dbx
PROFESSIONAL PRODUCTS

704X

Digital Output Card

User Manual

Important Safety Instructions

The dbx 704X should only be used in a dbx 786, 160S, or a 160SL. Please follow the safety instructions contained in the manual for the product in which the dbx 704X is installed.

dbx® PROFESSIONAL PRODUCTS

Notes

Introduction

Congratulations on your purchase of the dbx 704X Digital Output Card. The 704X interfaces with your dbx Blue Series product for a premium analog to digital conversion. Below is a list of the features found on the 704X:

- Sample rates at 44.1, 48, 88.2, and 96 kHz
- Wordlength output at 16, 20, or 24 bits
- Dither to 16, 20, or 24 bits using TPDF or SNR^2 algorithms
- dbx Type IV™ A/D Conversion System
- Sync input/output using low jitter phase-locked loops
- Two user selectable noise shaping algorithms for lower perceived noise floor
- Digital output on gold plated connectors
- Can be installed in a dbx 160S/SL Compressor or a dbx 786 Precision Microphone Preamplifier

Service Contact Information

If you require technical support, contact dbx Customer Service. Be prepared to accurately describe the problem. Know the serial number of your unit - this is printed on a sticker attached to the rear panel. If you have not already taken the time to fill out your warranty registration card and send it in, please do so now.

Before you return a product to the factory for service, we recommend you refer to the manual. Make sure you have correctly followed installation steps and operation procedures. If you are still unable to solve a problem, contact our Customer Service Department at (801) 568-7660 for consultation. If you need to return a product to the factory for service, you MUST contact Customer Service to obtain a Return Authorization Number.

No returned products will be accepted at the factory without a Return Authorization Number.

Please refer to the Warranty below, which extends to the first end-user. After expiration of the warranty, a reasonable charge will be made for parts, labor, and packing if you choose to use the factory service facility. In all cases, you are responsible for transportation charges to the factory. dbx will pay return shipping if the unit is still under warranty.

Use the original packing material if it is available. Mark the package with the name of the shipper and with these words in red: DELICATE INSTRUMENT, FRAGILE! Insure the package properly. Ship prepaid, not collect. Do not ship parcel post.

Warranty

This warranty is valid only for the original purchaser and only in the United States.

1. The warranty registration card that accompanies this product must be mailed within 30 days after purchase date to validate this warranty. Proof-of-purchase is considered to be the burden of the consumer.
2. dbx warrants this product, when bought and used solely within the U.S., to be free from defects in materials and workmanship under normal use and service.
3. dbx liability under this warranty is limited to repairing or, at our discretion, replacing defective materials that show evidence of defect, provided the product is returned to dbx WITH RETURN AUTHORIZATION from the factory, where all parts and labor will be covered up to a period of two years. A Return Authorization number must be obtained from dbx by

telephone. The company shall not be liable for any consequential damage as a result of the product's use in any circuit or assembly.

4. dbx reserves the right to make changes in design or make additions to or improvements upon this product without incurring any obligation to install the same additions or improvements on products previously manufactured.

5 The foregoing is in lieu of all other warranties, expressed or implied, and dbx neither assumes nor authorizes any person to assume on its behalf any obligation or liability in connection with the sale of this product. In no event shall dbx or its dealers be liable for special or consequential damages or from any delay in the performance of this warranty due to causes beyond their control.

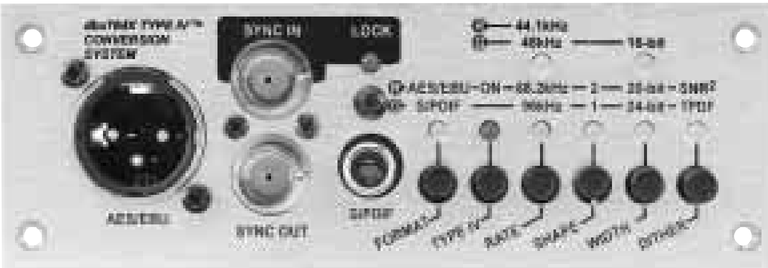
Installation

1. Remove lid of the 160SL or 786 by removing 6 phillips head screws (2 each side, 2 on the back) and 1 hex screw (top and center of front panel).
2. Remove the 4 silver screws holding the option cover plate on the rear.
3. Place the 704X in the 160SL/786 from the inside and note mounting holes labeled "A", "B", and "C".
4. Remove the 704X and then remove the 3 screws mounted in the 160SL/786 main board directly below points "A", "B", and "C" when the 704X is installed.
5. Install the 3 taller threaded standoffs where the three screws were removed.
6. Install the ribbon cable onto the blue header in the 160SL/786 next to the power supply housing.
7. Install the 704X by placing it in the 160SL/786 and then replacing the 4 silver screws into the rear option slot.

8. Install one of the three screws removed from the main board at point "C" on the 704X.
9. Install the two shorter standoffs at points "A" and "B" on the 704X.
10. Insert the ribbon cable from the main board to the blue connector on the 704X.
11. Install the upper 704X PCB by lining up the two standoffs with the mounting holes on the upper PCB.
12. Install the last two screws into the standoffs holding the upper 704X PCB.
13. Replace cover.

dbx 704X installed in a 786 Mic Preamp

Rear Panel



AES/EBU OUTPUT Connector: The 704X provides AES/EBU digital output format through the XLR connector. Be sure to use short lengths of 110Ωdigital cables rather than standard XLR to XLR cables. Using the correct cables will prevent digital dropouts and other interconnect problems.

SYNC IN and OUT Connectors: BNC connectors are provided for both sync in and out. The 704X uses low jitter phased-locked loops to synchronize to another unit's wordclock output through the 704X's SYNC in jack. The 704X will accept a 44.1, 48, 88.2, or 96 kHz wordclock input, or a 44.1 or 48kHz superclock (256X sample rate). You also may use the 704X as a host clock through the SYNC out BNC jack to supply stable clocks to other processors that accept a sync input. See "Sync Input" for further information.

SYNC LED: The SYNC LED will light red when the 704X is locked to an external clock through the SYNC IN BNC jack. Note that one of the RATE LEDs will light to indicate the clock frequency of the external source.

S/PDIF OUTPUT Connector: The 704X provides S/PDIF digital output format through the RCA coaxial connector. Be sure to use short lengths of 75Ω digital cables or 75Ω video cables rather standard audio RCA to RCA cables. Using the correct cables will prevent digital dropouts and other interconnect problems.

NOTE: Although digital information is coming out of both XLR and RCA jacks simultaneously, the correct format will only appear at the output for the format type selected. For example, if you have AES/EBU format selected, an AES/EBU formatted signal will appear at the output of both the XLR and the RCA connector. Or, if you have S/PDIF format selected, an S/PDIF formatted signal will appear at the output of both the RCA and XLR connectors.

AES/EBU / S/PDIF Switch: Selects either AES/EBU format or S/PDIF digital output format. The LED will be red for AES/EBU and green for S/PDIF.

TYPE IV Switch: Engages dbx's proprietary Type IV™ analog to digital conversion system. See page 9 for more information on Type IV™.

RATE Switch: Selects output sample rate of 44.1, 48, 88.2, or 96 kHz. The upper LED will light red for 44.1 kHz and green for 48 kHz. The lower LED will light red for 88.2 kHz and green for 96 kHz.

SHAPE: Selects noise-shaping curve of SHAPE 1, SHAPE 2, or none. Noise shaping essentially takes the noise floor and reshapes it in a fashion such that the ear perceives the noise floor to be quieter than it really is. See "Noise Shaping" graph on page 20. The LED will light green for Shape 1 and red for Shape 2. When the LED is off, there is no noise shaping taking place.

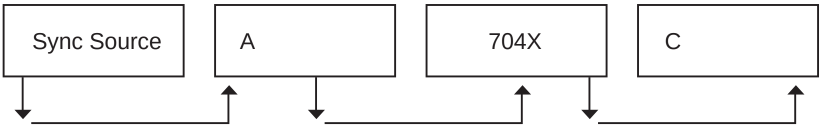
WIDTH Switch: Selects output wordlength of 16, 20, or 24 bits output resolution. The upper LED will light green for 16 bits. The lower LED will light red for 20 bits and green for 24 bits.

DITHER: Selects dither type of TPDF, SNR^2 , or None. Dither is random noise that is added to the audio signal which effectively eliminates the harmonic distortion created by truncation. See “TPDF Dither” and “Truncation” graphs on pages 19 and 20. The LED will light red for SNR^2 and green for TPDF. When the LED is off, there is no dithering taking place.

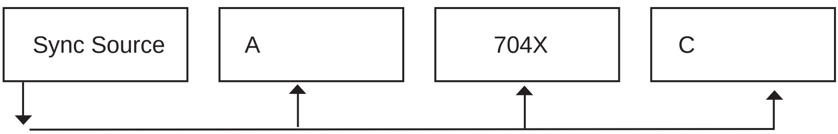
Sync Input

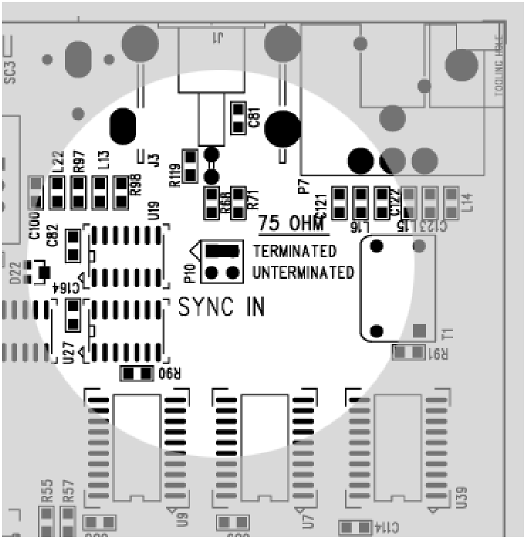
The dbx 704X comes with the sync input 75Ω terminated. For certain configurations, you may wish to have the sync input be unterminated. Certain "house sync" configurations will require you to change the default position of the termination jumper on the main circuit board. For example, if you run your sync to several pieces of equipment using a tapped configuration (using BNC T’s) as shown on the next page, only the last box, box C, would be terminated (marked "Terminated" on the circuit board). Unfortunately, some equipment does not allow the user to change the termination setting. These pieces of equipment are usually provided with a permanent termination. If you use the 704X with another piece of terminated equipment in tapped configuration, you should unterminate (marked "Unterminated" on the circuit board) the 704X’s sync input. The same is true if you wish to use several 704Xs in a tapped configuration. The dbx 704X can also be used in a daisy chain fashion where each piece of equipment can remain terminated so the termination can remain in the default "terminated" position. See figure on the next page for location of the termination jumper.

Daisy Chain Configuration



Tapped Configuration





dbx Type IV™ Conversion System

White Paper

by Roger Johnson

The dbx Type IV™ Conversion System is a proprietary analog-to-digital (A/D) conversion process that combines the best attributes of digital conversion and analog recording processes to preserve the essence of the analog signal when it is converted to a digital format. dbx Type IV™ not only exploits the wide linear dynamic range of today's A/D converters, but also enhances it and extends the useable dynamic range beyond the linear range. By providing a logarithmic "Type IV™ Over Region" above the linear A/D range, we benefit from the extended high-level headroom that is inherent in analog recording without compromising the noise performance of the A/D conversion process.

Digital conversion and recording processes proliferated in the 1980's primarily due to the "cleaner" sound of digital versus analog, an advantage resulting from the comparatively wider linear dynamic range of digital. Anyone who is familiar with the technical specifications of digital equipment knows that the typical maximum signal-to-noise specifications for 16-bit systems is in the neighborhood of 90-something dB. Compare this to the typical signal-to-noise specifications for professional analog tape of about 55 dB without the aid of noise reduction and around 75 to 85 dB with noise reduction such as dbx Type I™ or Type II™ applied.

This seemingly tremendous signal-to-noise advantage of digital over analog would suggest that digital would become the unanimous choice for recording. For the most part this has occurred, not totally due to its signal-to-noise advantage, but as much due to the benefits of digital storage such as random access and the inherent ability to withstand degradation, unlike that of analog tape or LP's. In spite of the benefits of digital, no one in the audio world can refute the rediscovery of analog recording and tube gear that has occurred in the 90's, attributable to the quest for that "analog character" that is missing from digital recordings. This continued use of analog gear with modern digital systems brings to light a favorable characteristic of analog recording which those who abandoned analog and jumped on the digital bandwagon were either never aware of or simply took for granted.

Anyone who has ever used analog tape knows that you can "hit it hard" without destroying the recording. The printed specifications of analog tape don't take into account the practical headroom available. The max signal-to-noise specification of analog tape is measured by defining the "max" signal as the point where a given signal level and frequency produces a given percent Total Harmonic Distortion (THD)—typically the level at which a 1 kHz signal produces 3% THD. In actual use, the signal can easily exceed this "max" signal level by 5, 10, or even 15 dB on peaks, depending on the type of signal being recorded, without unacceptable artifacts. High signal levels can be tolerated (i.e. more headroom) at the expense of increased THD which, incidentally, is often desirable as an effect, evidenced by the renewed popularity of tube equipment.

The obvious conclusion is that analog recording actually has more useable dynamic range than the specifications seem to indicate. For example, let's say we're recording a kick drum. If analog tape measures 55 dB from the 3% THD point down to the RMS noise floor and the peaks of the kick drum exceed the 3% THD level by, say, 15 dB and it still sounds good, then we have 15 dB of extra useable headroom. Therefore, we end up with 70 dB of useable dynamic range. Throw in noise reduction and we push into the 90-something dB dynamic range territory of 16-bit digital. This explains why well-recorded analog master tapes make good-sounding CD's with no objectionable noise.

One main drawback of digital is that it inherently lacks this forgiving and beneficial characteristic of analog recording. Although digital conversion exhibits wide linear dynamic range, when you run out of headroom for high-level signals, hard clipping or even ugly signal wrap-around occurs, not to mention that A/D converters have their own nasty side effects such as going unstable when their modulator is overdriven with high-level signals.

This shortcoming of digital conversion has drastically affected the way users operate their equipment. Users are paranoid of overdriving the converter input and end up recording at lower levels to ensure that there is ample headroom to allow for the large peaks that would ruin an otherwise perfect recording. This, of course, compromises signal-to-noise performance since the signal is now closer to the noise floor. Because users of digital equipment have to be extremely careful not to exceed 0 dB FS (full-scale), they must use peak-reading headroom meters. On the other hand, the forgiving nature of analog tape allows users of analog recording equipment the luxury of only needing to monitor the average level using VU meters, often having no peak indicators whatsoever. If only digital were more forgiving like analog, we could really exploit its wide dynamic range and more completely capture the essence of the musical performance.

Enter the dbx Type IV™ Conversion System. Like its related predecessor technologies—Type I™, Type II™, and Type III™—dbx Type IV™ succeeds in preserving the wide dynamic range of the original analog signal within a limited dynamic range medium. Whereas Type I™ and Type II™ expand the dynamic range of analog tape and other limited dynamic range media, and the simultaneous encode/decode process of Type III™ similarly expands the limited dynamic range through minimum-delay devices, Type IV™ breaks new ground by greatly enhancing the useable dynamic range of the analog-to-digital conversion process.

The dbx Type IV™ Conversion System combines proprietary analog and digital processing techniques to capture a much wider dynamic range than the A/D converter could by itself, preserving the maximum amount of information from the analog signal. This information is then encoded within the available bits of whichever A/D converter is used. This means that Type IV™ improves the performance of any A/D converter, from low-cost 16-bit to high-performance 24-bit! And no decoding is necessary beyond the conversion process!

As we have previously mentioned, digital systems have a wide linear region compared to analog tape and the dynamic range of A/D converters has improved significantly in recent years. The dbx Type IV™ Conversion System takes advantage of this and utilizes the top 4 dB of the A/D converter's linear dynamic range to create a logarithmic "overload region." This allows high-level transient signals passing far above the point where the overload region begins to be adequately represented in just 4 dB of the converter's dynamic range, whereas a typical A/D converter would clip. With Type IV™, you can never clip the A/D converter!

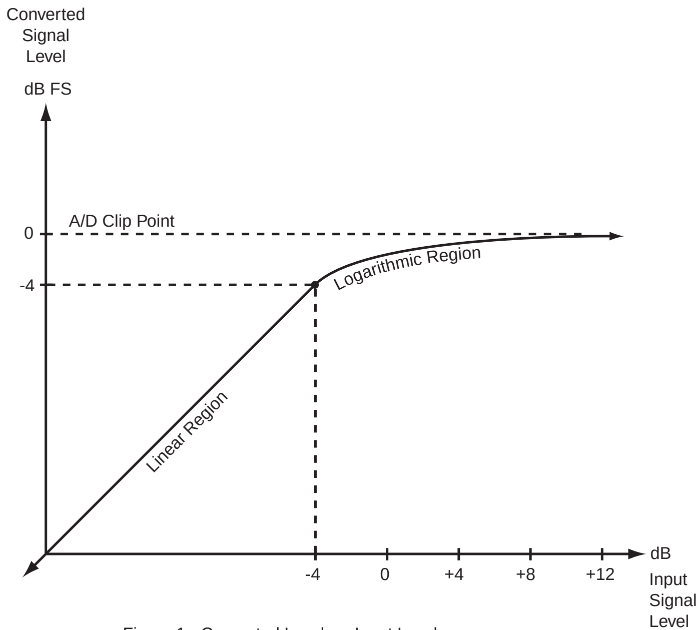


Figure 1 - Converted Level vs. Input Level

Fig. 1 illustrates this concept showing the level of the converted signal below and above the start of the overload region. The converted signal level is plotted along the Y-axis (vertical axis) of the plot vs. the level of the input signal along the X-axis (horizontal axis). The logarithmic mapping of the overload region begins 4 dB below 0 dB FS (full-scale) of the A/D converter. What this shows is that below -4 dB FS, in the linear region, the output signal is the same as the input signal. Above this, in the logarithmic region, high-level input signals get "mapped" into the top 4 dB of the A/D converter. This mapping is analogous to the signal compression effect that occurs when recording high-level signals onto analog tape.

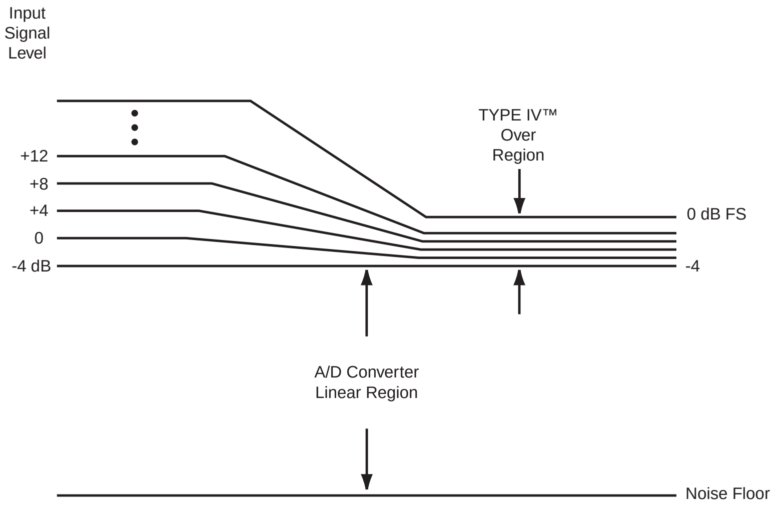


Figure 2 - Input Signal Levels Mapped to Type IV Over Region

Fig. 2 illustrates the mapping function in a different way. Input levels are shown on the left of the graph, while converted levels are shown on the right. Notice the mapping of large signal excursions to the 4 dB “Type IV™ Over Region.”

One might question the validity of such an approach—trying to represent a lot of signal information within a smaller “space.” The reason why this is not only valid but makes a whole lot of sense is that the digital codes in a converter are linear, or evenly-spaced, meaning that each consecutive code represents the same change in voltage of the input signal. This implies that half of the digital codes are used to represent input signals whose voltage level is below 1/2 of the full-scale A/D input voltage, while the other half of the codes are used to represent signals above 1/2 of the full-scale A/D input voltage. This seems reasonable until you realize that 1/2 of the full-scale input is only 6 dB below full-scale! So half of the codes are used to represent only the top 6 dB of signal information, while the other half are used to represent the remaining 80 to 110 dB of signal information, depending on the quality of the converter. It seems not only reasonable, but also desirable, to utilize the increased signal resolution afforded by this density of digital codes to represent more input dynamic range in this region.

Another advantage of the logarithmic mapping of our dbx Type IV™ Conversion System is that it preserves the high-frequency detail of the signal in the overload region. Figs. 3a through 3d illustrate what happens when you overload an A/D converter without Type IV™. Fig. 3a shows an input signal having both low-frequency and high-frequency components. When the signal overloads, or clips, (Fig. 3b) at the A/D converter, a disproportionate amount of high-frequency signal information is lost compared with the low-frequency information. The low and high-frequency components of the signal are separated in Fig. 3c to illustrate this more clearly. As you can see, the low frequency signal simply gets distorted but maintains most of its signal characteristics, while sections of the high-frequency signal are completely lost! With dbx Type IV™, its mapping preserves high-frequency signal information, as illustrated in Fig. 3d, since the signal is confined within the Type IV™ Over Region and never clips. The dashed line indicates the original input signal level. Below the Over Region no mapping occurs, while above this, mapping keeps all peaks of the signal below the A/D clip level, thus preserving the high-frequency content of the signal.

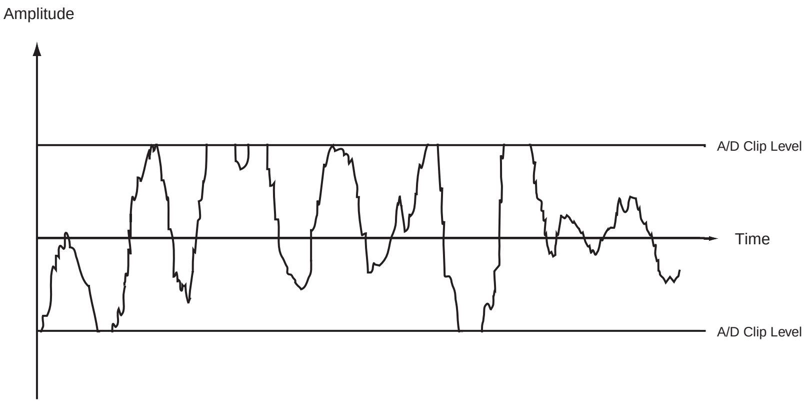


Figure 3b - Signal of Fig. 3a Going Beyond the A/D Clip Level

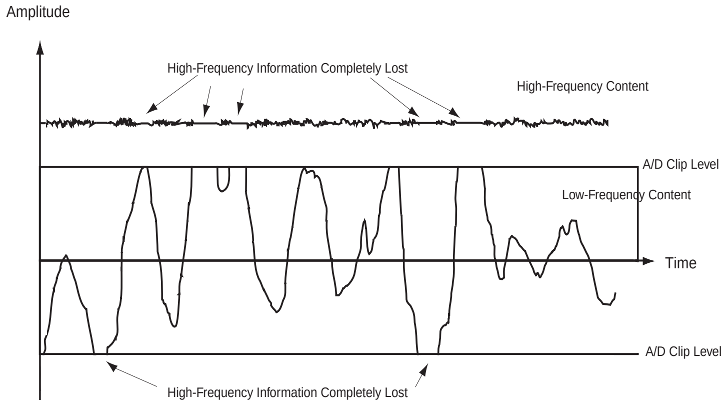


Figure 3c - Disproportionate Loss of High-Frequency Information Due to Clipping

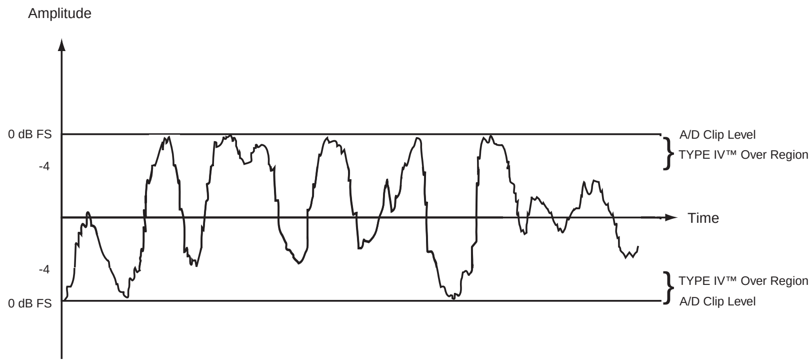


Figure 3d - Type IV Mapping Preserves High-Frequency Information

Now you're probably wondering, "What's the catch? I can't get something for nothing so what did I give up?" You may be worried that your A/D noise floor got 4 dB worse because we borrowed the top 4 dB of your converter. This is certainly a valid concern. Fortunately, we have the answer! Without going into the confidential technical details, by using our proprietary analog and digital Type IV™ processing, we reclaim the original A/D noise level! So what you get is free headroom!

The benefits of the dbx Type IV™ Conversion System can easily be heard by switching it in and out while listening to signals with high-level peaks captured in the Type IV™ Over Region. You will notice an obvious audible difference. With Type IV™ bypassed, you can't help notice the harsh, edgy sound of the A/D converter clipping. With Type IV™ enabled, those nasty artifacts disappear revealing a more open and natural sound. With Type IV™ enabled, you will get a more accurate and pure representation of the original wide-dynamic-range signal. You will absolutely agree that we really do give you "something for nothing." We give you peace of mind knowing that you never have to worry about clipping your A/D again! And when you listen to the noise floor of your A/D, you'll realize that we never compromise your noise performance with Type IV™!

The dbx Type IV™ Conversion System succeeds in combining the best of the analog and digital worlds to capture the truest essence and fullest dynamic range of audio signals. Who else but dbx would bring you this technology!

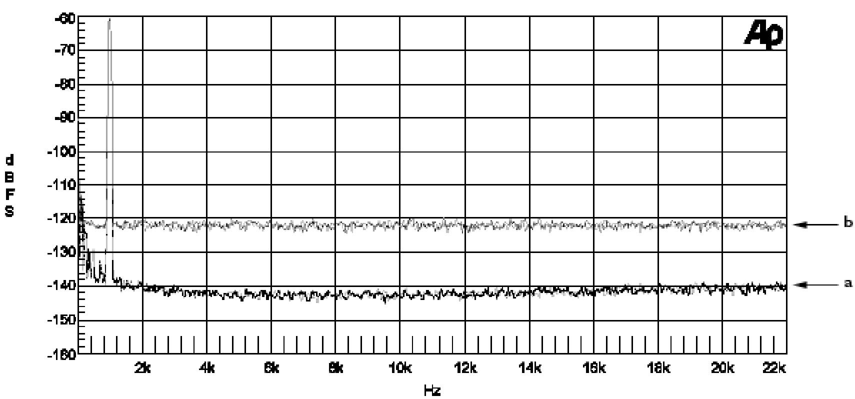
Specifications

A-D Conversion:	24 bit, dbx Type IV™ Conversion System
Converter Dynamic Range:	114 dB unweighted, 22 kHz bandwidth, Type IV™ engaged 117 dB "A" weighted, 22 kHz bandwidth, Type IV™ engaged
Type IV™ Dynamic Range:	Up to 127dB with transient material, A-weighted, 22-kHz bandwidth
THD+Noise:	<0.002% typical at -21.5dBFS, 1 kHz
Frequency Response:	20 Hz to 20 kHz, +0/-0.5 dB
Interchannel Crosstalk:	<95 dB at 1kHz
Sync Input Lock Range:	41.7 kHz to 49.9 kHz 83.4 kHz to 99.8 kHz

NOTE: +4dBU= -21.5dBFS

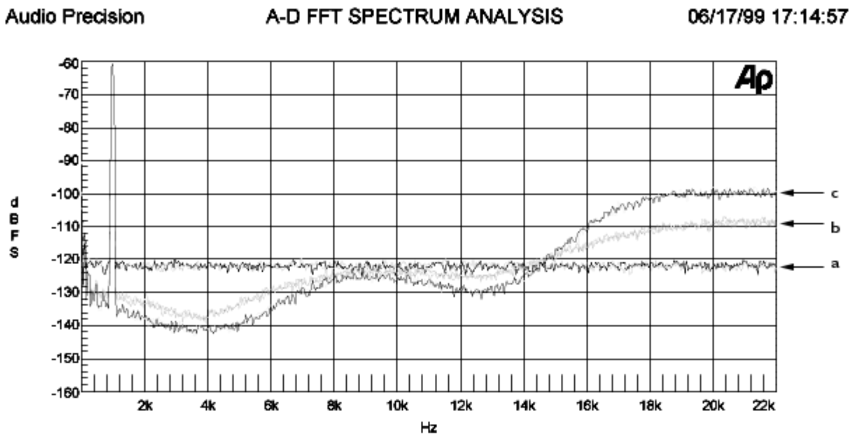
TPDF Dither

Audio Precision A-D FFT SPECTRUM ANALYSIS 06/17/99 17:03:13



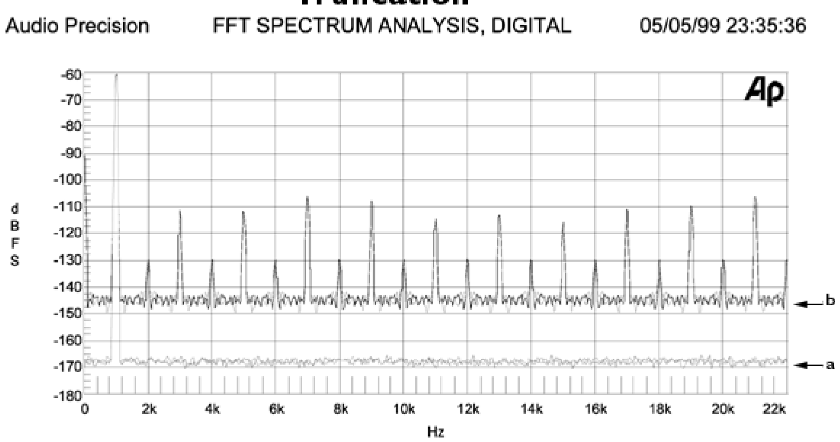
TPDF Dither. (a) 24-Bit word output, (b) 16-Bit word output. Parameters: Input -60dBFS, 1 kHz; FFT Length= 2048, Sample Rate= 48 Khz, Averages= 32; Graph Steps= 1024.

Noise Shaping



16-Bit TPDF dither. (a) Shape "off", (b) with shape set to "S1", (c) with shape set to "S2." Parameters: Input -60dBFS, 1 kHz; FFT Length= 2048, Sample Rate= 48 Khz, Averages= 32; Graph Steps= 1024.

Truncation



(a) 24-Bit word, (b) 16-Bit truncated output, no dither. Parameters: Input -60dBFS, 1 kHz; FFT Length= 2048, Sample Rate= 48 Khz, Averages= 32; Graph Steps= 1024.

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