CLASSÉ

DELTA SERIES

CA-D200
amplifier

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Classé is known for building world class amplifiers, stereo and multichannel preamp/processors that employ innovative and proprietary technologies, executed at the highest levels of quality. Our goal is to consistently deliver genuine performance benefits and value, not hype and hyperbole. The CA-D200 is a superb example of how proprietary Classé technologies, executed at a high quality standard, can yield a musically involving component of exceptional value.

Design Considerations

Superior audio designs are always the result of an informed balance of trade-offs. In a general sense, our design goals have placed sonic performance as the highest priority, above parameters such as cost, size and efficiency. The same can be said for most of the high-end amplifier designs on the market today. Despite what you may think about their relative performance, the three qualities common to all conventional high-end amplifiers are their high cost, large size and high heat dissipation.

Heat is a byproduct of inefficiencies, related to both the power supply and amplifier circuit topologies. It offers no benefit whatsoever to performance and can even prove to be quite harmful. In recent years, the Classé Design team has made real progress in addressing the problems associated with excessive heat by introducing an innovative cooling system that we call the ICTunnel™. While the amplifiers themselves remain somewhat large and inefficient, the cooling system allows control of their operating temperature to improve both performance and reliability, and enable more flexibility with installation locations.

Until now, Classé amplifiers have all used what are called linear topologies for their power supply and amplification stages. Linear amplifiers, classified as either A or A/B, are the topologies historically used in high-end audio applications. They have the advantages of relatively flat frequency response, low distortion, low noise and broad bandwidth. Their downside is primarily measured in cost, size and heat dissipation. The most efficient linear amplifiers used for high-end audio are of the class A/B family, which are at best about 60% efficient, meaning that 40% of the energy they consume is turned into heat.

Linear power supplies, like linear amplifiers, are relatively large, heavy and expensive; they also tend to be sensitive to the AC line voltage and when placed under load, struggle to maintain a constant output voltage. There are also problems linear supplies create for those other audio components with linear supplies that share the same AC circuit. High frequency harmonic distortion is put back onto the AC mains and large peak current demands can cause the AC mains voltage to sag. These problems can be partially addressed but only at great expense and unfortunately, size and heat are the necessary evils of the linear designs used in high-end amplifiers.

While it is possible to build low or moderately priced linear amplifiers, they involve design trade-offs that are not acceptable for a Classé component. Consequently, our audio performance design goals have dictated a relatively high entry level price and substantial form factor for Classé amplifiers—until now, with the introduction of a wholly new design concept from Classé—the CA-D200.

Switching Power Supplies and Amplifiers

Switching amplifier and power supply topologies have been used for many decades and in the last two or three have been successfully used in audio applications where high efficiency, low heat dissipation, small size and low cost for a given power output are the design goals. Performance limitations often thought to be inherent in these topologies are being overcome incrementally with new component parts, circuit designs and DSP control algorithms. The CA-D200 attacks these problems in unique and innovative ways to achieve higher performance than was possible with earlier designs or, indeed, anywhere near its price.

Switching Power Supply

For Switch Mode Power Supply (SMPS) designs, noise has been the principal limitation that excluded them from high-end analog audio amplification components. The Classé CP-800 broke through this barrier with its innovative new SMPS with Power Factor Correction (PFC), showing that the many benefits of a switch mode design—including rock steady output voltage regardless of variations on the AC mains—could be achieved without creating more noise than the most ambitious and expensive linear supplies would do.

The next challenge was to create an SMPS capable of delivering enough power to satisfy the demands of a Classé amplifier. The CA-D200 introduces just such a supply, boasting over 1,000 Watts of available power at better than 90% efficiency. The PFC stage preceding the SMPS itself operates at over 90% efficiency by implementing a zero-current-switching technique. It maintains low noise and low ripple current using proprietary TI Natural Interleaving™ technology. An SMPS with PFC pulls current from the wall throughout the voltage cycle, never requiring the peak current that a similarly sized linear supply would demand. Consequently, an SMPS with PFC operating at 90% efficiency can pull significantly more power from a given AC mains circuit than a conventional linear power supply powering the same amplifier circuit. As we apply this technology in power amplifier design, the benefits for power delivery can be quite impressive.

By including a generous amount of bulk capacitance, this power supply combines the benefits of stable DC supply voltage and the efficiency and compact size that switch mode supplies are known for, with the instantaneous, dynamic current supply capability that only the best linear supplies can manage. The low frequency extension and control of the CA-D200 and its ability to effortlessly drive difficult speaker loads can be credited in large part to the powerful and sophisticated power supply it employs. The SMPS with PFC provides a clean, seemingly limitless supply of power ideally suited to the demands of the CA-D200's revolutionary switching amplifier topology.[1]

[1] For more information on Switch Mode Power Supplies and Power Factor Correction, see the CP-800 white paper posted on www.classeaudio.com

Switching Amplifier

Many of the switching amplifiers used in audio applications suffer in performance when compared to the best linear amplifiers, so they are often relegated to subwoofers, home theater receivers, car audio and multi-room amplifiers where the standards are perceived to be lower and their other attributes including small size, efficiency and high power for the price are more highly valued. A few well designed switching amplifiers have gained recognition for their performance attributes, but until now, none have successfully displaced similarly priced linear amplifiers in popularity among the high-end cognoscenti. The explanation, we believe, is that certain well known technical limitations are commonly associated with and accepted as inherent in switching amplifiers. They manifest themselves in audible artifacts that critical listeners find objectionable, so our design goal was to render these shortcomings inaudible or eliminate them entirely.

Class D switching amplifiers are sometimes called “digital amplifiers” because they use the incoming audio signal to create a type of digital signal known as Pulse Width Modulation (PWM) that can be passed through an analog output filter to produce an analog signal that is a larger, more powerful copy of the original input signal. In some ways they’re like D-to-A converters which output a signal at discrete voltages that are adjusted up or down with each digital sample and then passed through what’s called an analog reconstruction filter where the abrupt transitions from one sample to the next are filtered out leaving a smooth, analog representation of the original signal. In comparison, class D amplifiers can be seen to represent audio digitally by varying the time each sample is on, referred to as the pulse width or duty cycle, rather than resolving it to discrete voltage steps as in a conventional DAC. The name class D is only coincidental though, since this class of amplification was developed after classes A, B and C.

The Classé Design team has established credentials for handling and processing digital signals, so we don’t shy away from the word digital. When done right, digital can be a powerful, even superior tool. Companies that market class D amplifiers often go to great lengths to stress that their version is not a digital amp since the analog signal is, strictly speaking, never converted to digital. You might say it’s semantics, but for any class D amplifier, whether an A-to-D converter is in the signal path of the amplifier or not, a PWM signal is produced by the amplifier and an output filter must (or should) be employed. The quality and characteristics of this output filter have a substantial affect on sound quality, so custom filter components and their implementation are critical factors in achieving the musically satisfying performance of the CA-D200.

The PWM signal is generated by switching output (FET) transistors on and off for varying lengths of time. Unlike linear amplifiers which continuously track the analog signal, switching amplifiers have outputs which are either turned on or off (another reason you might think of them as digital amplifiers). The length of time that the outputs are on within the switching interval relates to the varying analog amplitudes to be produced, so the longer the on time (or Pulse Width), the higher the amplitude. The switching interval or frequency with which new Pulse Width values may be generated in the CA-D200 is 384 kHz, which is well above the audio band. Lower frequency switching requires output filters with steeper roll off slopes that increase the likelihood of affecting performance in the audio band while higher frequency switching tends to result in ringing and excessive electromagnetic interference (EMI) as well as increased heat dissipation due to the increased number of switching transitions, all of which is known to create performance compromises without any sonic benefits to be gained.

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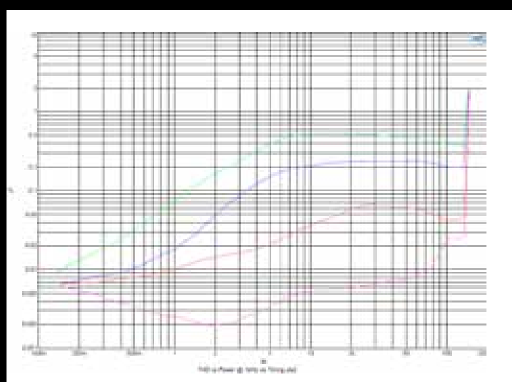

Small increases in dead-band time add significant levels of harmonic distortion. Shown are the relative levels of distortion from zero (theoretical, shown in purple) to 3 (red), 6 (blue) and 9ns (green) of dead-band time.

The output transistors are switched on and off by the preceding stage in the amplifier called the driver stage. The CA-D200 uses driver transistor ICs developed in conjunction with International Rectifier specifically for our application. They allow us to drive the outputs through what's called their linear state between off and on in the shortest time, which minimizes heat generation. The transition happens quickly but without overshoot and ringing, which would introduce unwanted high frequency noise. The drivers are also part of an innovative and proprietary control algorithm which helps us solve one of the most persistent and challenging limitations common to switch mode amplifiers.

If both positive and negative output transistors are conducting (on) at the same time, you have what amounts to a short circuit between the power supply rails (and in addition to a loud bang, you will probably have some smoke!). For this reason, it is important that the one set of outputs are fully switched off before the opposite polarity side is switched on. This finite time that is required to safely switch between the plus and minus halves of the amplifier is called dead-band time. Somewhat like the crossover distortion in class A/B amplifiers, dead-band time creates distortion; the longer the dead-band time, the more the distortion. It's such a critical parameter that a dead-band of only 15 ns (a nanosecond being 1/10-9 or 1/1000 of a microsecond!) for example, will introduce a whopping 12dB of distortion.

Historically, the dead-band time has been seen as an inherent limitation in class D topologies. In the interest of reliability, dead-band time is often set longer than strictly necessary just to be on the safe side and to account for part tolerances and the unit-to-unit variations associated with mass production. For the vast majority of class D amplifiers on the market, the dead-band time is the largest contributor to sonic compromise. Not only does it produce distortion directly, it does so indirectly by tempting designers to employ excessive amounts of global feedback to compensate. Large amounts of negative feedback will lower total harmonic distortion (THD), which is a standardized spec sheet measurement, but raise transient intermodulation distortion (TIM), which is not a standardized spec sheet measurement. TIM accounts for much of the flat soundstage, poor resolution and glare in the upper-mid and high frequencies, typical of class D amplifiers.

With its proprietary drivers and DSP tools, the Classé Design team solves the dead-band problem with precision and consistency for each and every CA-D200 we build. On power up, controller circuitry analyzes and adjusts the dead-band time for each pair of outputs. In this way, part tolerances for each individual amplifier are taken into account as is any potential drift that may occur over time. Before any global feedback is applied, the dead-band is brought to a safe but vanishingly small <3 ns for the entire output stage. This optimizes what is called open loop performance before any feedback is applied. The feedback loop is then closed to optimize overall performance, having done so with the least amount of feedback necessary. Our linear phase output filters are then employed simply to filter the 384 kHz switching frequency and not to roll off the top end of the audio band, as is often done to try to make amplifiers with high dead-band time more listenable. The result is a wide and deep soundstage with extended high frequencies that reveal a musically detailed and open midrange and top end.

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The CA-D200 is a digital class D amplifier in the sense that the analog input signals are routed through an A-to-D conversion stage prior to processing. The A-to-D is the same very high quality design as is used in the SSP-800 and CP-800, so we have experience with it and know how to implement it properly. To have some sense of how neutral the A-to-D can be, listen to an analog source through a CP-800 with the Tone control enabled and set flat. Toggle the Tone control "enable" off and on to hear the A-to-D. The path includes A/D, DSP and D/A with Tone control enabled, yet it is difficult to distinguish when those three elements have been inserted.

Preceding the A/D is the analog input stage, which is the same as that used in other Delta series amplifiers such as the CA-2300. Like other Delta series amplifiers, the CA-D200 features a true balanced input. The driver stage receives balanced PWM signals from the DSP circuitry. Like the CA- and CT-M600, the amplifier output is also balanced, so the speaker output terminals present analog signals of opposite phase to create the voltage across the speaker terminals. In the CA-D200 the topology is called a Bridge Tied Load (BTL). Each half-bridge is referenced to ground but since the output is differential, there is no ground reference between the speaker terminals. This method allows a safe, direct coupled signal path for the driver and output stages, free of servos or DC blocking capacitors yet without the risk of DC being presented to the loudspeaker.

Comprehensive overload protection resides completely outside the signal path as part of the proprietary driver stage design. In the case of a fault condition such as shorted speaker leads, the amplifier will shut itself off. For over-current or over-temperature conditions the output of the amplifier may be reduced with the precision of a single switching interval (1/384,000 of a second). This creates the effect of a well designed soft clipping circuit which is gentle and non-intrusive, exhibiting only a modest increase in distortion.

Summary

The CA-D200 is the first Classé amplifier to employ switching power supply and amplifier topologies. These complex technologies are challenging and beyond the reach of most high-end audio designers, but they offer enormous potential for exceptional performance along with the practical benefits of smaller size and greater efficiency. In short, they promise amazing value.

Some years ago we recognized the potential along with these obvious benefits and began expanding the Classé Design team to include specialists in switching power supplies and amplifiers. The CA-D200 is not a re-boxed class D amplifier from one of the small number of industry suppliers, differentiated primarily by its chassis and brand logo, but rather a ground-up Classé design that highlights the accomplishments of a team of highly qualified designers who, combined, bring well over fifty years of experience in these fields to the CA-D200 project.

The CA-D200 employs proprietary component parts and DSP technology along with sound engineering practice to optimize its sonic performance at a relatively affordable price of admission for a Classé Delta series amplifier. Compare it to anything even close to its price and you may well determine that digital amplification by Classé is the right choice for all the right reasons.

CA-D200 Specifications

Frequency response:	10 Hz - 20 kHz, -1 dB into 4Ω
Output power:	200W/Ch rms into 8Ω (14.5dBW) 400W/Ch rms into 4Ω (14.5dBW)
Harmonic distortion:	<0.018% @ 1kHz Balanced Input
Peak Voltage:	116V peak to peak, 58V rms no load 116V peak to peak, 58V rms into 4Ω
Input impedance:	100kΩ Balanced / 50kΩ SE
Voltage gain:	29 dB
Input level at clipping:	1.4V rms Balanced/SE
Intermodulation distortion:	>80 dB below fundamental into 8Ω Balanced
Signal-to-Noise Ratio:	-100 dB at peak output into 8Ω Measured Bandwidth 20 kHz
Mains Voltage:	90-264V, 50/60 Hz
Dimensions: (excluding connectors)	Width 17.5” (445mm) Depth 16.5” (419mm) Height 4.78” (121mm)
Weight:	28lb (12.7kg) Net 37lb (16.3kg) Gross

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