



A DAC THAT AMPLIFIES

Imagine if you could hook up your speakers directly to your digital source component, be it a CD or high-res audio file. Just think how much cleaner the sound would be without the preamp, power amps and all the cables connecting everything together. In the past, DACs could only work at line level and required careful electronic matching to the requirements of downstream analogue devices in order to get good performance. Now, NAD has devised a super DAC that can directly drive loudspeakers with very high power levels and yet still have the precision of the very finest line level DACs. How is this possible?

THE EVOLUTION OF AMPLIFICATION

In the beginning, amplification was achieved by mechanical means; a wave guide or horn was used to focus the sound and make it louder. Then, nearly 100 years later with the invention of the microphone and

loudspeaker, the signal was captured and reduced to a tiny electrical waveform that could then be amplified using a thermionic tube to be reconstituted via the loudspeaker to an approximation of original sound. Now, in this electrical form, the sound could be transmitted over long distances paving the way for telephony and radio broadcast. Later, transistors were substituted for tubes with the benefits of lower energy consumption and infinitely longer service life. These devices became more precise with years of development, but the principal of amplification was still the same. Most recently however, the recording and delivery system changed drastically. By digitally sampling the electrical waveform, unprecedented flexibility for storage and delivery without signal degradation is now possible. DirectDigital is the next step forward, eliminating all analogue circuits completely. With NAD DirectDigital the conversion from digital data stream to electrical waveform occurs right at the speaker output jack of the amplifier; up to that point the signal remains in the digital domain.



CLOSED-LOOP VS. OPEN-LOOP

Try putting a key in a key slot with your eyes closed; that's an open-loop system. Open your eyes and you have instant visual feedback on the position of your hand as you move the key toward the slot with a result that is faster and more precise. The same principle applies in amplifiers. Open-loop designs have no way to compensate for the inevitable errors caused by the imperfect active and passive components that must be used to create an amplifier. In the 1930s, as Bell Labs struggled to send telephone communications over longer and longer distances, they developed the concept of the closed-loop amplifier. By comparing the output to the input, any non-linearity introduced by the circuit could be corrected using Harold Stephen Black's 1927 invention, Stabilized Negative Feedback.

DirectDigital™ FEED BACK

Black's invention worked very effectively and has become universal in its application to linear amplifiers, both tube and transistor. Unfortunately, negative feedback is too slow to effectively compensate for the non-linearities of a switching amplifier. As a result, switching or Class D amplifiers have not been able to achieve the same performance as the best linear amplifiers – until 2005. Zetex Semiconductors, based in Manchester, England, developed a closed-loop switching amplifier concept in 2003 called, the Direct Digital Feedback Amplifier. NAD became involved in the development in 2005 and introduced the world's first closed-loop digital amplifier in 2009, the Masters M2 DirectDigital Amplifier. Now, at last, we have a pure digital amplifier that meets, and even exceeds, the best performing linear amplifiers. And because with a closed-loop design we can compensate for the less-than-perfect semiconductors and passive components required in an amplifier, we can now create cost effective designs with cost-no-object performance.

A NEW AUDIO SYSTEM ARCHITECTURE

DirectDigital. The source material is digital, the signal processing is digital, and the amplification is digital. By removing many layers of analogue circuitry and digital conversions, the music reveals its true vibrancy and intimacy. This is the audio system architecture of the future.

Let's look at just one aspect of system performance to show the superiority of DirectDigital: signal-to-noise ratio. Noise is non-musical sound added by the amplifying process. Let's compare the noise performance of a cost-no-object linear system with the M32.

FIGURE 1. State-of-the-Art Analogue System

DAC – 123dB	Preamp 108dB	Power 102dB	Ref. 200 watts	107.1dB SNR
Noise 1.78uV	Noise 3.98uV	Noise 22.5uV	Amplified x 40	Noise 178.4uV

In Figure 1, this 107.1dB figure is referenced to full power; restating it with a 1W reference (a more typical listening level) gives a figure of 84.1dB. Since much of the noise is residual, meaning it is constant regardless of volume level, it can easily be 10dB worse at 74.1dB. Keep in mind, these figures represent the best that is possible with this system architecture using the most exceptional analogue components; most systems are likely to be another 10dB worse or about 65dB.

FIGURE 2. M32 DirectDigital Amplification System

DAC/Amplifier	125.0dB SNR
Ref. 200 watts	Noise 22.38uV

In Figure 2, this 125dB figure is referenced to full power; restating it with a 1W reference gives a figure of 95dB. This is at least 15dB and as much as 25dB better than the old analogue system architecture.

This nearly total lack of noise is immediately audible as a silky black background against which instruments vividly stand out in three dimensions. The additional dynamic range exposes small details in the music previously obscured by noise. The effect is similar to some of the latest HD TVs with super high contrast ratios, capable of revealing fine details in the black images.



MODULAR DESIGN CONSTRUCTION

By placing most of the inputs on easily replaceable modules, NAD's MDC concept allows for customisation and future updating as new digital formats are developed. We already have three MDC Modules developed: an Asynchronous USB, an I2S via HDMI, and an Analogue Line and Phono module. The USB module is factory installed, while the HDMI and Analogue modules are dealer installed options. Because the M32 is a 'software defined' product, it is possible to add future functionality and features with a simple and easy software upgrade via USB memory stick.

DIGITAL TOOLBOX

Due to the processing power and memory built into the M32, there are some interesting features not normally found on stereo amplifiers. Sure, there are the expected controls like bass, treble, balance, and stereo/mono listening mode. However, unlike with analogue amplifiers there is no performance penalty to using these controls because they are all performed in the digital domain using DSP. Some additional goodies in the toolbox include polarity, speaker compensation, and a setup selector that allows renaming of inputs and the option of not showing inputs that do not have anything connected. Speaker compensation makes small adjustments to the top octave to offset the interaction of the M32's reconstruction filter with the connected loudspeakers tweeter impedance. There is also a digital domain crossover network with selectable frequency corners to allow bi-amping or the addition of mono or stereo subwoofers.

GREEN POWER

Perhaps it is icing on this audiophile cake, but the M32 also uses far less power in operation than the most common Class AB (not to mention extremely power hungry Class A and tube amplifiers) amplifiers and consumes less than 0.5 watts in standby mode. It also uses less metal and weighs far less than a linear amplifier of similar performance. This means less fuel used to deliver the M32 and less material to recycle at the end of its useful life.

PRICE/PERFORMANCE RATIO

You could spend double the price of the M32 for a comparable DAC, and four times the price for an amplifier/preamplifier, and still not approach the measured performance of the M32. An outboard electronic crossover with similar performance could cost as nearly as much as the M32, and none of these products would have the future-proof flexibility of MDC. The system of the future is DirectDigital with money to spare for purchasing the best possible loudspeakers.

Music has gone digital. Is your playback system still analogue? Now is the time to update, upgrade and upend your preconceived notions of what a music system looks and sounds like.

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