dbx

PROFESSIONAL PRODUCTS

504X

Digital Output Card

User Manual

Important Safety Instructions

The dbx 504X should only be used in a dbx 566, 576, 586, or 1086. Please follow the safety instructions contained in the manual for the product in which the dbx 504X is installed.

Introduction

Congratulations on your purchase of the dbx 504X Digital Output Card. The 504X interfaces with your dbx Silver Series product or dbx 1086 for a premium analog to digital conversion for use with your digital audio devices. Below is a list of the features found on the 504X:

- Sample rates at 44.1kHz or 48kHz
- Wordlength outputs of 16, 20, or 24 bits
- Dither to 16 or 20 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 shape algorithms for lower perceived noise floor
- Digital output on gold plated connectors
- Can be installed in a dbx 566 Compressor, dbx 576 Microphone Preamplifier/Compressor, dbx 586 Microphone Preamplifier, or a dbx 1086 Microphone Preamplifier Processor

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.

Service Contact Information (cont.)

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.

Warranty (cont.)

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

To install the dbx 504X Digital Output Card in a dbx 1086, follow these instructions:

1. Disconnect all power and audio cables to the 1086.
2. Remove the top cover by removing the 2 screws on each side of the 1086.
3. Locate the option slot on the rear panel and remove the 4 screws and cover plate.
4. Holding the cards by the edges, remove the 504X cards from the static protective bags.
5. Locate the 4 pin jumper next to the board-to-board connector on the top board. Move the jumper to the "10 Series" position if it already isn't there. See Fig. 3 on page 6 for location of jumper.
6. The card with the rear plate and interface jacks will be installed first.

   A. From the inside of the 1086, place the card so that the holes on the card line up with the threaded standoffs in the chassis bottom.
   B. Start, but do not tighten, the two hex male-female threaded standoffs (included with the card) through the holes in the card into the threaded standoffs in the chassis.
   C. Use the 4 screws that held the blank cover on the 1086 to secure the 504X plate to the chassis. Start all four screws before tightening them completely.
   D. Tighten the 2 standoffs on the card.
   E. Carefully install the 10 pin cable (noting polarity) from the 1086 main PCB to the 504X.

Installation (cont.)

F. Carefully install the long 14 pin cable (noting polarity) from the 1086 main PCB to the 504X.
G. Install the wire tie down blocks on the upper PCB in the 1086 and then wire tie the long cable.

7 Take the top card of the 504X and mount it carefully to its mating connector on the lower card.
8 Use the two 6-32 1/4" screws to secure the top card to the threaded standoff.
9. Install plastic insulator directly above 504X card on the inside of the lid.
10. Replace the cover and 4 screws to the 1086.

Fig. 1

dbx 504X installed in a dbx 1086

To install the dbx 504X Digital Output Card in a dbx Silver Series product, follow these instructions:

1. Disconnect all power and audio cables to the Silver Series unit.
2. Remove the top cover by removing the 2 screws on each side and 2 screws on the rear, and the top-center hex screw on the front panel.
3. Locate the option slot on the rear panel and remove the 4 screws and cover plate.
4. Holding the cards by the edges, remove the 504X cards from the static protective bags.
5. Locate the 4 pin jumper next to the board-to-board connector on the top board. Move the jumper to the “Silver Series” position if it already isn’t there. Refer to Fig 3 on page 6 for location of jumper.
6. The card with the rear plate and interface jacks will be installed first.

Installation (cont.)

A. Remove the two 6-32" screws on the Silver Series main PCB directly below where the 504X will mount.
B. From the inside of the Silver Series product, place the 504X so that the holes on the card line up with the holes in the main PCB.
C. Use the 4 screws that held the blank cover to secure the 504X plate to the chassis. Start all four screws before tightening them completely.
D. Carefully install the 10 pin cable (noting polarity) from the Silver Series main PCB to the 504X.
E. Carefully install the short 14 pin cable (noting polarity) from the Silver Series main PCB to the 504X.

7. Take the top part of the 504X and mount it carefully to its mating connector on the lower card.
8. Line up two 1-3/16" round standoffs to the screw holes between the lower 504X and the Silver Series main PCB.
9. Line up the other two 1-3/16" round standoffs to the screw holes between the upper and lower PCBs of the 504X.
10. Place the two 6-32 3" screws through the round standoffs into the Silver Series Chassis.
11. Install plastic insulator directly above 504X card on the inside of the lid.
12. Replace the cover and screws to the Silver Series Product.

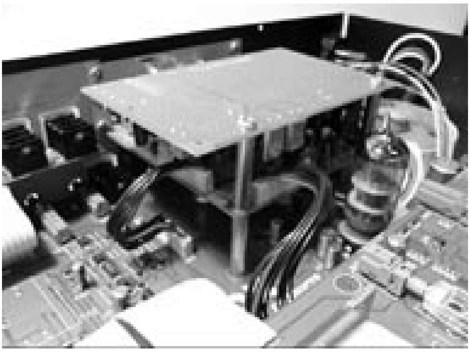


Fig. 2

dbx 504X installed in a dbx Silver Series

Installation (cont.)

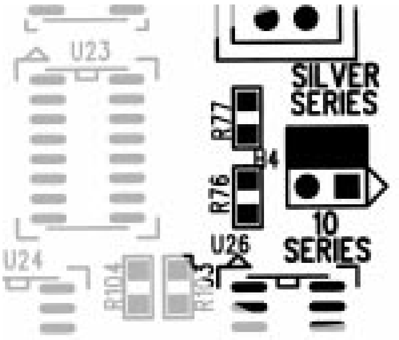


Fig. 3

Silver Series/10 Series jumper location. Silver Series selection is shown.

Rear Panel

AES/EBU / S/PDIF Switch: Selects either AES/EBU format or S/PDIF digital output format.
S/PDIF OUTPUT Connector: The 504X 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 dropouts and other interconnect problems.
AES/EBU OUTPUT Connector: The 504X provides AES/EBU digital output format through the XLR connector. Be sure to use short lengths of **110Ω** digital cables rather than standard XLR to XLR cables. Using the correct cables will prevent dropouts and other interconnect problems.

Rear Panel (cont.)

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.*

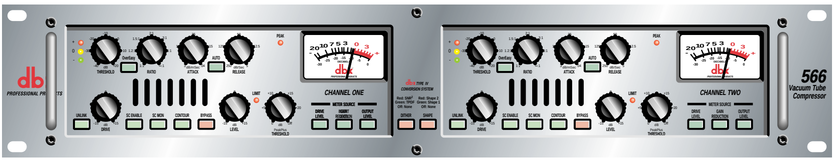
WORD IN and OUT Connectors: BNC connectors are provided for both wordclock in and out. The 504X uses low jitter phased-locked loops to synchronize to another unit's wordclock output through the 504X's word in jack. The 504X will accept a 44.1kHz or a 48kHz wordclock input with a toler-ance of ±100PPM. You also may use the 504X as a host clock through the word out jack to supply stable clocks to other processors that accept wordclock input. See "Word Input" for further information.

44.1kHz / 48kHz Switch: Selects output sample rate of either 44.1kHz or 48kHz.

16 Bit / 20 Bit Switch: Selects output wordlength of either 16 bits or 20 bits output resolution.

Note: *When the front panel Dither switch is set to off, the output wordlength will be 24 bits regardless of the position of the 16 Bit / 20 Bit switch.*

Front Panel



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 "Truncation" graph on page 20.

SHAPE: Selects noise-shaping type of TYPE 1 or TYPE 2. 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.

Digital Output Channel Swapping

When the dbx 504X is used in a dbx 576 or a 1086, where channel 1 is a microphone preamp and channel 2 is a dynamics processor, you may wish to swap the digital output channels or send one analog channel to both left and right digital outputs. This can be accomplished by following these steps:

1. Press and hold both the DITHER and SHAPE button on the front panel simultaneously for about 3 seconds until they start to flash red and green.
2. The DITHER button is associated with the LEFT digital output while the SHAPE button is associated with the RIGHT digital output. A button color of GREEN is associated with channel 1 while a button color of RED is associated with channel 2. So, if you wish to send the microphone preamp (channel 1 of dbx 576) to both LEFT and RIGHT of the digital output, simply press the SHAPE button (after step #1 above) so that it and the DITHER button are both GREEN.

Digital Output Channel Swapping (cont.)

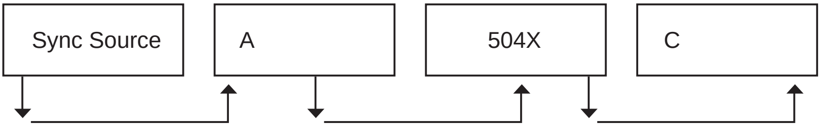
3. After you have selected the output routing, don't touch the DITHER and SHAPE buttons for a couple of seconds and then they will flash again and return to their normal operation.

NOTE: This channel swapping function has no memory once the unit has been powered down. You will need to reset the output routing upon power up if necessary.

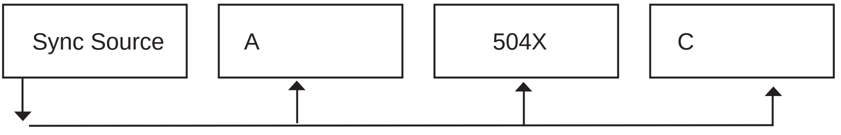
Word Input

The dbx 504X comes with the word 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 below, only the last box, box C, would be terminated (marked "T" 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 504X with another piece of terminated equipment in tapped configuration, you should unterminate (marked "U" on the circuit board) the 504X's sync input. The same is true if you wish to use several 504Xs in a tapped configuration. The dbx 504X 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 Fig. 4 for location of termination jumper.

Daisy Chain Configuration



Tapped Configuration



Word Input (cont.)

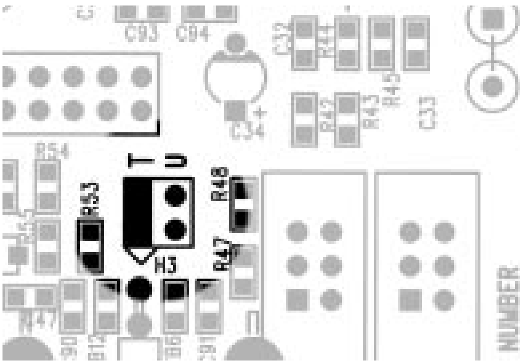


Fig. 4

Location of sync input termination jumper. "Terminated" selection is shown.

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!

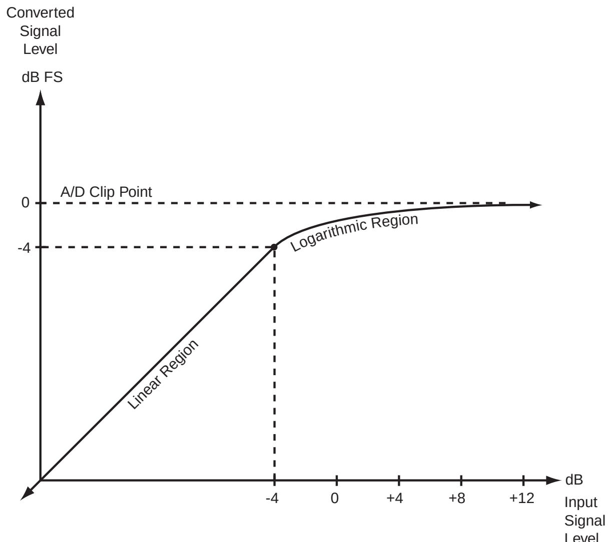


Figure 1 - Converted Level vs. Input Level

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.

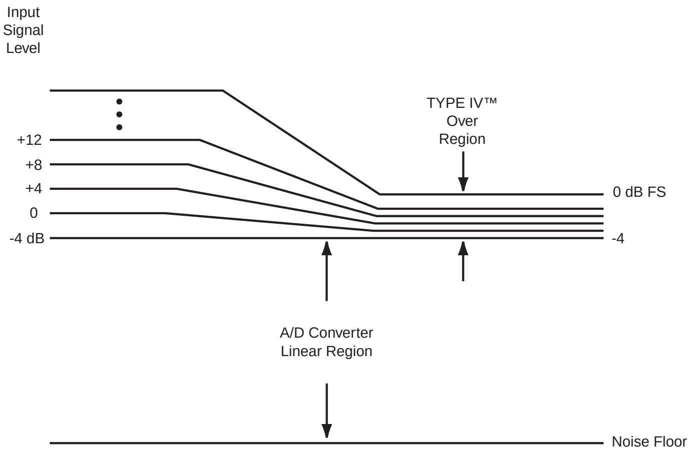


Figure 2 - Input Signal Levels Mapped to Type IV Over Region

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.

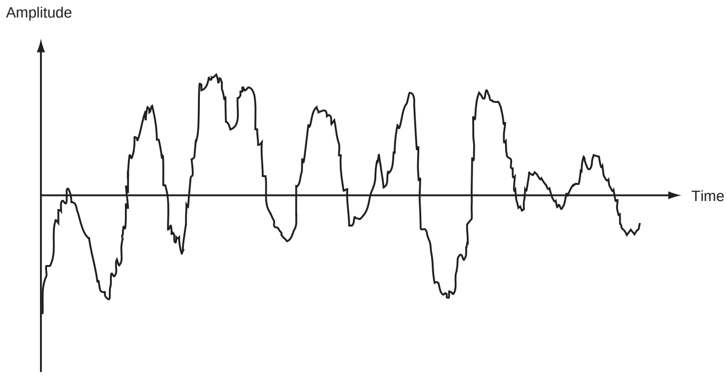


Figure 3a - Signal Having Low and High Frequency Content

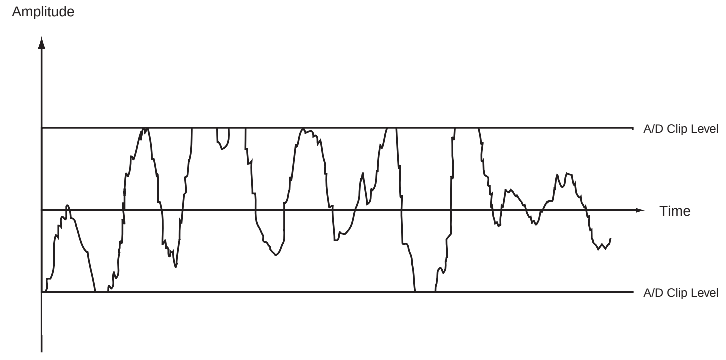


Figure 3b - Signal of Fig. 3a Going Beyond the A/D Clip Level

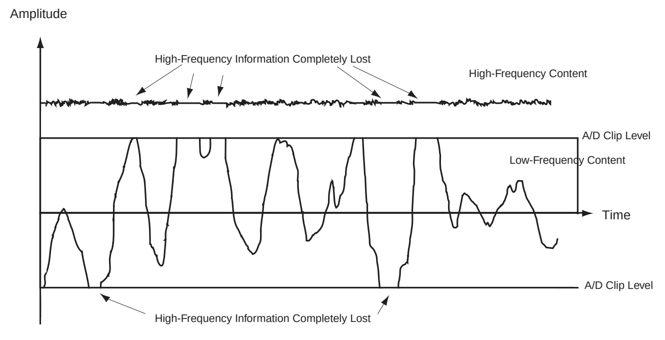


Figure 3c - Disproportionate Loss of High-Frequency Information Due to Clipping

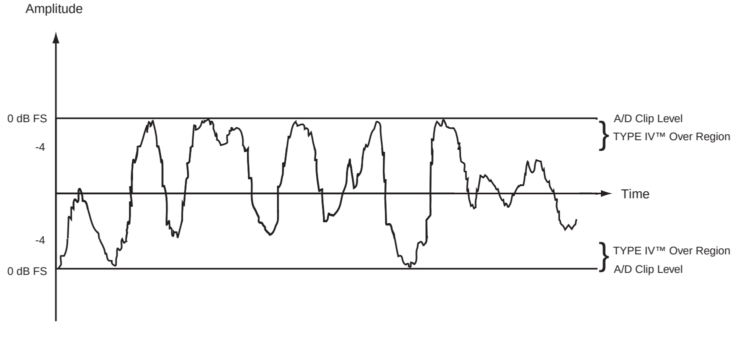


Figure 3d - Type IV Mapping Preserves High-Frequency Information

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!

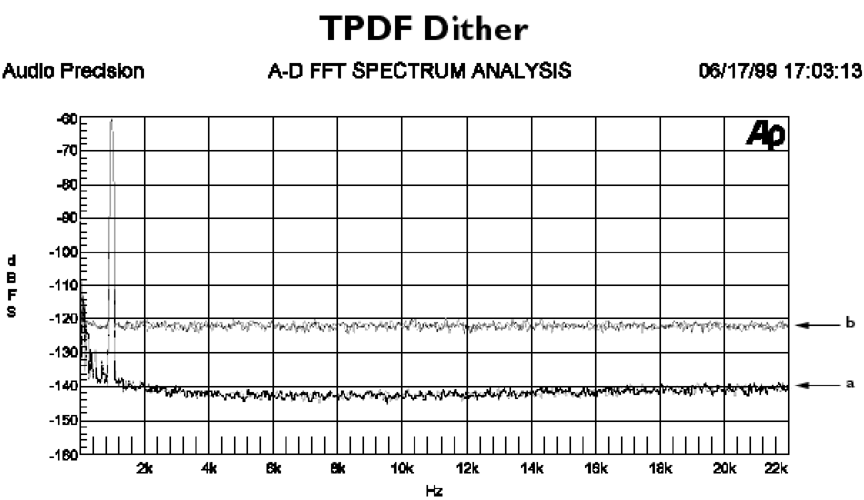
The benefits of the dbx Type IV™ Conversion System can easily be heard by switching it in and out while listening to signals with high-level peaks captured in the Type IV™ Over Region. You will notice an obvious audible difference. With Type IV™ bypassed, you can't help notice the harsh, edgy sound of 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:	110 dB unweighted, 22 kHz bandwidth 114 dB "A" weighted, 22 kHz bandwidth
Type IV™ Dynamic Range:	Up to 127dB with transient material, A-weighted, 22-kHz bandwidth
THD+Noise:	0.002% typical at +4 dBu, 1 kHz, input gain at 0 dB
Frequency Response:	20 Hz to 20 kHz, +0/-0.5 dB
Interchannel Crosstalk:	<100dB at 1kHz

NOTE: These specifications are for the dbx 504X card only. Performance may vary once installed in a dbx product.



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

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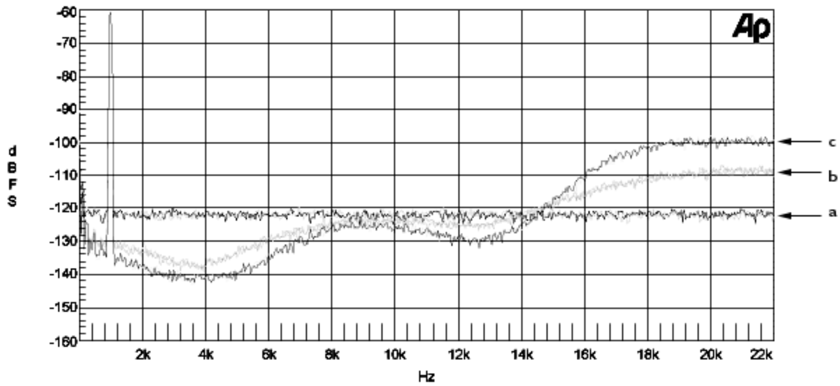

16-Bit TPDF dither. (a) Shape “off”, (b) with shape set to “S1”, (c) with shape set to “S2.” Parameters: Input -60dBFS, 1 kHz; FFT Length= 2048, Sample Rate= 48 Khz, Averages= 32; Graph Steps= 1024.

Truncation

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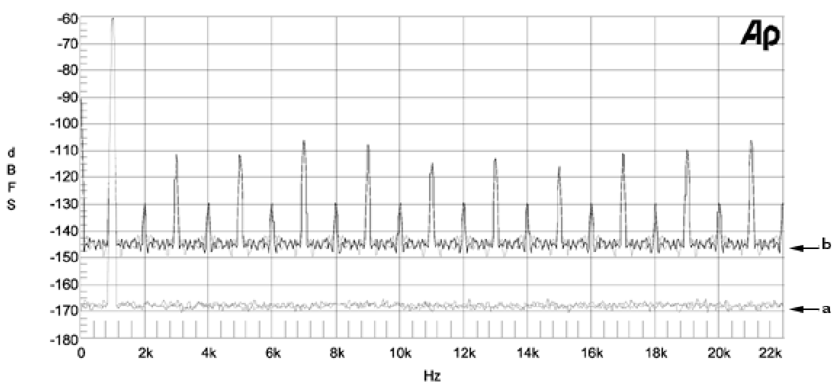

(a) 24-Bit word, (b) 16-Bit truncated output, no dither. Parameters: Input -60dBFS, 1 kHz; FFT Length= 2048, Sample Rate= 48 Khz, Averages= 32; Graph Steps= 1024.

8760 South Sandy Parkway
Sandy, Utah 84070
Phone: (801) 568-7660
Fax (801) 568-7662
Int’l Fax: (219) 462-4596

Questions or comments?
E-mail us at: customer@dbxpro.com
or visit our World Wide Web home page at:
www.dbxpro.com

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