusive Mode' to bypass the operating system's internal mixer, ensuring the DacMagic 200M receives the raw data stream.
4. Ground Loop Elimination: If hum is present, utilize the 'Ground Lift' switch often found on Cambridge Audio digital components to isolate the signal ground from the chassis ground.

Case Studies: Troubleshooting Common Operational Challenges

In high-fidelity environments, technical failures often stem from environmental factors rather than hardware defects. Two common case studies are examined below.

Case Study 1: Thermal Triggering in the Azur 851A

Symptom: The amplifier shuts down after 30 minutes of high-volume playback. **Analysis:** Class XD operation generates more heat than standard Class AB. If the unit is placed in a cabinet with less than 10cm of overhead clearance, the CAP5 system triggers an over-temp shutdown.**Solution:**Relocation to an open rack and verification of the speaker impedance. Low-impedance speakers (4:'' G aw more current, accelerating heat buildup.

Case Study 2: Jitter-Induced Audio Dropouts in the 851N

Symptom: Intermittent 'clicks' or silence when using an optical (Toslink) connection from a television.**Analysis:** Many televisions output a high-jitter SPDIF signal that exceeds the locking range of high-performance DACs designed for audio precision.**Solution:**Switching to a high-quality coaxial cable or utilizing the DacMagic 200M's adjustable digital filters can sometimes broaden the locking window, though the primary fix involves using a dedicated reclocker or a higher-quality source interface.

The Significance of Toroidal Transformers

A major technical differentiator in the Azur series is the use of **oversized toroidal transformers**compared to standard laminated EI transformers found in entry-level equipment. Toroidal transformers offer several advantages:

- Low Magnetic Flux Leakage: They do not radiate electromagnetic interference to nearby sensitive low-level audio circuits.
- Higher Efficiency: They provide more power relative to their physical size.
- Instantaneous Current Delivery: The low output impedance of a toroid allows the amplifier to handle sudden musical peaks (transients) without voltage sag, maintaining the dynamic headroom.

In the **Azur 851W**, the use of two such transformers in a **Dual Mono**configuration ensures that the power draw of the left channel does not affect the voltage stability of the right channel, maximizing stereo separation and soundstage depth.

The technical sophistication of the Cambridge Audio ecosystem—from the high-resolution processing of the **DacMagic 200M** to the refined power of the **Azur 851 series**—demonstrates a comprehensive understanding of

both electrical engineering and psychoacoustics. By addressing the fundamental issues of crossover distortion, digital jitter, and mechanical resonance, these components provide a transparent window into the recorded performance. As the industry moves further into the era of high-resolution streaming, the integration of robust analog foundations with advanced digital filtering remains the benchmark for audiophile-grade reproduction. The legacy of the Azur series continues to serve as a reference point for how modern engineering can preserve the nuance of the 'Great British Sound' in a globalized manufacturing context.

Tags: #Cambridge Audio #Azur 851 Series #Class XD Amplification #DacMagic 200M #High Fidelity Audio #Digital to Analog Converters