bel canto

Eco Modern – Eco Friendly

Efficiency, Elegance and Performance

The realities of today require that efficiency be considered as an important parameter in any new electronic design. Bel Canto's experience in developing and implementing efficient audio electronics has proven that operating efficiency can lead to superior audio performance. Careful implementation of the right technologies, devices and architecture can not only deliver lower power consumption, less weight, cool operation, high reliability and lower operating and construction costs but the resultant objective and subjective audio performance is superior to older, low efficiency designs. Efficiency and design elegance is achieved by paying attention to several key design areas.

Efficiency Starts With the Power Supply

Development of our Virtual Battery Supply (VBS) technology showed us the critical importance of an extremely low noise and well isolated power architecture. The VBS design also reduced the power consumption of our DAC3 in half while offering greatly enhanced sonic performance. Over 100X reduction in low frequency noise was achieved by going to highly efficient Switch Mode Power Supply SMPS architectures. While these architectures do produce noise at high frequencies (from 100KHz to several MHz) we found that it is much more effective to attenuate and filter this noise so that it does not effect the audio band. The problem with the traditional 50/60Hz linear supply is that there is so much 1/f and residual noise related to the line frequency that no amount of practical filtration can rid the supply of this low frequency noise. The SMPS modulates the low frequency noise to higher frequencies where it can be dealt with effectively.

Another insidious problem related to the old style power supplies is that magnetic components are very inefficient at low frequencies. This leads to the typical old-style large power transformer that weighs 20-50 pounds (10-20Kg!). These large transformers are in a losing race against size, weight and performance. The best transformer uses the least amount of copper so that copper losses are minimal but at low frequencies the magnetic core is so large and the number of turns needed for the transformer to work is so high that you can use literally POUNDS (Kilograms) of copper for a high power transformer. With SMPS technology the transformer size can be reduced by a factor of 100. The result is a better performing transformer that weighs nearly nothing and uses very few turns of large gauge copper.

Further: the noise generated by rectifying the 50/60Hz power creates a host of harmonics starting at double the frequency (100/120Hz) and running right up through the critical mid range frequencies, right where your ear is most sensitive. It is notoriously difficult to filter these frequencies, without resorting to very large inductors

and capacitors. The SMPS tackles this problem by effectively transferring this low frequency noise to very high frequencies where small, efficient filter devices can remove it. This design approach is used for all of the power amplifier stages in our amplifiers, even the output stage is fed from clean, well regulated SMPS. The result is mid-range clarity that otherwise would require extreme amounts of iron, steel copper and aluminum capacitors. Inelegant and wasteful at best, and not performing as well as the compact elegant regulated SMPS power supply architecture.

Ultra-Low Noise Signal Source Architectures

The analog front end electronics use second stage SMPS power supplies that provide extremely low noise operation from DC through 20 MHz or more. This power supply is very quiet and very well isolated. The small size of the SMPS transformer also provides the advantage of reduced stray coupling so that common mode noise from the power line input is rejected more effectively. Small inductors and solid polymer electrolytic capacitors complete the design to provide a very low impedance and low noise power source for our critical audio stages. Most of the audio circuitry runs quite efficiently and we just bias the most critical analog stages in Class A at the output stage of our DAC designs. When we developed the VBS for the DAC3 power dissipation for the DAC went from over 12 watts to about 6 watts and the subjective performance level went up several critical steps. So, not only does efficient design reduce the energy footprint of the design but when implemented correctly it can lead to great performance enhancement in the subjective audio quality.

Efficient Power Amplifier Architectures

While segments of the audio community still have some trouble accepting highly efficient Class D architectures for audio amplifiers the current state of the technology has undergone a rapid evolution. The best examples of these amplifiers today can more than hold their own sonically with more traditional designs, while remaining disarmingly cool, compact and reliable. Indeed, the inherent efficiency of the Class D amplifier holds several advantages that can pay dividends in the resulting performance of the power amplifier. Bel Canto's amplifiers are analog switching designs, using Class A analog electronics to control the operation and performance of the Class D output stage.

A well implemented Class D design operates with very few MOSFET switches on the output. The absolute minimum of 2 N-channel MOSFET switches are used in most designs, even to deliver hundreds of watts of audio power, while full bridged, balanced output architectures use only 4 devices and can deliver over 1000 watts of power. Traditional linear architectures require 20-30 or more output devices to achieve this kind of power level. The absolute inelegance of the old amplifier architectures leads to

the massive heat sinks, power resistors, matched pair transistors and long wiring lengths that really do NOTHING to enhance the inherent potential of the amplifier but just serve to render the design more complex and prone to misbehave. When you add in the complexities of biasing and stability, thermal bias wander that depends on the audio signal and the complexity of protection circuitry it is a wonder that any traditional Class A/AB audio amplifiers sounds good at all. The comparative elegance of the Class D architecture with its absence of biasing needs, thermal wander (the audio signal has little effect on the temperature of the output devices) and minimal number of output devices the resulting design leads to a short, clean signal path. This short signal path is the real Holy Grail in audio amplifier design and seems to always result in better subjective performance, think of the single-ended triode without any of the limitations of that ancient architecture…

So we end up with a quiet, cool, compact, wide bandwidth amplifier with low distortion, good power delivery and a fully regulated power supply that can deliver 500 watts of power using less than 10 watts. Even under operation the amplifier rarely uses more than 10 watts, head banging may reach 15 watts.

The Paradigm for Today

To ignore the reality of energy usage today is to ignore the future-traditional audio philosophy says that wasteful, large, hot running audio electronics will always be the best. Bel Canto's experience in designing some of the most efficient and high performance audio equipment has shown this inherited 'wisdom' to not only be the wrong direction for the future but to also be self limiting. The recent developments in efficient amplifier and power supply architectures truly show the way forward toward even higher performance audio components that can co-exist with your musical and energy needs. A top of the line Bel Canto system can use less than 40 watts of power and deliver music performance with astonishing realism. Our efficient, elegant designs do more with less to deliver more of the music.

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