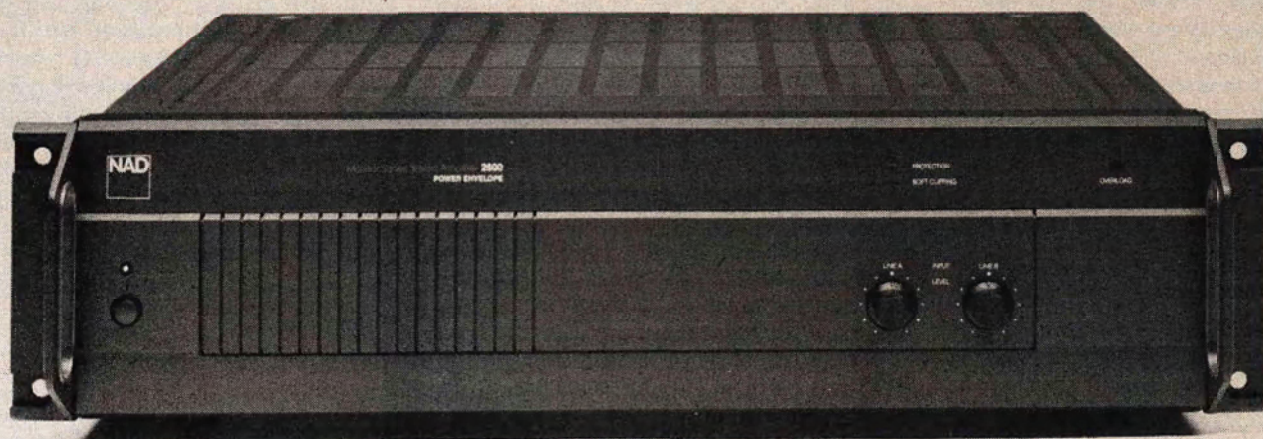


AMPLIFIER HEADROOM:



IS IT A CON?

Amplifier headroom is a subject of considerable debate amongst audio enthusiasts. Is it a legitimate way of increasing amplifier power or is it all a con? Well, it depends.

By LEO SIMPSON

The compact disc is to blame. If the compact disc hadn't come along some five or six years ago, this controversy probably would never have arisen. Amplifier manufacturers would have gone on in the same old way, gradually refining their designs, lowering distortion, increasing reliability and so on.

But all of a sudden, the compact disc changed the rules. No longer were contemporary amplifiers up to the job of coping with the signal quality of compact discs. Nor were loudspeakers up to it for that matter and, indeed, many still aren't.

Before CD

Let's backtrack a little and consider the pre-CD era, say ten or more years ago. Vinyl discs and cassette tapes ruled supreme and signal dynamics were nice and predictable. Recording engineers knew damn well that the sound quality of vinyl records was nothing

like as good as that off master tapes and master tapes weren't really able to cope with the signal dynamics of live performance. Everyone knew it but that was life.

Then along came direct-cut vinyl recordings. Mixing was minimal, with no taping, no signal processing, no nothing. The recording sessions went straight onto the disc and suddenly vinyl recordings took on new life. They sounded "live" — certainly much more dynamic than contemporary recordings.

But people persisted in playing them at the same general loudness as they were used to, or even louder, and speakers began to "blow". There was one particular direct-cut disc of the 1812 *Overture* that hifi dealers dreaded.

People would buy it, get it home, whack it on the turntable, turn up the wick and let 'er rip. Everything would be more or less OK until the cannon shots and then the speakers

would blow out! Some hifi dealers used to reckon that the record should have been banned.

What was happening was that these new recordings had much more dynamic range than the old ones and when a really loud crescendo came along the amplifier would overload severely. Not only did that sound terrible but, paradoxically, an amplifier in severe overload actually delivers a hell of a lot more power to the speakers.

Not surprisingly, the speakers don't like that. More often than not, the tweeters are the first to croak, giving up without a whimper, in just one short burst of power. Midrange drivers can suffer almost as badly and frequently burn out too.

Woofers mightn't burn out but they can be so badly over-driven that one or more turns on the voice coil can be loosened and then they sound as though their voice coils

Facing page: NAD's biggest commutating amplifier, the model 2600, has a dynamic headroom of +5dB, giving it a burst capability of 500 watts per channel compared with a continuous rating of 150 watts per channel into 8Ω loads.

are "poling". The result is the same as if they were burnt out — they have to be re-coned or replaced.

After CD

Compact discs made the situation even worse. Now the recording engineers didn't have to worry about whether the phono cartridges could actually track the discs (often they couldn't). This meant the dynamic range could be even wider than for direct-cut vinyl discs. Signal "crushing" was a thing of the past. Pianos, percussion instruments, brass and wind instruments, all came through the recording process with their full signal range intact.

Speakers were dying all over the place — or being found severely wanting.

Mind you, the quietness of compact discs didn't help. At least when you put on a vinyl disc the noise of the run-in groove gave you some clue as to how loud the volume control was set. But not with compact disc. Put the disc in the machine, press a button and then wham, right out of utter silence came this ultra-loud music.

People have taken a while to learn that CDs are different in that respect.

So the era of the compact disc has made new demands of amplifiers and loudspeakers. It adds up to a much larger dynamic range than ever before — louder peaks and much quieter background levels. This does not mean that the average listening level need be any louder than people have become used to. It is just that, having set the volume control for a comfortable listening level, the normal peaks of the music will be "crushed" (read: clipped, chopped off, overloaded, whatever) unless your amplifier and loudspeakers are out of the ordinary.

To produce the same average loudness level as you have become

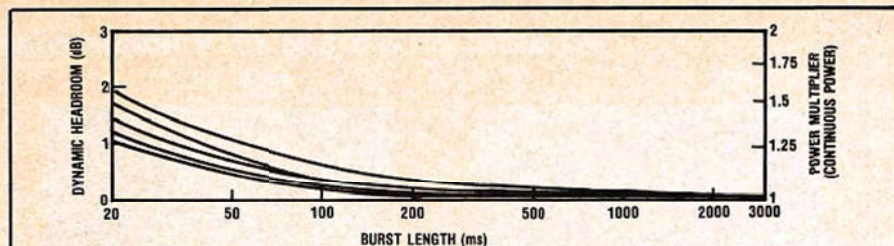


Fig.1: this diagram shows the "power envelope" for conventional amplifiers. For a 20ms burst, the best "dynamic headroom" these amplifiers can achieve is about +2dB.

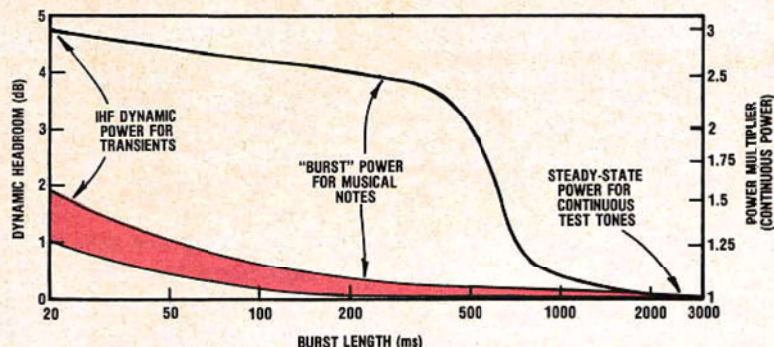


Fig.2: commutating amplifiers have much higher dynamic headroom than conventional amplifiers (shaded portion). They can also maintain their very high "burst" power outputs for as long as 500ms.

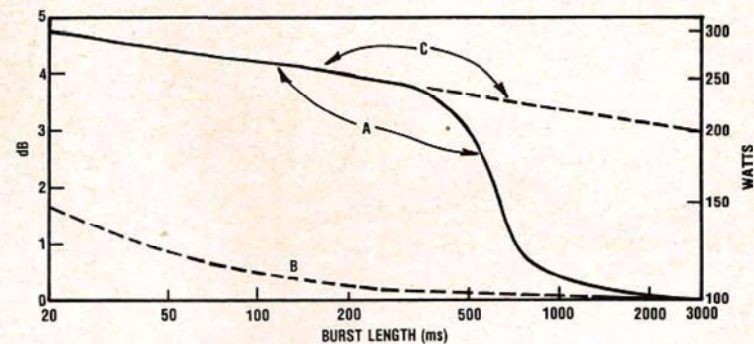


Fig.3: curve A is for a commutating design such as NAD, curve B is for a conventional amplifier as depicted in Fig.1, and curve C is for a very big conventional amplifier.

used to used with vinyl discs, your amplifier must be able to deliver a great deal more power, to safely handle the normal peaks of the music. If it can't, you will be missing out on the full signal quality which the CD system can deliver.

(Strictly speaking, you could get the same result by having speakers which were much more efficient but that is not a really easy solution. So more amplifier power is the solution. Lots more.)

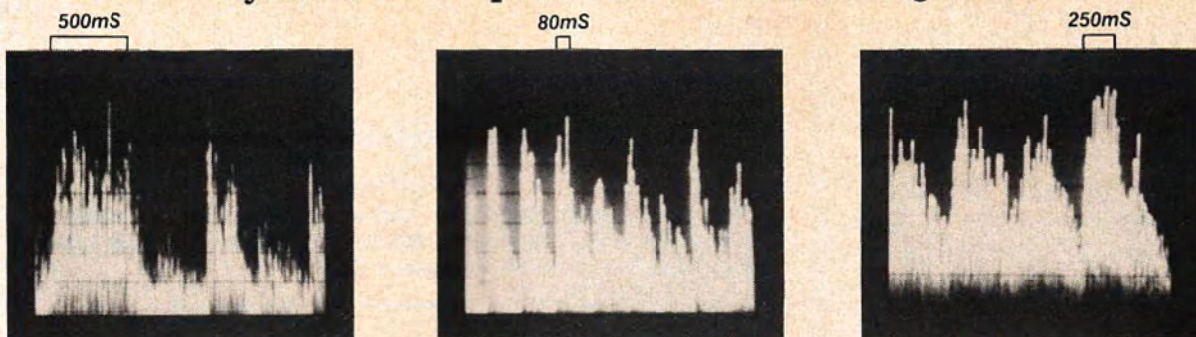
Unfortunately, with just a few exceptions, amplifiers have not become more powerful. (They have become quite a lot more expensive but that's another story which is all too familiar).

The ideal system

Given a pair of loudspeakers with typical efficiency of 90dB (at 1 watt, 1 metre) in a typical lounge room, you really need an amplifier which will put out several hundred watts per channel, if you are not to "clip" the music signal on peaks.

Trouble is, genuine hifi amplifiers with a continuous rating of several hundred watts per channel aren't cheap. Big transformers, high voltage high capacitance filter capacitors, lots of output power transistors and big heatsinks cost real money. But if you want genuine big power, continuously rated, that's the only way to go. Or is it?

Dynamic Envelopes of Various Music Signals



These oscillograms show typical signal "envelopes" from today's CD recordings. Fig.4 at left is from the Bee Gees "Paradise" disc and shows a 500ms signal burst. Fig.5, at centre, is from Genesis "No Reply At All" and shows bursts 80ms long. Fig.6 at right is from a recording of Bruckner's Symphony No 4 and shows 250ms bursts. (Photos by courtesy of The Falk ElectroSound Group).

Quite a few years ago now, at least one amplifier manufacturer realised that there was a way to obtain a great deal of power from a relatively small amplifier, but there was a catch. With this approach, you could obtain several hundred watts per channel from quite a small amplifier but only for very short periods, say for a tenth of a second or less. After that, if high power was still being demanded by the music signal, the amplifier was only able to deliver quite modest power, say 50 watts per channel, on a continuous basis.

The reason why this approach works is that music signals are not "steady state". They vary all over the shop with the really loud peaks, say from a cymbal clash or trumpet crescendo, happening along with fairly long intervals between each such event; time enough for the amplifier's power supply to recover and be ready for the next burst.

Bob Carver (with his "magnetic field" amplifier) is generally recognised as the person who pioneered this approach but there were others before him. Hitachi was probably the first, with "class G" amplifiers. Then there was Soundcraftsman with "class H" and then later in the piece, Yamaha, NAD (with the "Power-Tracker"), Proton and Crown produced amplifiers with similar concepts.

Commutating amplifiers

Such amplifiers are sometimes referred to as "commutating"

amplifiers. They are able to deliver such high short term power outputs by varying their power supply rails in response to the signal. When a big input signal comes along, which will require a lot of power output capability if it is not going to be clipped, the amplifier automatically increases the supply voltage to its output transistors. This allows the transistors to deliver very high power.

When the music signal drops back to normal levels, the supply voltages to the output transistors are also reduced, so that the average power dissipation in the output transistors is kept at a low level. This allows the designers to get away with a much smaller power transformer, much smaller heatsinks, and so on.

Typically, in one of these "commutating" amplifiers, the supply voltages are increased by 50% or, in some cases, by more than 100%. This can mean prodigious increases in short term power, 400% or more. For example, an amplifier with a continuous power rating of 50 watts per channel can have short term power output of 200 watts per channel or more.

Just quoting one example, the 7240PE stereo receiver from NAD has a continuous power rating of 40 watts per channel into 8Ω loads but a short term power output of 160 watts per channel into 8Ω loads. Or take the Proton D1200 power amplifier. It has a continuous power rating of 155 watts per channel into 8Ω loads but its short term

ratings give it over 590 watts under the same load conditions.

Headroom, dynamic power and all that

Well, there is no doubt that such amplifier design techniques work. In terms of amplifier "bang per buck" they are unbeatable. But how do you measure such amplifiers legitimately?

In the past there was music power. This is the short term power delivered by an amplifier with "music" signals. Then there was peak music power which without going into the maths of it, gives a rating which is twice that of music power without giving the slightest bit more sound power. These terms became largely discredited years ago when some amplifier manufacturers were "conning" the buying public with enormous ratings which meant nothing in reality.

What stopped this rort was the US Federal Trade Commission (FTC) which ruled that amplifiers had to be sold with a "continuous power" rating. This rating could only be arrived at after the amplifier had been preconditioned for an hour at one-third of its rating. This forced the amplifier designers to be much much more conservative in their ratings and so the public then got amplifiers which really did have genuine power ratings.

Even so, high fidelity enthusiasts and designers recognised that virtually all amplifiers could deliver more power on a short term basis. To take note of this, the United

States' Institute of High Fidelity (IHF) devised a tone burst test of amplifier power. This was defined as the power output delivered by an amplifier for a burst of 20 milliseconds at intervals of 500 milliseconds (ie, twice per second).

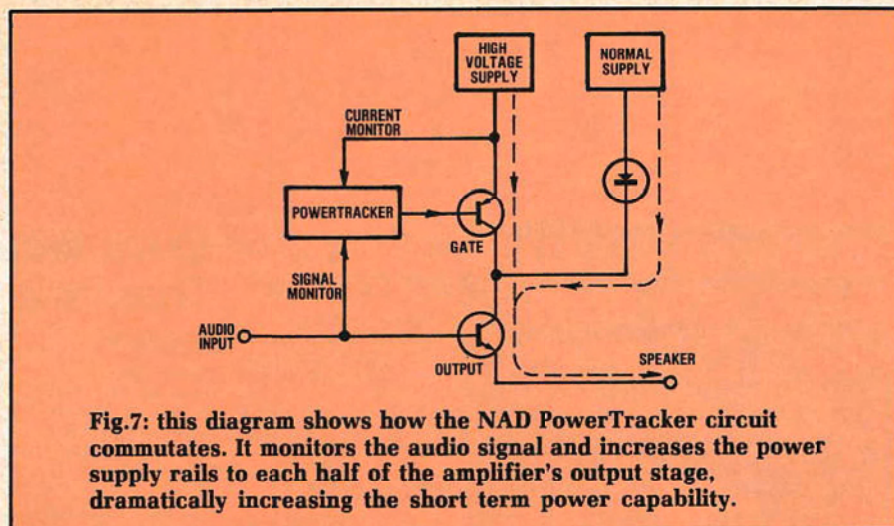
The IHF also came up with a new term called *Dynamic Headroom* which was expressed as the ratio between the continuous rated power of an amplifier and the power delivered under the tone burst test just defined. Being a ratio, Dynamic Headroom is not specified in watts but in decibels, which is a logarithmic measurement of ratio.

Typically, amplifiers designed to meet the FTC conditions deliver not much more power under tone burst conditions than they do under continuous tone conditions. This is because they have well-regulated power supplies which don't vary much, regardless of the power demands. For example, an amplifier with a continuous rating of 100 watts per channel (under FTC guidelines) might have a short term (20 millisecond) power output of 120 watts per channel. This gives a dynamic headroom of only +0.8dB which is nothing to get excited about.

But when one of these newer commutating amplifiers comes up with a dynamic headroom of +6dB, then it's time to sit up and take notice. There is some controversy however. Some amplifier designers and keen enthusiasts regard the 20 millisecond tone burst test devised by the IHF as having no relation to real music. In their opinion, musical peaks and crescendos last much longer, up to as long as 500 milliseconds. And they offer some compelling evidence in the form of oscillograms of music recorded on today's compact discs.

Some of these oscillograms are included with this article. They show that peak program signals can easily last for 250 milliseconds or more.

Now you might say, "So what? If the peak demand lasts longer that's easily fixed by setting the volume control so that the amplifier doesn't easily overload". If that is your attitude you've missed the message



about the dynamic range of compact discs. The peaks are much louder than the average signal and, as we have just seen, they last for relatively long periods of time. So either you listen at your accustomed loudness levels and "clip" the music on peaks or you listen at much lower levels and miss out on all the soft bits of the music (or listen on headphones).

Clearly, if amplifiers are to cope with these signal demands they need to be very powerful. So you have two choices. One, go the brute force way and get an amplifier with as high a continuous power rating as you can afford; or two, purchase an amplifier with large dynamic headroom. The second choice is possibly the better way to go

because then you can spend more on loudspeakers, the more efficient, the better.

There remains one question. Some enthusiasts reckon that the "commutating" action of these new high headroom amplifiers leads to audible distortion. On some of the early amplifiers of this type, the sound quality was not as good as it should have been and possibly this was partly due to the action of the power supply switching circuits.

These days though, amplifier designs produced by manufacturers such as NAD, Proton, Carver and others are highly respected for their sound quality. They are the new generation of amplifiers, more powerful, more compact and more affordable.



Another big commutating amplifier, the Proton D1200 (shown with its companion D1100 stereo preamplifier) has a dynamic headroom of +6dB and a dynamic power output close to 600 watts per channel.