HARMAN KARDON'S DOUBLE DAC

Harman Kardon's HD7625 is one of a new series of players using Realtime Digital Smoothing to 'join the dots' of the digital waveform

by PAUL MILLER

Realtime Linear Smoothing is the product of intuition rather than the pursuit of specmanship, a technique that has allowed Harman to avoid the high order analogue filters associated with the design of mainstream CD players

As evocative a buzz-word as any of its competitors', Realtime Linear Smoothing, Harman claims, is 'a new conversion process that makes digital sound more relaxed, less fatiguing and superior in its imaging'. But outwardly, the new players look little different from last season's '3D Bitstreamers'. The HD7625 is clearly modelled on the older HD7500II with its contoured drawer, fluorescent display, program and repeat facilities. These are underlined by a similarly styled bank of direct track access, fast search and skip controls, leaving index skip, intro scan and A/B repeat to the mercy of its remote handset. Conventional fare, by modern standards, the features list contains nothing to justify the substantial £500 price tag; so we must look inside.

TECHNOLOGY

Realtime Linear Smoothing is the product of intuition rather than the pursuit of specmanship, a technique that has allowed Harman to avoid the high-order analogue filters associated with the design of mainstream CD players. HK's engineers are convinced that any non-linear group delay caused by a high-order, multi-pole filter is of greater subjective consequence than, say, the choice of underlying DAC technology.

In any conventional player an analogue filter is required to remove the extended harmonics produced by the step-like structure of a multi-bit DAC or, alternatively, absorb the wash of ultrasonic re-quantization noise that emerges from a bitstream converter. Such filters are unavoidable if the original musical waveform is to be accurately restored.

Nevertheless, the third-order filters of its established multi-bit players and complex sixth-order filters of its MASH/PWM bitstreamers had sent a chill through Harman's research facility. HK's Holy Grail was a DAC technology that required a simple first-order analogue filter, a filter that would minimise any 'phase distortion' within the audio band.

RLS is Harman's solution to this digital conundrum, combining a single 8-times oversampling filter with two mono 18-bit DACs/ch. After oversampling, the information describing each channel is divided into two parallel datastreams. One is fed directly to a 'reference DAC', the other is delayed by one 8-times oversample period (using a bank of 8-bit shift registers) and addressed to the second or 'working DAC'.

Once in the analogue domain, the output of the reference DAC is used to determine both the rate and direction of change in the delayed samples being delivered by the working DAC. This is achieved using a comparator which interpolates between successive samples emerging from the working (delayed) and reference DACs, using the latter to look 'one sample ahead'. In theory then, the comparator knows in advance the exact amplitude of the next incoming sample, using the difference between this and the existing sample to interpolate a line between the two.

Instead of creating a series of squarewave 'steps' between consecutive samples, in the fashion of a conventional multi-bit DAC, HK's interpolation links one sample directly to another. As a result the shape and harmonic content of its pre-filtered analogue signal is already very much closer to the original, reducing its RF output above 8-times the sampling frequency (352.8kHz) and needing little more than a first-order filter to complete the job. In fact HK uses a single-pole filter set at a high 88kHz.

So even if this route actually increases the physical number of components in the analogue signal path, Harman will be content that its own principal goal has been achieved. Whether this might be judged an 'own goal' in another sense is discussed in the lab report.

SOUND QUALITY

During my research for this article I had occasion to speak with Marty Zanfino, Harman's Vice-President of Engineering, who declared a preference for warm and 'non-digital

sounding' CD players: and the HD7625 is indeed a pipe-and-slippers players that allows its music to ebb and flow in an almost dream-like fashion.

This sweet and mellow character carries over into most forms of music, the double-bass making a brief appearance on Kenny Davern's 'Mood Indigo' before an equally easy-going tenor sax took centre stage. Other jazz CDs sounded just as open and lively, though individual instruments were only vaguely depicted, a shimmer that caused the exact position of clarinet, sax and piano to hover uncertainly.

There's plenty of energy and vibrancy then, but a lack of the finesse, focus and subtlety that one might expect at this price.

On the whole, classical recordings maintained this placid outlook, with the likes of Arnold's Viola Concerto drifting somewhat aimlessly rather than describing a series of dances or scenes, a complacency that's not especially troubling even if it does hamper the natural evolution or progression of the music. Turning to Mahler's 2nd, this prompted a cloudburst of sound, one that retained a marvellous sense of scale despite being exceedingly 'fuzzy' about the edges. Rather like an analogue cartridge whose stylus is enveloped in a ball of fluff, the crescendos developed by the HD7625 are appropriately grand but inappropriately vague.

Rock music puts a different slant on things, with the strings of a powerful bass guitar sounding more like rubber bands, trading the urgency and bite of the original for something altogether more comfortable. Again, there's no escaping the contrived but soft focus of this player. Even a dominant vocalist such as Lyle Lovett (*Friend of the Devil*) is revealed as a man with a huge mouth and tonsils to match, the image of his voice strewn across the front of the soundstage, leaving the cry of guitar to soar unchecked and unfocused.

Interestingly, the music did exhibit a strangely 'phasey' quality, rather like listening to an otherwise fine set of speakers whose L/R pair-matching is slightly out of kilter. For the HD7625 is undoubtedly very pleasant to hear, so long as you listen to music for sedation rather than refreshment or invigoration.

LAB REPORT

Sure enough, the mild response ripples and V-shaped stopband images on the 3D plot [Fig 3] are features of the NPC SM5840 8-times oversampling filter yet, in virtually every other respect the technical performance of HK's HD7625 is influenced by its analogue circuitry, and linear interpolation in particular. Firstly, HK's technique will not reduce the level of noise appearing at frequencies below 8Fs (352.8kHz), so the 106dB signal-to-noise ratio is entirely realistic for one of Burr-Brown's PCM6 1P DACs.

More important, however, are the consequences of mis-matches in linearity that inevitably occur between the reference and delayed or working DAC. If the levels of samples from both the reference and working DAC do not coincide, then the interpolation will be misguided, resulting in waveshapes that deviate from the original. This will add to the odd-order distortion, the noise, and composite non-linearity of the RLS stage, especially at low signal levels, where resolution invariably deteriorates, and at high signal frequencies, where the rate of change from sample to sample is greatest.

The 3D plot reveals traces of third- and fifth harmonic distortions at 0dB while at lower levels the −70dB/1kHz trace [Fig 2] exposes a spray of odd-order products extending beyond the 99th harmonic, raising the ultrasonic noise floor beyond that expected of a conventional multi-bit DAC. Meanwhile the intensity of in-band third, fifth, seventh etc harmonics increases, particularly at high frequencies where, at 20kHz, distortion exceeds 100% when signals fall below −75dB in amplitude.

Even at −60dB, distortion in the RLS stage increases from 0.36% at 1kHz to 7% at 20kHz [Fig 4]. Moreover, its resolution also takes a nose-dive at 20kHz with huge errors of −11dB being recorded at −90dB. These errors contribute to a treble roll off that varies with signal level (see −60dB response, Fig 1).

CONCLUSION

'Joining-the-dots' from sample to sample is a laudable intention, especially if the struggle against ultrasonic noise and high-order filters is deemed to be of over-riding importance, and Harman is to be congratulated for having the confidence to break from the mainstream and plough a thoroughly novel furrow with its Realtime Linear Smoothing.

Unfortunately, though, the implementation of RLS has not been thoroughly researched, and even the choice of DACs appears to have been arrived at by default rather than experiment. As a consequence the foibles of its execution may well swamp any possible advantage predicted on paper, leaving us with a player that's the musical equivalent of a mug of Horlicks. Gentle massage for tired ears only.

HARMAN KARDON HD7625

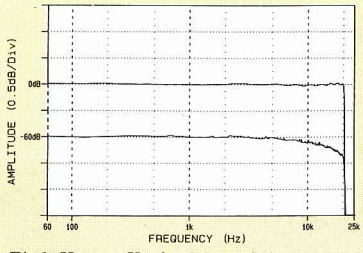

Fig 1. Harman Kardon HD7625: frequency responses at 0dB and −60dB (0.5dB/div)

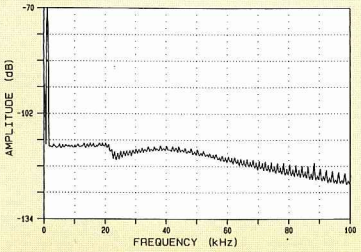

Fig 2. Harman Kardon HD7625: spuriae up to 100kHz associated with 1kHz tone at −70dB (dithered)

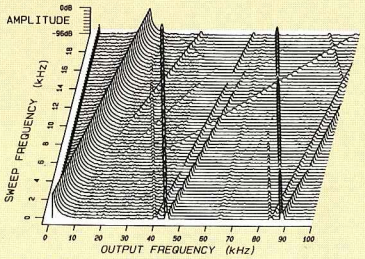

Fig 3. Harman Kardon HD7625: spurious output up to 100kHz resulting from swept tone (0-20kHz) at 0dB

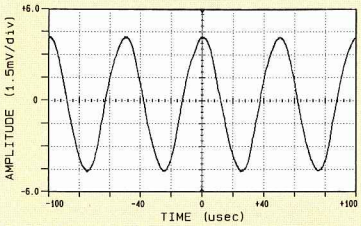

Fig 4. Harman Kardon HD7625: waveform of 20kHz signal at −60dB

Once in the analogue domain, the output of the reference DAC is used to determine both the rate and direction of change in the delayed samples being delivered by the working DAC. This is achieved using a comparator which interpolates between successive samples emerging from the working (delayed) and reference DACs, using the latter to look 'one sample ahead'

Test results	Harman Kardon HD7625		
	20Hz	1kHz	20kHz
Channel balance (dB)	0	0	0.04
Channel separation (dB)	104.3	101	90.6
Distortion (dB):			
THD at 0	−99.1	−99	−76.6
THD at −30	−84.6	−77	−54.6
THD at −60	−52.5	−48.8	−23.1
THD at −80	−28.1	−28.4	−1.15
Dithered, −90	−17.7	−17.9	+14.7
Dithered, −100		−15.1	
Dithered, −110		−3.5	
Linearity (resolution, error in dB)			
Error at −60dB		−0.03 −0.38	
Error at −80dB		−0.10 −3.95	
Error at −90dB		−0.75 −10.7	
Error at −100dB		−0.50 +3.90	
Peak output level, L/R		2.363V/2.363V (+1.45dB)	
Output impedence		151ohms	
Radio frequency spuriae		55mV at 13.3MHz	
1Hz Noise modulation		+5.6dB	
CCIR IMD, 0dB		−95.6dB	
Suppression of stop-band IMD		60.7dB	
De-emphasis accuracy	**1kHz**	**5kHz**	**16kHz**
Error (dB)	+0.01	+0.01	0.01
Signal-to-noise ratio (dB)			
A-wtd, with emphasis, OLSB		106.5	
A-wtd, without emphasis, OLSB		106.4	
A-wtd, without emphasis, ILSB		105.5	
Digital output		coaxial	
Crystal clock accuracy		−246.3ppm	
Track access time (track 99)		5.5 secs	
Typical retail price (inc VAT)		£500	

Note: we regret that gremlins attacked the captions in PM's earlier technical report on the Marantz CD5211 SE, May issue, page 51. References to 'digital in' and 'analogue in' were erroneous and should be ignored. Fig 1 showed responses at 0dB and −60dB; Fig 3 showed spurious output resulting from a swept 0-20kHz tone (not 0.2kHz!)

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