

multi media manufacturer[®]

Manager's Guide to AV Design & Development

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PHOTO 1: Tripath corporate headquarters in Santa Clara, Calif.

Tripath Profile: Class T

by Mike Klasco

The time is right for high efficiency amplification. Stereo audio products have morphed to five, six, or even seven channels. The market is demanding receivers that are slimmer and more compact, yet more powerful. Many AV amplifiers now feature seven channels of over 100W each, along with DSP processing. Consumers are expecting more audio performance from their flat panel TVs, car stereos, portables, and computers.

Power supplies and heatsinks take up a lot of real estate and are heavy and expensive. Underwriters Laboratories (UL) mandate temperature limits inside the chassis and yet brute force solutions like fans are noisy and fail. You need more compact audio power solutions, which generate less heat.

There is no shortage of vendors who have recently jumped into this digital power category offering AV manufacturers their solution to high-efficiency

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PHOTO 2:
Hitachi's 42" plasma television
(TDTT55M).

amplification. The current crop of high-efficiency amplifiers are clearly focused—via performance, packaging, and features—on specific applications, such as surround-sound receivers or flat panel TVs. There are two paths to high-efficiency amplifications, component and module level.

Since many amplifier designers were weaned on analog class A/B topology, and switching amps and their idiosyncrasies are uncharted territory, many turn to modular solutions first. B&O's ICE, D2Audio, Power Physics, and others offer board level solutions. Get your power supply right and plug the module into your design and you are at least halfway to a working design that passes FCC and CE interference regulations. The downside to the module approach is the cost. You cannot be competitive with modules—most AV manufacturers know this is only a transitional solution.

The parts level solutions include Tripath, Texas Instruments, Apogee, and others. Even at the parts level, there are various levels of integration. Tripath offers a full range of options, such as System-On-a-Chip ("SOC") in which even the power FETs are within the chip package. For greater design flexibility (and required for power levels beyond 100W/channel) are the chipsets with external power FETs. Obviously the SOC integrated package is the simpler path, while the chipsets

enable maximum performance and customization. If you are an innovative and savvy amplifier designer there are quite a few external tweaks for higher efficiency, lower distortion, and less noise that you may be able to throw around the chipsets. Performance is one reason, but your marketing department also needs its bragging rights for product differentiation.

Class T vs. Class D

Plain vanilla class D—especially earlier generation attempts such as the Harris Cool Audio designs—delivered high ef-

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ficiency up to a few hundred hertz, but actually had marginal efficiency gains and much higher distortion when used for full-range audio. There is no shortage of vendors offering Class D amplifiers for subwoofers.

Tripath Technology has a low market profile but a major share of the wide-band switching amplifier IC market, with their proprietary Class T technology. Perhaps you have seen Class T emblazoned on the top of a Sony home theater in-box receiver or Sony VAIO computer, or heard mention of Class T in a review of many Apple computer products. Class T may also have been referred to in passing in a review of a tweak power amp from Audio Research, Bel Canto, Veritas, or pro-sound power amps like Ashly, Altec, Bose, Carver Pro, and multi-room residential power amps from Elan; or in a surround receiver review from brands such as Denon, Onkyo, Marantz, Yamaha, and Kenwood.

Who Are These Guys Anyway?

Dr. Adya S. Tripathi started the company in December 1995 with \$50 million



PHOTO 3: TA2041 4 x 70W, Class T audio amplifier evaluation board.

raised from Sanyo, Cisco, Intel, and others. In 2000 their initial public offering was completed for another \$50 million. During these years many lessons have been learned and Tripath now has a strong, defensible patent portfolio with 48 issued and another 41 pending worldwide. Their product line runs from under 10W per channel up to over 2000W per channel.

Beyond Class D, Tripath's Class T 1-bit sigma-delta modulation technology is a more sophisticated solution. You can optimize a switching amp for clean low-level sound, or for subwoofer woofer operation, or for full-range operation. But you cannot keep your operating parameters fixed without compromising overall performance with dynamic signals such as music. Class T is signal-dependent operation. The audio content is monitored and operational parameters are constantly optimized on the fly. Feed forward architecture provides stability at the exceptionally high switching frequencies. Class T adjusts clock modulation parameters for operating conditions as heavy bass passages, low signal levels, or full power.

State-of-the-art techniques include adaptive predictive (pre-distortion) and sophisticated feedback. Continuous time feedback corrects for inherent nonlinearities of switching power MOS-

FETs eliminating the need of close matching of the output FETs. The clock is modulated to lower the Q of the EMI field easing shielding requirements. Patented pulse qualification allows for high switching frequencies in the controller. The high clock frequency (500MHz and above) allows for "finer" discrimination compared to PWM (100s kHz). The high clock also enables a less severe output filter set octave above the audio band. Tripath Class T is one of the few switching amplifiers viable for wideband SACD and DVD-Audio applications. This wideband performance is not just a theoretical capacity, but has opened other markets for Class T technology including DSL and RF power.

Class T DSL line drivers enable cable service providers to increase the number of subscriber lines, reach, and signal speed without modification to existing infrastructure. Alcatel Shanghai Bell was one of the first to implement TLD4012 Class T ADSL line drivers in its 24-channel DSL line cards in its central office DSLAM equipment.

The next application for digital power processing techniques is the RF power amplifier arena. Next generation cell phones will yield longer battery life and longer talk time because of Class T.

To ease customer development, Tri-

path offers functional and documented reference design boards for most of their amplifiers. For customers who want a module solution, Tripath has third party vendors who are hungry for this business and offer a wide range of proven solutions.

Tripath has shipped almost 40 million channels to customers including Sony, Bose, Panasonic, JVC, Sharp, Hitachi, Blaupunkt, Sanyo, Toshiba, Yamaha, Apple, Denon, Kenwood, Marantz, Aiwa, and Samsung. Even tweak audiophile brands like Bel Canto and Audio Research have standardized on Tripath for their switching amplifier designs. The reviews have been uniformly positive.

A New Power Level in Automotive Head Units

Automotive head units are a great example of an application that can take advantage of the fidelity and efficiency of switching amplifier designs. Traditionally, car head units use A/B amplifiers in a bridged configuration operating directly from the 12V battery (up to +14V depending on the mood of the electrical system). The industry standardized on 4Ω speakers to achieve the maximum power possible from this configuration. This traditional setup can deliver about 25W typically into four channels; any more than that and the unit would overheat in the cramped dashboard. The demand for more power has driven the market for external "trunk" and underseat amplifiers for decades.

With Class T topology the rules change. The drastic savings in heat eliminate the danger of excess temperature, and the space saving allows the addition of DC to DC converters for higher supply voltages. Panasonic has recently begun shipping a head unit with four channels of 50W using Class T. That's twice the traditional setup. A 2Ω stable version offers another 50% more output power. This configuration should have quite an impact on the market; it eliminates the need for an external amplifier in most applications.

What Is Next?

On the technical side, Tripath has two developments that will be shipping before the 2005 CES show.



PHOTO 4: Panasonic's car audio head unit with the TA2041 Class T audio amplifier.

On the cost reduction side is a power stage architecture platform nicknamed "Godzilla." The new platform separates the driver from the MOSFETs (Metal Oxide Semiconductor Field Effect Transistors), enabling the use of standard low-cost MOSFETs. The driver itself is made from a low-cost HV CMOS (High-Voltage Complementary Metal Oxide Semiconductor) process that is lower cost and more commonly available than the previous process used.

Another cost reduction aspect that is not so apparent is circuitry that corrects for asymmetries between the external FETs. Production of switching amplifiers has challenged many tonnage offshore vendors and eliminating the need to presort external FETs avoids grief (as amplifier manufacturers just won't sort!). The resulting architecture is very cost effective, even against traditional A/B amplifiers, without sacrificing efficiency or audio quality.

The new architecture is suited for a range of applications, from 10 to over 150W. The solution is scalable, the outputs can be bridged, and the power can be tailored by using the appropriate FETs and power supplies.

A few years back the first digital input switching amps were introduced. The concept was appealing: avoid all the conversions back and forth between analog and digital. The reality was that so much program material is analog; all the designers did was require an external A/D converter. Direct digital inputs will progressively make sense with more digital formats coming to the mainstream. To simplify the design of these AV systems, Tripath has announced a 6-channel digital controller for home theater. This will allow systems to feature "all digital" solutions.

The controller is compatible with the new Godzilla output stages as well as Tripath's existing output stages. The new digital controller features volume and line level outputs for headphone or subwoofer, making it ideal for 5.1 and 6.1 systems. The controller features a variety of interfaces and supports sampling rates up to 192kHz. Tripath is likely to extend its digital controller portfolio to include parts tar-

geted at automotive and television applications simplifying those designs as it has for home theater as well as adding signal processing features and functionality.

For the last seven years I have worked on projects with Tripath and watched the product and the company mature. I have also worked with Tripath's competitors. I have seen a half dozen competitors jump into this game, and watched as they got a taste of the learning curve and got out, abandoning their customers and design wins. I have suffered with clients who selected one of the new guys, and got clobbered as the vendor attempted to get up to speed. If a switching amp vendor cannot answer who their customers are, and for how long they have been shipping, it is a signal to run away!

Tripath offers a wide product line, with performance and experience that is hard won. These days they manage to hang onto their customers and have the most design wins with customers expanding the application of Class T throughout their product lines. Maybe there is a lesson here. *