

Trick Or Treat?

Fun and games with amplifier specifications

By Tommy O'Brien

Now that Class-D power amplifiers are common in professional audio, much attention has been directed toward their performance compared to conventional analog amplifiers.

Let's briefly address the question of what Class-D means in order to clear up any confusion, because marketing people have conjured up several fictitious designations.

An amplifier that uses its output devices as switches is Class-D. It's as simple as that. Everything else is analog, so "analog amp" means "not a switching amp." The phrase "conventional amp" equates to "analog amp." It is understood that the nomenclature can be confusing.

Class-D is the latest "wave" in topology because it offers high efficiency at reasonable cost. Early Class-D designs suffered from poor noise and distortion performance, but as the years rolled on and the technology continues to be developed, this has been addressed, and in some cases, cured.

Some of the "specsmanship" games pertain to consumer electronics more than pro audio, although the same pattern generally applies to all power amplifiers, regardless of intended application.

There are several key amplifier specifications that get most of the attention when the "what can this amp do?" question is asked.

KEYS TO THE CASTLE

One key specification is noise, measured as Signal-to-Noise Ratio (SNR). Analog amps are very refined in that they have been around since the



beginning of audio, so noise is easily kept low. Noise in an analog amp has much to do with circuit design and layout, just as in a Class-D amp.

However, with Class-D, an additional factor contributes to noise performance. That factor is timing. In a switching amp, the timing of the switching transitions translates to the output voltage, so timing errors wind up being voltage errors, and timing "jitter" winds up being output voltage noise. Thus, designing Class-D for low noise is significantly more difficult than with analog.

Another key figure is distortion, measured as Total Harmonic Distortion (THD). Actually, the measurement used in typical spec sheets is THD+N, where the N is noise.

THD+N can be a better indication of audible performance because it takes into account the total error of the output. This measurement is taken over a specified bandwidth, 10 Hz to 30 kHz, for example, where output error outside this bandwidth is disre-

garded. This works in favor of Class-D amps because many of them use noise shaping to push errors out of the audible spectrum. Analog amplifiers have been able to produce very low distortion for many years, but Class-D has had a hard time catching up due to circuit design complexity and availability of key components.

Most amplifier design engineers consider THD+N of 1 percent to be the "onset of clipping" where output power should be measured as "maximum power." The input test frequency can be fixed at 1 kHz, or range from 20 Hz to 20 kHz (and sometimes beyond), but this should be specified per measurement. The load resistance should also be stated.

In some cases, THD+N is measured at its lowest point along the THD+N versus power curve. And sometimes, THD+N is measured at a low power level such as 1 watt or 10 watts, even for higher-powered amps.

A more useful but less common measurement is THD+N at half power, which indicates output quality before distortion starts ramping up to the maximum power point. A graph representing THD+N versus output power (usually measured at 1 kHz) is particularly useful. For a broad power range, starting at milliwatts, THD+N usually decreases as power is increased until distortion overcomes noise. This part of the curve is the "noise dominates" section. As power continues to increase, THD+N usually stays at its minimum until power approaches maximum. At that point, THD+N will rise until clipping is reached. The shape of the THD+N curve can tell you a lot about the amp.

The third and most important performance figure is power output, measured in watts. "How much power?" is the question most frequently asked, because it is important in determining just how much audio can be pumped into a given venue with a given loudspeaker system.

Class-D made its way into audio with the promise of big power in small packages due to high efficiency. One of the first applications for Class-D was driving car audio subwoofers, where noise and distortion are not nearly as important as raw output drive. In analog amps, power comes with the expense of heat dissipation, and the primary purpose of Class-D is providing more power with less heat.

CRITICAL FIGURES

Marketing is extremely important in driving amplifier sales. That's why the performance figures are critical for the success or failure of a given amplifier product. Marketers are always looking for ways to differentiate their products, and in the process, sometimes they live "close to the edge" on the truthful data front.

If there's a trick out there to rate a 500-watt amplifier at 1000 watts under certain conditions, the marketing crew is all over it. They know that the buyer looks at certain numbers before anything else, and power output usually tops the list.

Other performance figures can also be manipulated to increase the power rating. The most common trick: Have you ever seen a DVD receiver-plus-loud-

speakers (also known as "home theater in a box") package that claims something like "350 watts of total power"? This power spec is written on the box in a larger font than anything else.

But in the fine print, you'll also notice the caveat: "at 10 percent distortion." If you've ever heard what 10 percent distortion sounds like, the term "garbage" comes to mind.

So how do they get away with this? Because they're not lying, but rather, are using specmanship to state a higher power output figure.

This tactic applies to pro audio as well, but in a less obvious fashion. Rating distortion at 10 percent is a throwback to the days of car audio power boosters, which ran bridged amps from the 14 volts of power readily available in cars. In order to get a 40-watt output rating, power output was rated at ultra-heavy clipping.

Some chipmakers in the Class-D arena also use tricks of this type in their data sheets. In fact, certain ones even rate power output as a "saturated square wave." This means that the output is clipping (driven past its output voltage range) nearly 100 percent of the time!

There are several standards for rating power that help keep manufacturers in line when releasing specs. These rules come from the Federal Trade Commission (FTC), Electronic Industries Alliance (EIA) and others.

The problem is that different equipment manufacturers use different standards for rating power output. Most pro audio manufacturers state the standards

used, so keep that in mind when you compare specs - always try to understand the context of the specs, and compare apples to apples.

Another sleight of hand found in the home theater genre is measuring amp channels in pairs rather than all five (or more) being driven simultaneously. It can be argued that this is actually a more practical approach due to the nature of movie sound, but it also doesn't mean certain advantages aren't being taken and touted.

MULTIPLE VERSIONS

There are many permutations of Class-D amps. To list a few options, there are open loop (no feedback) and closed loop versions, analog input and digital input versions, also fixed switching frequency and variable switching frequency versions.

Most common to pro audio is the analog input, closed loop, fixed switching frequency type. Measurement tricks for this type of Class-D amp are much like those used to measure conventional "analog amps."

In the consumer world, digital input Class-D is gaining ground; especially what is called "true digital," which equates to digital modulation, open loop. Naming this variation "true digital" is misleading, albeit commonplace. (All Class-D is analog at some point.)

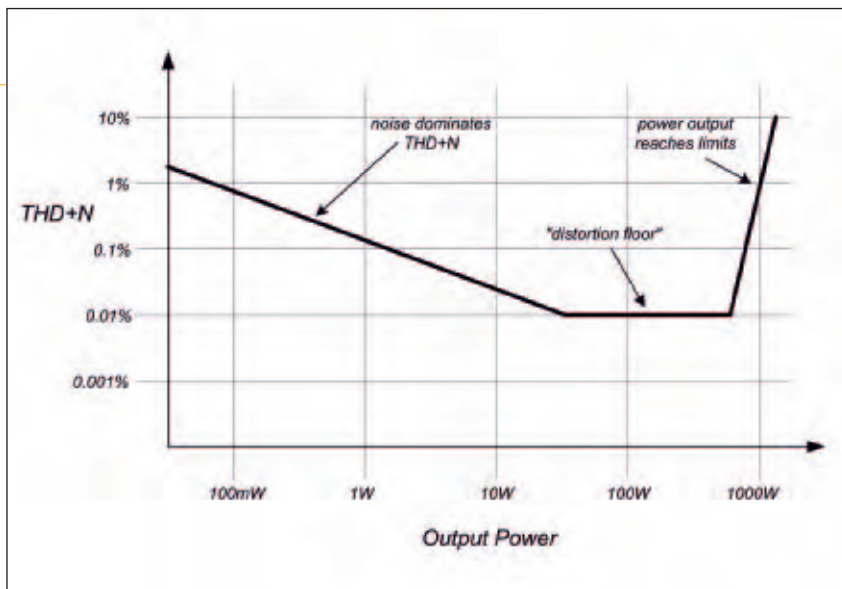
Switching amps generate high-frequency output voltage "ripple." Alternating drive current through the output filter causes this "side effect." The details are quite involved, so an

Silly Amplifier Spec Tricks

Even though Class-D chips haven't seen much play yet in pro audio due to general lack of power output, they're bound to creep in as time goes on. Here are some of the more obvious "silly spec tricks" - some of which have already been mentioned:

- Using filters to measure distortion
- Special modes that hurt performance but reduce EMI
- Rating power at 10 percent THD (or even higher)
- Using exaggerated maximum power points to get artificially high SNR and DNR figures
- Measuring SNR with output stage turn-off/muting
- Measurement of performance with key components that are impractical for "real world" uses
- Use of peak or instantaneous peak power specs
- Lack of useful measurements, such as PSRR (Power Supply Rejection Ratio)
- Rating efficiency at above-maximum power

- Tommy O'Brien



Typical 1kW amplifier THD+N versus output power curve.

explanation of the nuances here would be impractical. In any case, the output ripple can cause measurement equipment to produce false readings, usually by way of exaggerated distortion or noise readings.

To compensate, some chipmakers and measurement equipment manufacturers have devised switching amp measurement filters, such as the AUX-0025 from Audio Precision. Some of these filters (not including the AUX-0025) can be used to fictitiously improve performance figures, sort of like reverse discrimination. Be wary of amps measured with manufacturer-specific filters.

Some Class-D designs turn off the outputs when the input level is below a certain threshold, much like gating is used to reduce background noise picked up by a microphone. This can create exaggeratedly high SNR figures, and is more common in open loop digital input amplifiers than for analog input amps.

The primary motivation for non-conventional amplifiers is efficiency, but how is efficiency measured? Unfortunately, it's typically measured as a single data point at maximum power. Some Class-D manufacturers measure efficiency at higher power level than that for which the amplifier is rated.

For example, an amp might be rated to supply output of 100 watts at 1 percent THD+N, but efficiency might be rated at 150 watts output, where THD+N is off the charts. This is

done to eek out the closest-to-100 percent number possible. As a rule, efficiency should be stated at listening level (1/8th power) and at full power (1 percent THD+N).

Another useful figure is idle power dissipation, which indicates how much power is wasted when the amp is "quiet." Class-D amps that turn off the output stage during the absence of audio give an exaggeratedly low idle power dissipation figure. Turning the output stage on and off can cause audible effects such as clicking or popping. Even in designs with decent noise performance, turning the idle noise on and off is audible.

EFFECTIVE RESOLUTION

The digital version of Dynamic Range (sometimes referred to as DNR) essentially indicates the effective "resolution" of a digital audio device. When used for amplifier measurement, it provides a number related to SNR in that the numbers should be pretty close (for example, 102 dB SNR and 100 dB DNR).

DNR is mostly used to measure digital devices, such as A/D (analog to digital) and D/A converters, and has recently become prevalent in the measurement of digital input amplifiers. It can be used to measure analog amps as well. The typical method for measuring DNR is to input a small signal (-60 dB, referring to 0 dB for maximum output) and measure THD+N in dB, and then add 60 dB to the measurement. The -60 dB input is

focus
(v. to concentrate energy)

3.0° 3.15° 2.0° 1.25°
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force

(n. energy exerted or brought to bear)



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Power Lines

used to prevent auto turn-off of any signal stages that might contribute to noise.

If you notice SNR and DNR measurements that aren't close, a trick is probably being used. The trick in this case is usually some form of gating, as mentioned previously. Gating results in an erroneous SNR figure, but doesn't effect DNR, so you might notice a much higher SNR than DNR in this case. Exaggerated maximum power ratings also artificially inflate DNR and SNR figures due to increased headroom that's not really there.

Another trick used to get higher power ratings is to drive very low impedance loads. This has been used on conventional pro audio amps for many years, but for all the right reasons, because "paralleling" several loudspeakers for more output is common.

However, some Class-D manufacturers rate power output at 4 ohms or even 2 ohms, then rate distortion at 8 ohms. Read the fine print and you may find this trick to be quite common.

In car audio, using low impedance has gone to the extreme, mostly with Class-D, but sometimes with conventional amps as well. For example, some car amps, especially subwoofers, are made to drive loads of less than 1 ohm.

Of course, this is impractical with any appreciable wire distance due to simple resistance. As long as the other specifications are rated with the same load as the power output, this is not a problem.

Most power ratings are based on continuous output of a sine wave, typically 1 kHz. Yet another ratings trick is used to indicate outrageously exaggerated power output. "Peak power" is sometimes specified, but rarely for pro audio amps, though this is a common consumer market trick.

Peak power is measured several different ways. One way to measure it is to use a burst tone at the input and measure momentary power output. This method is not dishonest, even though the result can be deceptive. If the conditions of the test are stated to adequate detail, the measurement is on the up-and-up.

Another way to measure peak

power is to double the continuous power measurement. Theoretically, the "instantaneous peak" power is the power to the load at the top of the sine wave. Continuous output is most common, and usually most honest, but music is not continuous.

IN RELATION TO ANALOG

Switching power supplies have come a long way, but linear supplies are still the cheapest option for amplifiers. One trick employed throughout history in the power amp business is the use of underrated transformers.

For example, you might buy a 500-watt amp that has a 300-watt transformer in it. How can you get 500 watts from a 300-watt transformer, even at 100 percent efficiency? Simple – consider the phrase "not for long." A 300-watt linear transformer can deliver 500 watts for short bursts, but it begins to heat up (and eventually blow out) if asked to put out that kind of power continually. If we take advantage of the fact that audio is transient in nature, we can downsize the transformer.

Class-D benefits more from this than conventional amps due to increased efficiency. In most cases, a well-designed Class-D amp could use a transformer half the size of one required for a conventional amp with equal power output.

The caveat is that many Class-D designs have poor power supply rejection ratio (PSRR), a spec that the chip guys often neglect to provide. Linear supplies suffer from ripple, and the frequency of the ripple is double the line frequency, typically 100 Hz or 120 Hz (very audible spots in the spectrum). Some designs require regulated supplies due to this problem.

Although Class-D amps provide definite advantages over conventional units, the methods used to measure these new products should be carefully considered. Fortunately, measurement tricks are decreasing in popularity for professionals, and increasing in popularity for consumers.

But – always be sure to read the fine print. ■

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