PRODUCTION MANAGEMENT

Vergleichstest 24-Bit-Wandler

■ Apogee AD-8000 und RME ADI-8 DS

Comparative test 24-bit-converters

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Head-to-head comparison of Apogee AD-8000 and RME ADI-8 DS 24-bit converters

The Upstart versus the Grand Master

The contest between Apogee and RME's top models is, on the face of it, a struggle between unequal opponents. Whilst the AD-8000 is recognised as the reference in the high-end sector of the market, the ADI-8 DS is a newcomer based on a new concept. In the event, this duel between the legendary grand master and the impudent upstart threw up a whole series of surprises.

summary

The Apogee AD-8000 and the RME ADI-8 DS eight-channel converters are unequal rivals when you look at their specifications. In terms of the actual conversion, however, there is a surprising result, indicating interesting new departures in product design.

From a cursory look at the front panels of the two devices and a glance at their specifications you could be forgiven for concluding that there is scant basis for comparison between the two subjects of our test. Whilst the AD-8000 is a pure eight-channel AD converter, which on the digital side is furnished with individual I/O ports using optional interface cards and can also optionally be fitted with a DA module, the features and connectivity of the ADI-8 DS, both on the analogue and on the digital side, are fixed. Since, however, the RME converter includes the basic functions of the Apogee and comes as standard on the digital side with the same functions as at least some of the Apogee expansion cards, the products do turn out on closer examination to be comparable. The additional features of each of the two devices will ensure that different customers will find the one or the other more attractive, but that is, after all, the point of having different products and independent research and development.

Goliath

The front panel of the 2U Apogee AD-8000 is packed with control elements including a high-resolution level meter for each channel, an access key and a seven segment display by means of which digital „overs" are indicated numerically. A matrix is provided for routing signals to the interface cards, whilst a headphone socket provides monitoring of all sources in 18-bit resolution.

In its standard version, the AD-8000 offers eight balanced analogue inputs on XLR jacks, the signals of which are available after conversion in up to 24-bit/48kHz quality on four AES/EBU outputs. In addition to the internal clock, an external AES/EBU or S/PDIF signal or even word clock can serve as sync signals. A low-jitter clock with active jitter suppression is provided. Other standard features include the well-known UV22 dithering algorithm, which flawlessly translates the AD-8000's 24-bit high-resolution output for 16 bit mediums, and

PHOTOS: THOMAS SANDMANN

Soft Limit circuitry, which prevents analogue overloading of the AD converter.

A special feature of the AD-8000 is the AMBus card bay, which can accommodate a variety of interface cards. By this means, the AD-8000 can be furnished for example with an ADAT or TDIF interface. The cards are bi-directional and therefore allow the reintroduction of digital signals to the AD-8000. The device we were given for testing was fitted with the Digi-8+ AMBus card for use with Pro Tools. For the purposes of making a direct comparison with the RME converter, an ADAT card would have been more useful, but the German distributors apparently had no such card in stock, since, as they told us, the device is sold "almost exclusively to Pro Tools users". Unfortunately the optional DAC-VIII card, which provides eight balanced analogue outputs on a 25-pin Sub D socket, was not fitted either.

David

The ADI-8 DS from RME is only 1U high and offers, in place of bar metering, a Signal Present LED for each input and output channel. On the input side, Clip LEDs are also provided. RME argue that level meters are in any case present in the recording program. In addition to the mains switch and Input and Output Level selector switches, a number of other selector switches with Status LEDs are provided for the digital settings. These will be described later.

With the AID-8 DS, no options are offered, but this hardly constitutes much of a drawback seeing that the basic specification is so comprehensive. The device, which is also available without the dual sampling frequencies as the ADI-8 Pro and appears also in the guise of Nuendo hardware under the name "8-I/O", offers eight balanced analogue inputs on individual _" TRS jack sockets and simulta neously on a DB-25 (25-pin D-type connector) for an optional XLR multicore cable. After the AD conversion, the signal is available in up to 24-bit/96kHz quality on ADAT optical and TDIF connectors. The same is true in the opposite direction: the DA section is equipped with TDIF and ADAT connectors and the analogue signals are available on eight _" TRS sockets and a DB-25 connector.

In addition to the internal clock, ADAT optical, TDIF or word clock can serve as sync signals. The user interface for the digital settings is easy to use, thanks to features such as SyncCheck and Intelligent Clock Control (ICC). The AD and DA sections of the device run independently and can even be operated simultaneously at different sample rates. A function called Copy Mode provides purely digital routing, allowing the device to operate as a format converter from ADAT to TDIF (or the reverse). Also included are bit splitting, which permits the uncompromised recording of 24-bit data streams on 16-bit mediums, and dithering. The RME is also indirectly Pro Tools compatible through the use of Digidesign's ADAT Bridge.

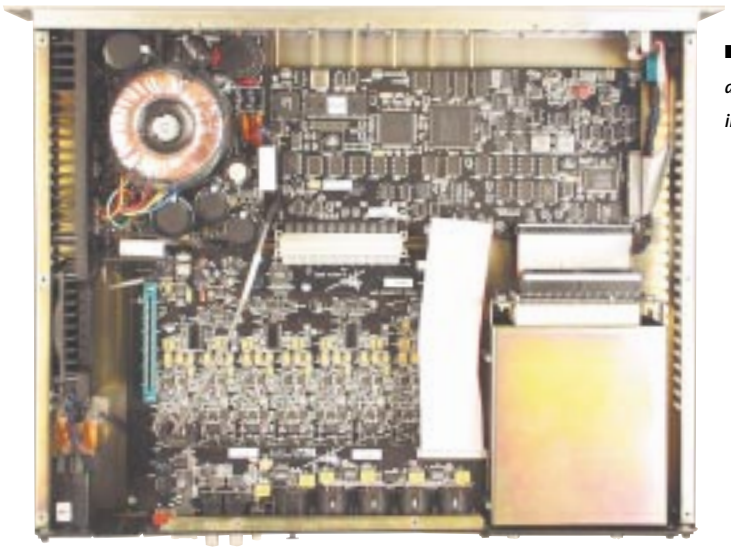
Under the bonnet

There can be few devices surrounded with as much mystique as the Apogee AD-8000. Apogee have polished the top of the converter chip as a precaution and covered it with black paint, but naturally we weren't going to let a little thing like that put us off, so we took it into the laboratory to get a closer look. As an AD converter, it uses the AK5391 from Asahi Kasei (AKM). In a way, this is hardly surprising, since in 1997, when the AD-8000 was created, there was virtually no alternative; on the other hand, since 1998, AKM have been offering the pin-compatible AK5392, which easily outstrips the AK5391, delivering 3 dB better values for THD and S/N. It is the later chip that is to be found in the ADI-8 DS. A balanced input circuit, with CMRR balancing and basic sensitivity (+4/-10) switchable by relay, is followed by an amplification stage offering up to 20 dB of gain, which can be calibrated per channel using the Trim pot on the front panel. In front of the AD converters is the analogue part of the Soft Limit circuitry, which represents a limiter that appears to be digitally controlled.

These circuit elements are found on the same board as the AD converters at the back of the device. The entire digital section on the other hand is to be found

Product:	**AD-8000**	**ADI-8 DS**
Manufacturer:	Apogee	RME
Ditstributor:	SMM	Synthax
Price:	c. 13.000 DM	c. 3.500 DM

■ *Apogee AD-8000 and RME ADI-8 DS*



■ *Full circuit boards and solid technology in the AD-8000*

on a separate board near the front panel. Such a layout is theoretically less susceptible to faults than the alternative adopted by the ADI-8 DS, which is to put all the components on the same board. However, as we will see later, theory and practice do not always correspond.

The digital section of the AD-8000 is lavishly equipped with several FPGAs (Field Programmable Gate Arrays), a Motorola 56002 DSP, a micro-controller and many additional digital ICs. On the right hand side are to be found a fan and a large heat sink for the linearly controlled power supply unit with its large toroidal mains transformer. The fan is pleasantly quiet, though it will still annoy purists. All in all, the device conveys a reassuring sense of robustness.

The inside of the ADI-8 DS from RME has a very tidy appearance. Virtually all the electronics, analogue and digital, are to be found on the mainboard. On the left is the AD section; in the centre, the digital calculation and control unit; on the right, the DA section. What is noticeable is that the digital section consists almost entirely of a single Xilinx FPGA. Clearly the control, format conversion, data processing and even the dithering are all performed by this chip, which was programmed by RME's own developers. This seems to be a speciality of the German manufacturer, since the well-known DIGI96 card series is also based on this technology.

Both the AD and the DA sections of the ADI-8 DS are — apart from the coupling capacitors directly next to the sockets — entirely DC coupled. The converter chips include DC filters and automatic calibration, eliminating any DC offset. Electronic CMOS switches allow level adjustment +4 dBu/-10 dBV as well as the use of an additional high level setting (Lo/Hi Gain) that operates in the area of +19 dBu and should bring joy to users of analogue consoles subscribing to the same philosophy.

In the AD section, the audio path from the sockets to the AD converter is entirely balanced with no CMRR balancing or individual level adjustment. According to RME, the ADI-8 is also available in a Broadcast Version with +6 dBu instead of +4 dBu so it is only the missing AES/EBU interfaces that stand in the way of its use in all professional areas.

In the DA section, Analog Devices AD1852s are used. On the manufacturer's web site, it is claimed that this chip achieves extraordinary THD values and is less susceptible to clock jitter than comparable DACs. The analogue inputs and outputs are electronically balanced and offer automatic level adjustment in unbalanced mode. The symmetrical output stage has been calibrated by trimmer for full symmetry.

Finally, on the right hand side is to be found a Taiwanese switch-mode power supply unit — something you would not normally expect to find in an audiophile device, though this, too, provided us with a surprise.

The minimalism of the digital section and the switch-mode PSU ensure that power consumption is moderate and that the device is very energy efficient. This also means that far less heat is generated and no fan is needed, the device scarcely even becoming warm after sustained use. The relatively simple chassis fulfils its purpose and offers adequate mechanical stability.

Frequency response and dynamic range

Both the devices under examination performed well in terms of frequency

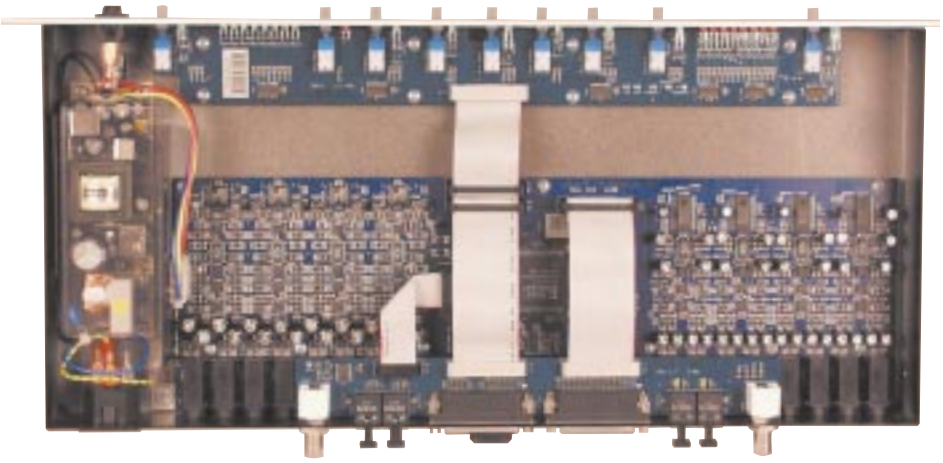
■ *The AMBus of the AD-8000 offers universal interface options*

response. Thanks to extensive DC coupling, the lower level is determined almost entirely by the DC filters on the digital level. Even the top end is determined by the ADC, whilst in-between the response is linear. In 96 kHz mode, the ADI-8 DS is able to excel with a frequency response up to 46 kHz.

We were somewhat surprised by our measurements of the signal-to-noise ratios. As with all modern converters, the values for the signal-to-noise ratio and dynamic range (i.e. the signal-to-noise ratio with, and without, a stimulating signal) were identical. According to its handbook, the Apogee AD-8000 should be able to achieve 112 dB RMS unweighted, but the AK5391 it uses does not deliver this. Even after adjusting the gain and sensitivity, it proved impossible to achieve any value better than 109 dB and even this result was only reached by two channels; the others delivered values between 106 and 108 dB.

It was a different story with the ADI-8 DS: just under 113 dB in the positions Low Gain and +4 dBu and 109 dB with the setting -10 dBV – and the results were identical on all eight channels, giving the lie to the theory that using a single, large board and a switch-mode PSU would spell death to all hopes of achieving high-end measurements. Nor does the ADI-8 DS's DA section have anything to be ashamed of: with 109 dB (106 dB at -10 dBV) – again, a result duplicated on all eight channels – the performance was far better than one might at first have expected.

A more precise examination using spectrum analysis provided an explanation for the large differences between the performance of the Apogee's different channels. Whilst the noise floor is the same on all eight channels of the ADI-8 DS, with the Apogee device there are different peaks rising up as fixed artifacts. Such effects, which can be produced by cross-modulation of different clock signals within a device, are the kind of thing many people would have expected to find in the ADI-8 DS rather than in the Apogee. The diagrams illustrate the comparison and also the low noise floor of the ADI-8 DS.



■ *The interior of the ADI-8 DS: neat and clearly laid out*

Total harmonic distortion

When we measured the total harmonic distortion, we were impressed with the performance of both devices - the reading being clearly below 110 dB THD in each case. Small changes in the level sometimes brought about marked improvements, the UPL sometimes gave readings as good as -138 dB, though here it can be asked how reliable such measurements are, since they are outside the UPL's range of measurement.

When it came to THD+N, the Apogee did not get a look-in because of its markedly higher basic noise level. Even in the best channel, Channel Two, of the device we tested, the -105 dB measurement was inferior to the -107 dB that the ADI-8 DS produced on all eight channels. Its DA section, with -105 dB THD, is considerably better than solutions with comparable DACs (e.g. AK4393) and even a figure of -102 dB for THD+N (once again, identical on all eight channels) is nothing to be ashamed of. What is not clear is how Apogee can justify the claim in their handbook: "Relative THD+N -108 dB".

Crosstalk attenuation

Whilst the ADI-8 DS delivered exactly the values RME claim for it in their Technical Information (over 130 dB), the Apogee suffered a surprise defeat in this department. Instead of the 113 dB listed in the handbook, the best measurement we could get was 95 dB within stereo pairs – a clear symptom of crosstalk in the analogue section of the AD converter. Across stereo pairs (i.e. between different stereo pairs) it was 103 dB, but here too it was outmatched by the ADI-8 DS which delivered 106 dB within, and 115 dB across, stereo pairs.

Synchronisation

A precise examination of the clocks is essential when devices are used in such a wide range of different contexts, since their quality can make a vast difference to the overall results and can dramatically alter the quality of the AD conversion. In principle, the Apogee, with its active jitter suppression, should have had the edge here; you test this by feeding in an AES/EBU signal with jitter as clock and the result should correspond to one without jitter. We were surprised, therefore, by the basic quality of the conversion by external clock which, despite the jitter suppression, was markedly inferior to that using the internal clock. It seems

■ *Simple and functional: the RME ADI-8 DS*

then that if you work with half-way clean external clocks, this special Apogee circuitry brings no apparent advantages.

Concretely, the AD-8000 with the internal clock exhibited 2.2 ns (44.1 kHz) and 1.2 ns (48 kHz) of jitter at the AES/EBU output. Using the word clock or AES/EBU input as the clock source, there was 4.5 ns of jitter at the output, so it is no wonder that the conversion is markedly inferior in this mode. A more precise jitter analysis, however, showed that this was very low frequency jitter (under 400 Hz) and therefore virtually undetectable by the human ear.

The AD-8000's jitter suppression seems to operate on at least two levels. If the amount of jitter in the signal is pronounced, the PLL remains in the coarse, wide capture range. Nonetheless, we were able to detect a slight improvement by factor 2 of the jitter-affected word clock input signal to the WC output. Beneath 40 ns and where the deviation from the basic frequency is not too great, it switches to the Low Jitter Clock, presumably a very slow reacting VCXO-PLL. This eliminates all fluctuation except for internal ones.

What struck us when making these measurements was this: when the internal clock was being used, the mere connection of an AES/EBU signal led to a deterioration of the AD conversion. Here the CS8412 operating as the receiver PLL appears to be interfering with the internal clock which is directly next to it on the front digital board. The effect is, of course, too slight to be audible.

In the ADI-8 DS the clock section is kept more simple internally. Two quartz oscillators produce the internal clock, there are three PLLs locked to both ADAT inputs and the word clock input. As already mentioned, there is practically no jitter-damping, a jitter-affected word clock signal will therefore be delivered unchanged by the ADI-8 DS and will cause a deterioration in the AD and DA conversion. The diagrams show in each case the influence of 20 ns of jitter with sine modulation. Tests with an ADAT PC card and an ADAT recorder however showed, firstly, that the ADAT PLL of the ADI-8 DS works excellently (RME speak of a Bitclock PLL capable even of tracking ADAT XT Varipitch consistently) and, secondly, that the level of jitter from such sources is normally less than 5 ns and therefore scarcely affects the quality of the conversion. What is interesting in this connection is that the ADI-8 DS showed no clock problems at all with Tascam's DA-88 and DA-38, neither as master nor as slave, which is by no means self-explanatory. The internal clock, with 1.5 ns of jitter at 44.1 and 48 kHz, has comparable values to those of the Apogee.

The ADI-8 DS has two other desirable features. Firstly the AD and DA sections can operate completely independently. Inevitably in such a case there is going to be distortion within a device, since there are different clocks running asynchronously. Incredibly, however, the distortion caused by asynchronous operation is not detectable. Neither the outstanding signal-to-noise ratio of the AD converters nor that of the DA section were affected. One is tempted to look for a hidden separation between the AD and DA sections of the device, but there isn't one. Only when completely different sampling rates are used, for example

For signal-to-noise and frequency response, we took our own measurements rather than simply relying on the figures provided by the manufacturers.

Signal-to-noise

Apogee AD-8000

Channel	RMS unweighted	A-weighted
1	107 dB	110 dB
2	109 dB	113 dB
3	108 dB	112 dB
4	107 dB	111 dB
5	106 dB	108 dB
6	109 dB	113 dB
7	106.5 dB	110 dB
8	107.5 dB	112 dB

RME ADI-8 DS

Channel	RMS unweighted	A-weighted
1-8	113.5 dB	117 dB

Frequency response

Apogee AD-8000

Frequency response @
44.1 kHz 10 Hz-0.1 dB
20.4 kHz -0.1 dB
20.6 kHz -0.2 dB
20.71 kHz-0.3 dB
20.81 kHz-0.4 dB
21.44 kHz-3 dB

RME ADI-8 DS

Frequency response AD	@ 44.1 kHz @ 88.2 kHz @ 96 kHz
10 Hz	-0.1 dB
10 Hz	-0.1 dB
10 Hz	-0.1 dB
20 kHz	-0.1 dB
20 kHz	-0.1 dB
20 kHz	-0.1 dB
20.52 kHz	-0.2 dB
35.63 kHz	-0.2 dB
35.90 kHz	-0.2 dB
20.62 kHz	-0.3 dB
40.60 kHz	-0.3 dB
41.10 kHz	-0.3 dB
20.72 kHz	-0.4 dB
41.01 kHz	-0.4 dB
44.67 kHz	-0.4 dB
21.44 kHz	-3 dB
42.89 kHz	-3 dB
46.52 kHz	-3 dB

Frequency response DA @ 44.1 kHz @ 88.2 kHz @ 96 kHz	
10 Hz	-0.1 dB
10 Hz	-0.1 dB
10 Hz	-0.1 dB
20.70 kHz	-0.1 dB
38 kHz	-0.1 dB
41 kHz	-0.1 dB
20.90 kHz	-0.2 dB
39.20 kHz	-0.2 dB
42.50 kHz	-0.2 dB
21.00 kHz	-0.3 dB
39.60 kHz	-0.3 dB
43.00 kHz	-0.3 dB
21.05 kHz	-0.4 dB
40.00 kHz	-0.4 dB
43.40 kHz	-0.4 dB
22.00 kHz	-3 dB
43.50 kHz	-3 dB
47.50 kHz	-3 dB

44.1 kHz in the AD section and 48 kHz in the DA, does the signal-to-noise ratio deteriorate, and then only by 2 dB; there is a uniform rise in the level of the noise floor without any sharp edges. Secondly, with the ADI-8 DS it is possible to operate the DA section with the internal clock. This is also a very unusual feature and it guarantees the highest possible audio quality for the DA conversion. Technically, this requires an additional buffering of the incoming digital data, so that it can be read without distortion by the internal clock, and it worked flawlessly in our tests.

RME has built in a feature it calls 'Intelligent Clock Control', an intelligent user interface providing internal control for its complex clock-options, preventing the user from making self-contradictory or absurd settings: if, for example, you select "DA Internal", the AD section can only be operated on "Internal". The corresponding LEDs blink if a clock is absent. It sounds simple but it works excellently in practice and means, in effect, that you can operate the device without bothering to read the handbook. To make things better still, a function called SyncCheck is provided which checks whether the clocks being used are in fact running in sync. This is an important feature not only for the DA Internal mode mentioned above but also because the Bit Split and 96 kHz modes require the presence of two TDIF and ADAT inputs each. Thanks to SyncCheck you can tell at once whether the second signal is merely locked or really in sync. In the event of a fault, the LED of the offending input blinks.

Dithering

With the UV22, Apogee created the standard that is accepted world-wide, so at first sight it seems logical to offer this much sought-after process in the AD-8000 as well. UV22 shifts the added noise into a region to which the human ear is not sensitive i.e. from 10 kHz to half the sampling frequency. After the truncation, UV22 ensures that the noise is far less audible whilst eliminating altogether the dreaded quantisation distortion.

Of course, UV22 is also the subject of controversy, since the enormous noise level in the high frequency region (-81 dBFS RMS unweighted) can, if the master needs to be re-edited, lead to problems.

Apogee has licensed the process widely and it is now to be found also in several software packages. Whether dithering at the very front of the signal processing chain makes sense in this extreme form is also open to question. The advantage of the UV22 in an 8-channel converter is therefore relative. On the other hand, the converter is of such high quality that it is naturally suitable for pure two-track operation when mastering, and UV22 can therefore be regarded as a useful feature.

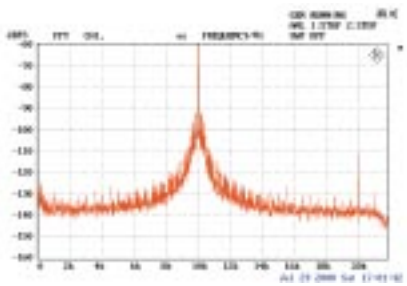
Although RME, as is apparent from their web site, consider the value of dithering to have been wilfully exaggerated, the ADI-8 DS also contains such a process. Since in 96 kHz mode the Bit Split option is no longer available, RME were left with little choice. The dithering operates with uniformly distributed noise corresponding to 1LSB. The spectrum analysis shows as expected that both processes result in the total elimination of quantisation distortion.

Soft Limit

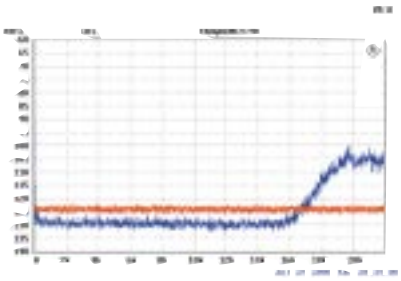
This circuit on the AD-8000 is supposed to work like dbx's Type IV: to avoid overloading the AD converter, a limiter provides non-linear limiting in the area -4 to 0 dBFS; the nearer the level comes to zero, the stronger. However, either Apogee's circuitry is defective or the attack and release times are to short, since as soon as Soft Limit comes into action, there is around 3 per cent distortion. Of course, a measurement of such a peak limiter always looks worse than it sounds. Whilst with ordinary pop material, the Soft Limit circuit can produce an intensification and volume increase without pumping effects, it leads to a raw sound with critical material.

At this point it might be worth asking: „what do the two devices sound like?". The answer is: „they don't have a sound". As the measurements show and subsequent listening confirms, the accolade 'neutral' can be awarded to both the devices tested. This changes, of course, when the Apogee Soft Limit circuit is activated since this has a considerable influence upon the sonic characteristics of the converter.

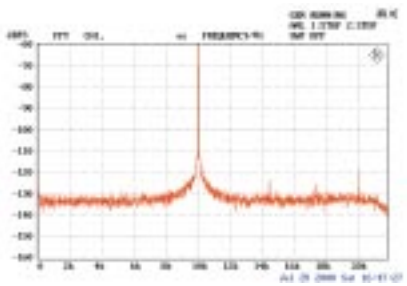
■ ***The full connectivity comes as standard with the ADI-8 DS***



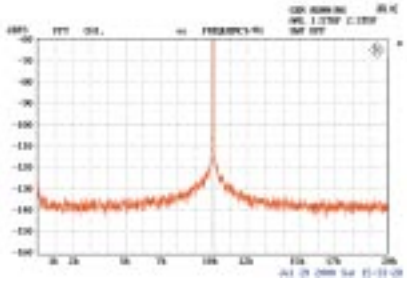
■ *AD-8000: AES/EBU Clock, 10 kHz*



■ *Dithering: Blue AD-8000 with UV22, red ADI-8 DS with evenly dispersed noise*



■ *ADI-8 DS: Synchronisation to ADAT input, 10 kHz*

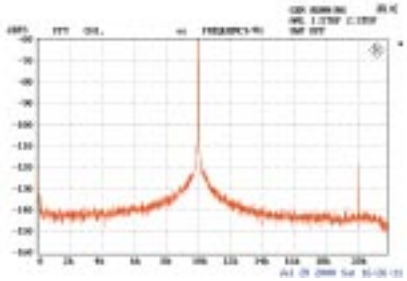


■ *AD-8000: Internal clock*

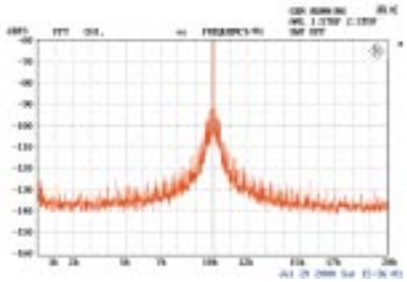
A win on points

In as far as the devices can be compared at all – the meaningful limits of any such comparison having been discussed above – there is a winner and one that will surprise many people. The RME ADI-8 DS not only offers a wide range of useful features, convincing functionality and many and diverse possibilities, but also outstanding AD and DA conversion up to 96 kHz. When you consider the low price tag, all you can say is that this represents outstanding value for money, making it the clear points winner. Apogee's AD-8000 also offers a wealth of unique features, from the AMBus system to the universal sync and clock options and the UV22 technology, but the actual AD conversion provided by the Apogee is open to criticism. For a reference device, these values could be better and in view of the high price tag one can expect to see an adaptation of the hardware to current developments. ■

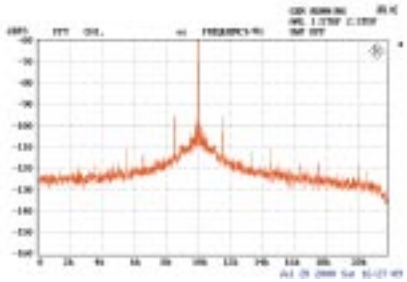
TEXT, MEASUREMENTS AND PHOTOS:
DIPL.-ING. THOMAS SANDMANN



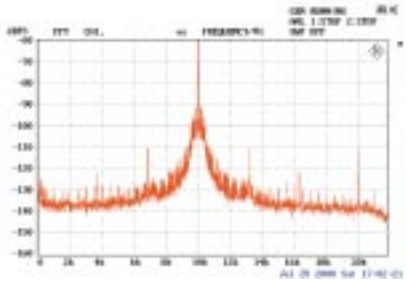
■ *ADI-8 DS: Internal clock*



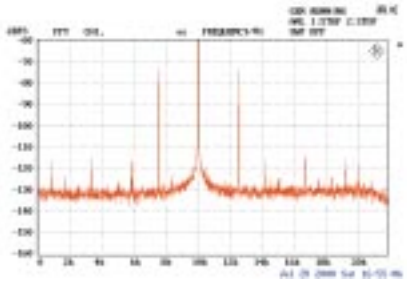
■ *AD-8000: Word clock synchronisation, 10 kHz*



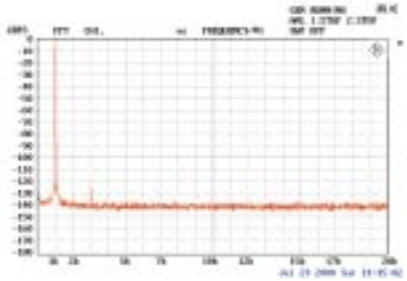
■ *ADI-8 DS: Word clock synchronisation, 10 kHz*



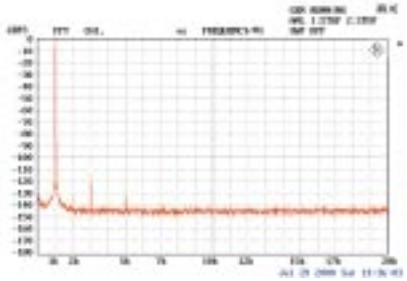
■ *AD-8000: AES/EBU jitter, 10 kHz*



■ *ADI-8 DS: Effect of jitter, 10 kHz*



■ *AD-8000: THD+N*



■ *ADI-8 DS: THD+N*