The secret world of the hi-fi reviewer

Chris Thomas and Paul Miller have been having far too much fun playing with half a dozen tasty amplfiers, but what exactly have they been doing?

A couple of months ago we decided to take an in depth look at six of the more high profile pre/power amplifiers on the UK market. After much haggling and more than a couple of problems we ended up with the selection you will see on the following pages.

In order to get a different perspective to the usual Choice fare we went for a more extravagant price bracket and brought in the talents of Chris Thomas. Chris is not a new member of the reviewing fraternity, just a lapsed one, and his perspective has a distinctively fresh yet worldly feel to it as a result.

We also let Paul Miller loose with his probes and test equipment. For the technically inclined among you he explains his tests fully and completely over the page.

To round off the reviews Paul Messenger and I spent some time with the amps at Paul's place. The results are chronicled in the 'Second opinion' column. We used rather similar sources to Chris but somewhat more manly speakers. The fact that the results tally so well is a touch alarming, but at least we managed to contradict Mr Miller's expectations on occasion.

The Subjective response

Amplifiers come in all shapes and sizes from a single box to a multi component active set-up . You can pay many, many thousands for hardware that essentially does the same thing as a £150 integrated. Back in the days of yore, cost went hand in hand with power and more consideration was given to an amps ability to deal with sine waves on a test bench than musical information. But after the British hi-fi renaissance of the early and mid seventies it was realised that amplifiers did indeed have a major say in the way that systems handled music. It took a big improvement in source components to bring this about, however, and these days the choices on offer have never been greater.

None of the six amplification systems under consideration here tells the whole truth. Each one of them adds its own particular brand of coloration and distortion to the incoming signal. Each of them behaves in a different way when confronted with a real life loudspeaker load. The difficulty presented to any reviewer or prospective owner when auditioning them is which version of the truth to believe. Somewhere in our heads we manage to conjure up a reference against which we are comparing what we hear, and making judgements. We could simply compare the sound of instruments pouring from our speakers with our experience of them in a live situation, though it gets tougher when you realise the enormous impact a recording studio can have, right down to altering completely the whole shape or envelope of each note, which goes to the heart of the character of all musical instruments. Given an input of sufficient quality a very good amplifier plays music in all its weird and wonderful forms, by allowing you into the architecture of the piece. The tempo, chordal structure and progression, rhythm, instrumentation etc — and of course the most important thing to all good musicians, the 'feel'. Musicians react emotionally to both their instruments and the piece they are playing whether it be the most plaintive folk tune from a solo flautist or the sort of heavy electronic street-rap designed to make you reach for your Uzi. A hi-fi system should allow you to make emotional contact with the music. It should be able to lift you beyond constant analysis of the sound to a place where the equipment is irrelevant and the musicians speak to you. When it does this it can be called a great hi-fi system.

To try and understand what each of these amplifiers is capable of I lived with them for as long as copy dates would allow and tried them with a number of inputs. These include my Naim CDS CD player, a Sony DAT machine, using studio masters that I know quite well , while the phono listening was done on my LP12/ARO/Lyra Clavis set-up perched atop a Mana Reference table. Speaker connections were made using Naim NAC A5 cable, and the interconnects, where not provided, were from the Chord Company Cobra range. Loudspeakers were chosen to provide differing problems and flavours for the amplifiers . The efficient Audio Note AN-Js, the inefficient and diminutive ATC SCM 10s and my own Naim SBLs were all pressed into service.

The measurement programme

The test program includes both standard IHF-A202 measurements together with more advanced techniques made available by the IEEE controlled digital test equipment currently employed in my lab.

Power output, dynamic headroom and peak current

Quoted in good old fashioned Watts this refers to the maximum output voltage of the amplifier into 8 and 4ohm loads, one channel driven to 1 per cent THD. The IHF-A202 dynamic headroom test employs a gated 1kHz signal, 20 cycles on/480 cycles off, and refers to a maximum of 1 per cent THD into 8ohms relative to the continuous power available into that same load.

By contrast the maximum current available from an amplifier is measured over a shorter 5msec period into 1ohm, though still adhering to a limit of 1 per cent THD.

Separation, THD, IMD, noise and sensitivity

All input sensitivities are measured with respect to an output of 0dBW (=1W/8ohm) and full power at 1kHz for each pre/power combination. Noise is measured with respect to the IHF input levels of 5mV (MM) and 0.5V (CD/line), input shorted, A-wtd and assessed as the true rms figure of twenty, 3rd-octave averages.

Separation is measured some +20dB above the nominal sensitivity while THD is referred to an input of 2V (CD/line), 50mV (MM) and 5mV (MC). For CCIR IMD the respective peak composite (19kHz + 20kHz) levels are 10mV (MC), 100mV (MM) and 2V (CD/line).

Broad-band radio frequency intermodulation test

In general terms this test reveals just how sensitive an amplifier is to spurious radio frequency noise, whether introduced directly or indirectly.

Conventional measurements examine the performance of the amplifier under closed-loop conditions where many of the inherent circuit non-linearities are compensated for by one or more feedback networks. By contrast this RF test probes the linearity of the amplifier under open-loop conditions where it is both non-linear and uncompensated.

A precision RF signal generator is employed to produce an RF carrier signal at 20mVp-p, modulated to a depth of 100 per cent using an external pseudo-random noise source. The resulting non-correlated AM/RF signal is then ramped between 1MHz-1GHz by controlling the generator through an IEEE interface BUS and using a dedicated program.

Once connected to the amplifier (via a line input) any subsequent demodulation/intermodulation between the sweeping carrier and its pseudo-random sidebands results in a non-correlated noise appearing at audio frequencies at the output of the amplifier. This represents a change in the noise floor of the amplifier over a discrete portion of its frequency range.

By comparing the steady-state noise-floor of the amplifier with its noise floor under the influence of RF IMD, a measure of the difference and therefore the actual effect of RF IMD can be deduced. It is this difference in the noise floor that is shown on the RF IMD plots.

The depth or Z-axis is calibrated in steps of 100MHz and denotes the changing frequency of the RF carrier. By contrast the X-axis is restricted solely to the audio band (in this case 50Hz-20kHz) and is calibrated across a log, rather than linear scale. The vertical or Y-axis gives an indication of relative amplitude and is scaled in steps of 2dB over a maximum range of +16dB.

Clearly, any demodulated RF noise that causes a change in the noise floor greater than 16dB will give rise to a plateau effect on the plot. This situation is clear enough on the example plot which demonstrates an amplifier's undue sensitivity to RF noise centred on bands at 140, 200, 575, 730 and 850MHz.

If an amplifier were singularly insensitive to RF noise then this plot of relative change would appear as a series of straight, unperturbed lines.

Ultrasonic distortion test

This is a particularly revealing test that highlights the interaction of signals at different levels and changing frequencies. Harmonic and intermodulation distortions are produced (called `routes' in the text) by such mechanisms as slew-limiting or the progressive reduction of feedback, the latter revealing an increase in open-loop non-linearities.

Three driving signals are employed, a 0-20kHz sweep (1 = $F_{0\text{-}20k}$) and continuous 20kHz tone (2 = F_{20k}) which raise the amplifier to just 1W output (re 4ohm) while a 0-50kHz-0Hz bi-directional sweep (3 = $F_{0\text{-}50k\text{-}0}$) continues some -24dB below. A 2V CD/line input is adopted, but for MM disc inputs a pre-equalised signal is used (re 10mV @ 1kHz). An amplifier should be treated as a voltage source so each plot is individually calibrated in dBV (0dBV = 1V at 4ohms).

These sweeps were chosen to represent the kind of HF and ultrasonic signals likely to be handled by an amplifier in normal use. The ultrasonic spuriae generated by CD players is a well-documented example, but it is less widely appreciated that the 20-50kHz band noise from an record player or FM tuner can persist at levels only 10-20dB lower than peak signals in the audio band.

Moreover the relatively low 1W/4ohm output chosen for these plots is typical of the power level encountered during our listening tests using high sensitivity loudspeakers. This also means each amplifier is evaluated at the same low output where unpleasant crossover distortions are more obvious.

Certain of these ultrasonic distortions will introduce IM products within the audio band of the amplifier - a point of particular interest with disc stages where IM routes typically increase in level with decreasing frequency as a function of the RIAA characteristic.

The most obvious harmonic products are determined by multiples of the $F_{0\text{-}20k}$ sweep (1) (given by 4,5) and the F_{20k} tone (2) (given by 6,7). The remaining distortions shown on the 3D are produced by intermodulation between either or all of (1), (2) and (3) and (1) together with the harmonics of (2), ie (6) and (7).

Directly audible IM distortions include the difference products $F_{20k} - yF_{0\text{-}20k}$ [y = 1,2] given by (8) and (9) and $2F_{20k} - 2F_{0\text{-}20k}$ given by (10). Higher-order difference IM distortions associated with multiples of (2) and (1) will also wend their way directly into the audio band.

This example plot shows a variety of basic IM routes such $F_{20k} + yF_{0\text{-}20k}$ [y = 1,2,3] given by (11,12 and 13) together with higher-order secondary IM distortions such as $2F_{20k} + yF_{0\text{-}20k}$ [y = 1,2,3] and $3F_{20k} + yF_{0\text{-}20k}$ [y = 1,2,3,4]. These are marked as (14)-(16) and (17)-(20) respectively. Extremely high-order routes such as $4F_{20k} + yF_{0\text{-}20k}$ [y = 1,2,3], (21)-(23) are also visible.

Of course there are the interactions between (3) and (1) and (2) to consider. Three summation IM routes are clearly visible: $F_{0\text{-}50k\text{-}0} + F_{0\text{-}20k}$ (24), $F_{0\text{-}50k\text{-}0} + F_{20k}$ (25) and $F_{0\text{-}50k\text{-}0} + F_{0\text{-}20k} + F_{20k}$ (26)!

In general the presence of 2nd-order in-band IMD products seems to encourage a warmer, softer and richer sound quality, particularly if these distortions arise in the disc stage. The equivalent 3rd and higher-order IMD mechanisms introduce a harder and less beguiling character.

A word of warning. Do not use these plots as some sort of guide to the absolute quality of the amplifiers because this is simply not the case. Any distortion mechanism represented on the plot will have some subjective consequence. Conversely, just because a peculiar coloration or distortion is heard this does not mean it will necessarily be manifest on the 3D plot. This test remains but one piece in a very complex jigsaw and the results must be viewed in the light of those obtained via the RF IMD test.

The combination of ultrasonic distortion and RF IMD plots can provide a valuable indication both of the amplifier's subjective performance and its likely compatibility with other audio equipment, particularly CD players. An amplifier that gives rise to a `clean' ultrasonic plot but suffers RF demodulation may well sound coarse or muddled as a result. Conversely, a relatively constant carpet of innocuous closed-loop distortions can effectively mask the fatiguing effects of RF IMD. Taken together, these two plots give considerable insight into the potential sound quality of an amplifier.