

## LINEAR AND SWITCHING AMPLIFIER OVERVIEW

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### Conventional Linear Amplifiers

The type of audio amplifier historically used in virtually all audio equipment from the smallest transistor radio to the largest movie theater or concert sound system is called a “linear” amplifier, usually of a type called Class-A or Class-AB. In this type of amplifier, the output power transistors are always in a mid-conduction state to one degree or another, depending on sound loudness and speaker impedance. Mid-conduction refers to having both a voltage drop across and a finite current flowing through the transistors. This combination of voltage and current dissipates power as heat given by the equation  $P = V \times I$  that is simply wasted energy that never reaches the speaker.

### Switching Amplifiers

Alternatively, switching amplifiers produce audio signals by modulating a rapidly alternating “digital” (or two-state) voltage so that its averaged (or low-pass filtered) voltage represents the desired audio signal. The switching frequency is always much higher than the highest frequency of the desired audio output signal, usually 10 times or more. This rapidly switching output signal is passed through a filter comprised of capacitors and inductors (which are ideally lossless components) before being passed to the speakers. The advantage in using this switching output approach is that the power output transistors, usually MOSFETs as shown in Figure 1, are ideally never operating in mid-conduction and instead operate much like switches either fully “on” or fully “off.” When “on” and conducting current to the speaker, each transistor acts like a closed switch, with zero voltage ( $V = 0$ ) across its terminals and therefore  $P = V \times I = \text{zero}$ , ideally yielding no wasted power. Of course, when “off” the switch is open,  $I = 0$ , and the wasted power is also zero.

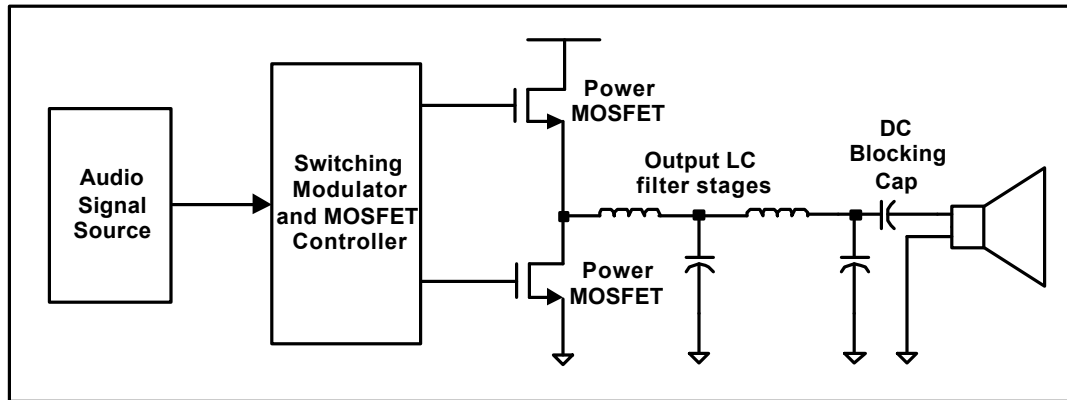


Figure 1: A typical, single-ended switching amplifier

As a result, the digital amplifier's efficiency is far better than its conventional Class-A, -AB, or -B counterparts and can reach 80% or 90%. In contrast, linear amplifiers are usually less than 50% efficient. The high efficiency of digital amplifiers can be a critical advantage in systems where excessive heat can be a problem, such as in multi-channel surround audio receivers or enclosed systems such as powered subwoofers. Also, in applications where power is at a premium, such as battery-operated portable stereos or laptop/notebook PCs.

## Class-D Pulse Width Modulated Amplifiers

Figure 2 shows the most basic and traditionally most common form of switching amplifier modulation, called pulse-width modulation, or PWM. Though Tripath actually uses a different technique, having nothing to do with PWM, these waveforms are presented as an example because they are more easily understood as a basis for discussion.

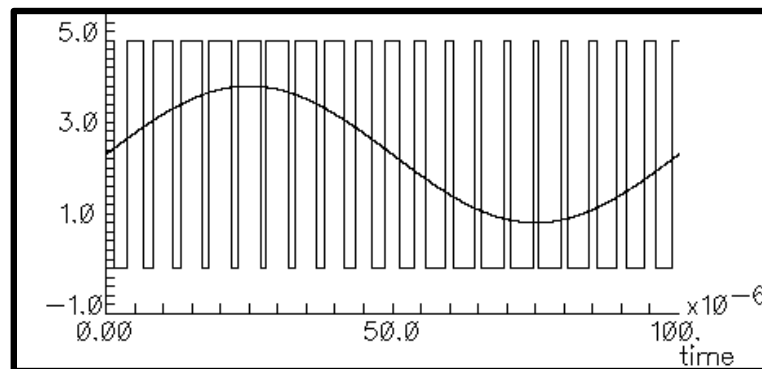


Figure 2: Pulse-width modulation waveform

The rapidly switching waveform traversing between 0V and 5V is the direct, unfiltered signal from the amplifier's power MOSFET output transistors.

The smooth, continuous sine wave is the resulting audio obtained after the switching signal is passed through an LC-type filter and then on to the speakers.

## **Tripath Class-T Digital Amplifiers**

Tripath's Digital Power Processing™ technology, which forms the basis of its Class-T amplifiers, uses a proprietary approach to create a new class of amplifier. Unlike a linear amplifier, Tripath drives the output transistors with a digital signal, a series of "1's" and "0's" whose amplitude is fixed, giving Tripath amplifiers the efficiency advantages of a switching design. Unlike a PWM Class-D amplifier, Tripath's technique digitally switches the output across a high frequency spread spectrum and contains predictive and adaptive feedback to constantly adjust and dynamically change its digital switching characteristics. This technology gives the Tripath Class-T amplifier the audible sound quality as good as the highest performing linear amplifiers. The amplifier digital adjusts its algorithms based on the input signals and output load characteristics.

Since Class-T amplifiers have a completely different output characteristics (both high efficiency AND high fidelity) than alternative linear and PWM Class-D techniques, AND their internal function is completely new, the designation "Class-T" is a more appropriate shorthand for the technology than other amplifier classes in use today.

## **Tripath Class-T Digital Amplifier Advantages**

Digital amplification offers distinct advantages over conventional, linear or PWM amps:

- Smaller, cheaper power supply (less wasted power)
- Smaller, cheaper heat sinks
- Greater circuit density, smaller form factors (less need for heat transfer and air circulation)
- Lighter-weight products
- Higher wattages in single chassis systems (e.g. sound reinforcement)
- More channels (e.g. home theatre/surround audio) without the need for a fan
- Longer battery life in portable systems
- Dramatically higher fidelity compared to Class-D PWM amplifiers

As mentioned above, Tripath's signal processing technology is very different than other switching techniques and overcomes the inherent fidelity limitations which have plagued Class-D PWM switching amplifiers for years. The result is greater linearity (better THD and especially IMD), lower noise floor, greater dynamic range, flatter frequency response, flat group delay, simpler filter construction, and better EMI characteristics; all of which finally elevate the digital amplifier to mainstream high fidelity performance levels previously attained only by high quality linear amplifiers.