



Amplifier Perfection

In 2009, NAD introduced the world to what was termed by the press as a “new amplifier paradigm” in the Masters M2 Amplifier; essentially a DAC that amplifies and uses noise shaping error correction – a digital form of negative feedback – to reduce distortion across the band. Making the error correction work properly led directly to a DAC architecture with amazing linearity, extremely wide dynamics, and performance that is almost totally free of jitter, the timing errors that plague all conversions from digital-to-analogue. Many audiophiles blame jitter for the poor sound quality often associated with ‘digital sound.’ Several other highly acclaimed NAD models have used the DirectDigital™ process to attain award-winning performance. NAD DirectDigital, using CSR’s patented DDFA technology, remains a core technology used in many NAD products including the new companion M12 DirectDigital Preamp/DAC and the award-winning M51 DirectDigital DAC.

But we never rested on our laurels and NAD’s Director of Advanced Development, Bjorn Erik Edvardsen, identified a very unique and promising new technology being developed by Hypex Electronics in the Netherlands. While the idea for a self-oscillating Class D amplifier had been around for many years, nobody could perfect it to an acceptable performance level before Hypex introduced the amazing UcD concept in the early 2000s. Unlike DirectDigital, which starts with a digital signal and uses active digital processing to perform error correction, the UcD concept is a switching analogue amplifier with all parameters highly optimized to allow self-regulation. The all-discrete driver and output stages have extremely low open-loop THD as well as low idling losses, normally conflicting requirements with conventional IC driver circuitry. An added control loop incorporating an integrator with adaptive clipping enables 20dB more feedback to be used across the audio band because of its extremely low phase shift, resulting in a dramatic reduction in distortion across the audio band. This is in addition to UcD’s already amazing characteristics of load invariance and high current capability, common characteristics of great sounding amplifiers.

Although there are many examples of amplifiers with poorly executed feedback to reinforce the negative reputation, most of today's best amplifiers rely on feedback to linearize response, reduce noise and distortion, and increase damping factor – all positive performance attributes. Only badly designed or poorly executed amps with high feedback sound bad. Giving feedback a bad name was a generation of high negative feedback amps with very low THD, but with other serious shortcomings like high Transient Intermodulation Distortion (TIM), inadequate current capability and badly distorting protection systems. The bad sound was erroneously blamed on the high negative feedback.

The shortcomings of poorly executed negative feedback were clearly detailed by Matti Ojala in the 1970s with his AES papers describing a measurement technique for identifying Transient Intermodulation Distortion or TIM. Rather than perfecting the use of negative feedback, these findings led many designers to reduce the amount of feedback and therefore accept much higher levels of THD. This reaction by the designers threw out the "good" with the "bad." Although NAD experimented with a zero feedback design in its S300 Integrated Amplifier in the '90s, we found more success in developing high current amplifiers using smaller amounts of localized feedback to reduce phase shift and achieve both low TIM and low THD. As long as there is no internal overload in worst case loads (<2 Ohms) across the musical spectrum, and no nasty current or VI limiting, we have used as much as 30dB of negative feedback to obtain 0.004% THD at 20kHz into 4 Ohms. While this is achievable in a Class AB output stage, Class D has opened up the possibility of using even higher levels of feedback without any of the shortcomings we faced in the Class AB world.

Of course, the output stage is only one of several circuits in the amplifier, and each must compliment the other to obtain optimal performance. Part of what makes NAD's HybridDigital architecture so appealing is the way it handles digital source material. By carefully engineering every aspect of the signal path the end result can actually surpass the individual parts of the circuit. Using multiple DAC channels to create a dual-differential circuit is just one of the clever solutions developed to gain exceptional performance from every part. Inverting one channel relative to the other as it passes through the amplifier, then recovering the correct polarity at the output is another, in what we term as Asymmetrical PowerDrive™. This innovative circuit optimizes the overall power available by distributing the internal loading more efficiently.

The new C 338, C 368 and C 388 amplifiers are DC coupled throughout, from input to output, with no capacitor at all in the forward signal path. Control for the Asymmetrical PowerDrive is derived by sensing the average output power, applying a time constant, and then cleanly hard clipping the signal, thus limiting

it to the rated continuous clipping power over a sustained loading. By controlling the power envelope we obtain maximum clean power for every operating condition.

The performance of the entire signal path is critically dependent on the power supply; in this case a well regulated, but not too tight, custom switch mode design. This allows maximum dynamic power and a very high current yet with very low distortion at all times and under all operating conditions. Some key features of this NAD-developed supply include:

1. High efficiency over a very wide operating range, including <0.5W in standby (about 150mW).
2. Very low conducted and radiated EMI.
3. Very low acoustic noise unlike most other high power switch mode supplies at high power.
4. Synchronous rectification for low losses and the elimination of supply pumping.
5. Low complexity, simple topology circuit for high stability and reliability with the design specially adapted for optimal performance with nCore amplifier output stages.
6. Safety Class 2 insulation (double isolation).
7. Sophisticated protection with hiccup mode.

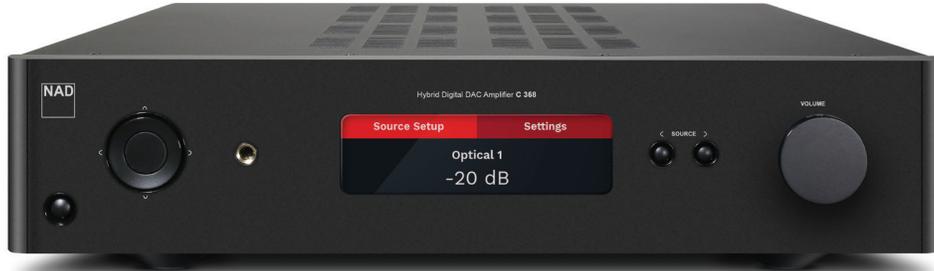
The electronic protection is unique and acts much faster than relay protection, and in comparison allows only a small amount of energy to reach the speaker before the supply shuts down.

The most amazing characteristic of these new NAD HybridDigital amplifiers is the uniform excellence of all important performance criteria under every operating condition. While measurements don't tell the whole story of amplifier sound quality, all great amplifiers share certain common characteristics. Including, low IM distortion at all operating powers and load conditions, harmonic distortion low in level and dominated by 2nd and 3rd harmonics, high signal-to-noise ratio, clean clipping behavior with instant recovery, wide flat frequency response, high current capability and stability into low impedance loads. The new Classic amplifiers do all this and more to provide a distortion-free view into the musical recording with highly accurate expression of musical detail and space. The sound is completely neutral and fatigue-free even when listening at very high sound pressure levels. Complete control of complex loudspeaker loads makes it possible to partner these Classic Series amplifiers with the world's best sounding loudspeakers. High efficiency and low power consumption is just icing on the cake.

C 338
Hybrid Digital
Intergrated Amplifier



C 368
Hybrid Digital
DAC Amplifier



C 388
Digital
DAC Amplifier



Specifications

Model	C 338	C 368	C 388
RMS Power 4/8	50W (at rated THD, 20-20kHz, both channels driven)	80W (at rated THD, 20-20kHz, both channels driven)	150W (at rated THD, 20-20kHz, both channels)
IHF Dynamic 2/4/8	200W/150W/90W	260W/240W/145W	400W/350W/250W
THD	0.01%	0.009%	0.009%
IMD	0.01%	0.009%	0.009%
S/N @ 1W	<-92dB (IHF; A-weighted, 500mV input ref. 1W out in 8 Ω)	<-92dB (IHF; A-weighted, 500mV input ref. 1W out in 8 Ω)	<-94dB (IHF; A-weighted, 500mV input ref. 1W out in 8 Ω)
S/N dBA @ rated	<-104dB (IHF; A-weighted, ref. 50W in 8 Ω, max volume)	<-110dB (IHF; A-weighted, ref. 50W in 8 Ω, max volume)	<-113dB (IHF; A-weighted, ref. 50W in 8 Ω, max volume)
Damping Factor	>200 (ref. 8 Ω, 50Hz and 1kHz)	>200 (ref. 8 Ω, 50Hz and 1kHz)	>200 (ref. 8 Ω, 50Hz and 1kHz)
Freq. Response	20Hz-65kHz	10Hz-65kHz	10Hz-65kHz
Chan. Separation @10kHz	70dB	70dB	70dB
Sample/Bit Rate	192kHz/24bit	192kHz/24bit	192kHz/24bit
Standby Power	0.5W	0.5W	0.5W
Gross Dimensions (W x H x D)	435 x 71 x 302mm (17 1/8 x 2 3/4 x 11 7/8)"	435 x 71 x 407mm (17 1/8 x 4" x 16)"	435 x 71 x 302mm (17 1/8 x 4 3/4 x 16)"
Net Weight	4.85kg (10.7 lbs)	8.6kg (18.9 lbs)	11.9kg (26.2 lbs)
Shipping Weight	5.9kg (13 lbs)	10.2kg (22.4 lbs)	13.9kg (30.5 lbs)

