

dbx

122 & 124 noise reduction systems

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What do we recording

The ultimate aim in recording is to capture the sound of a live performance with full dynamic range but without adding audible noise or distortion. This objective has remained the same ever since Thomas Edison recorded "Mary had a little lamb" on his crude tin foil cylinder recorder a century ago.

Why aren't we getting what we want from recordings?

Our technology has improved dramatically over the years, but recorded music which fully recreates the sound of a live performance has not been achieved. To learn the reasons, it is necessary to consider the physical dimensions of musical sound. In concert, the sound level of a symphony orchestra's loudest fortissimos may be as much as 105 dB* sound pressure level, with occasional peaks far above that. Rock groups in live performance often exceed 115 dB sound pressure level. By contrast, much significant information which contributes to our appreciation of music consists of higher harmonics heard at very quiet levels. This difference between the loudest and the quietest portions of the music is called its dynamic range and is expressed in decibels or dB.*

Ideally, to record all the sound of live music without adding noise or distortion, the recording medium should accommodate a dynamic range of at least 100 dB (plus a safety margin to handle peaks such as drum beats or cymbal clashes which are much louder than average) between the inherent background noise level of the equipment and the peak signal level at which distortion becomes audible.

*The dB or decibel is a unit of measurement for the relative loudness of sound. One dB is usually described as the smallest easily detectable change in loudness. The threshold of hearing (the faintest sound you can perceive) is about 0 dB, and the pain threshold (the point at which you instinctively cover your ears) is about 130 dB sound pressure level.

What is the limitation of the tape recording process?

Unfortunately, even the best reel-to-reel audiophile tape recorders are capable of only a 60 dB theoretical dynamic range at a tape speed of 7½ inches per second. This is the measured signal-to-noise ratio of a high signal level which causes three percent harmonic distortion (which results in audible degradation) to the level of the electronic and tape noise. Thus, the nominal signal-to-noise ratio of the tape recorder as specified by the manufacturer is not all clean, usable dynamic range. It is necessary to subtract at least 10 dB from the specified signal-to-noise ratio of 60 dB to provide an adequate safety margin below the point of audible distortion and above the tape noise. This reduces the usable dynamic range to around 50 dB. The tape recorder is thus required to record a musical program with a dynamic range in dB of nearly twice its own capability.

If music with 100 dB dynamic range is recorded on a 50 dB dynamic range tape recorder, either the top 50 dB of the music will be distorted and driven into tape saturation or the bottom 50 dB of the music will be buried in the tape noise and thus obscured, or there will be a compromise of the two. See Figure 8.

Although magnetic tape and tape recorder technology have improved significantly in the quarter century history of tape recording in the US, a technological plateau has been reached. Industry experts agree that future developments in the medium will contribute to subtle improvements of a dB here and there, but nothing near the 50 dB improvement that would be required to accommodate the full dynamic range of live music on tape.

We must, therefore, accept the limits of the tape medium and the

recorder as they presently exist, and consider the altering of the program itself by manual control or electronic signal processing as a means of tailoring the dynamic range of the music to fit within the limits of present tape recording technology.

How can the music be modified to fit within the limits of the recording process?

The traditional solution used by the recording industry is to intentionally reduce the dynamic content of the music during recording. This restricts the dynamic range of the music to fall within the capabilities of the tape recorder, permitting most of the quiet sounds to be recorded above the tape noise level while recording loud sounds at levels on the tape which are only slightly (although audibly) distorted. The dynamic range of a program can be intentionally reduced in several ways. The conductor can instruct the players not to play too loudly or too quietly. This produces a limited dynamic range for the microphones to pick up, often results in artistically poor performances. A more common method is for the recording engineer to "gain ride" by manually controlling the signal level fed to the tape recorder. If the engineer knows a quiet portion of music is coming, he gradually increases the level to place the majority of the music above the level of the noise introduced by the tape recorder. When a loud passage of music comes, he gradually decreases the level to prevent overload of the tape and audible distortion. Electronic gain or level controls called compressors and limiters can also be used. A compressor reduces the dynamic range by gently reducing the gain of loud signals and/or increasing the gain in presence of quieter signals. A limiter acts more

want from the process?

drastically to restrict any loud signal that exceeds some present level. This prevents loud signal peaks from overloading the tape and causing audible distortion.

While these methods effectively reduce the dynamic range to fit within the limits of the recording medium, some portion of the music is irretrievably lost in the process, and this is why recordings fail to compare favorably with music performed live. Even the gross amounts of signal "tampering" which accompany the recording process cannot get rid of tape hiss which has always been audible since the invention of the tape recorder and can be heard in the quiet portions of your tapes (and even your discs, since they originate on tape). Clearly, some means of "noise reduction" and retrievable dynamic alteration are necessary if recordings are to qualitatively approach the live listening experience.

What is noise reduction?

Noise reduction is electronic signal processing which seeks to separate the noise from the music, suppressing the noise and letting the music flow through the system unchanged. There are basically two classes of noise reduction systems available. The most numerous are single-ended or "after the fact" systems, which operate on conventionally recorded material to suppress its noise content.

Single-ended (after the fact) noise reduction systems

Noise filters can reduce noise by eliminating or suppressing those high frequencies where most noise occurs. Most of the "after the fact" systems use some filtering which reduces high frequency response. Auto-correlators break the frequency spectrum into bands and treat each band individually. An

electronic gate in each band opens to let music through and shuts when the music stops to prevent noise from getting through when there is no music in that frequency band.

The problem with both noise filters and auto-correlators is that at certain levels the sensing circuits of these devices are unable to electronically distinguish between the music and the noise. Thus, these types of frequency manipulative noise reduction systems, even properly adjusted and used, inevitably reduce vital harmonic content in the music, and often have irritating audible side effects.

Expanders operate over the entire frequency spectrum and can reduce noise by making loud passages louder and quiet passages quieter. As the quiet passages are reduced in level, the background noise is suppressed. As the loud passages are increased in level, the dynamic range of the music is also increased, resulting in a noise reduced, dynamically enhanced listening experience. Even expanders must be chosen with caution, however, because some available brands operate more in one portion of the audio spectrum than another, unfortunately altering the original musical balance and dynamic perspective.

dbx offers a line of expanders (dynamic range enhancers) that reduces noise and increases dynamics on records, tapes and FM broadcasts. These products, described in a separate publication, expand uniformly over the entire audio frequency spectrum, and use no filters or frequency discriminative components which would rob the music of its high frequency harmonic content.

Double ended (compression/expansion) noise reduction systems

The second approach to noise reduction uses a two-part system consisting of a compressor at the time of recording and a complementary expander at the time of playback. See Figure 1. This group includes the Dolby "A" and "B" systems, and dbx.

The dbx professional noise reduction system is used in state-of-the-art recording studios throughout the world, and has become the newly accepted technical standard in professional recording industry noise reduction. dbx optimized this system for discriminating audiophiles and the result is the 120 family of noise reduction systems. dbx 120 systems make all the state-of-the-art superiorities of dbx professional studio noise reduction available to the individual recordist and audiophile at modest cost. For a complete technical description of compression/expansion as used in the dbx system, see the section "For the technically inclined".

Introduction to dbx 120 noise reduction

dbx 120 noise reduction is a sophisticated application of the classical compression/expansion concept of noise reduction.

The dbx approach is unique. It uses linear-decibel compression/expansion at a factor of 2:1. The result is a tape recording that cannot be distinguished from the original. The only noise heard, if any, is that present in the input signal, plus the residual noise of the mic preamp. The dbx 120 system makes possible for the first time totally noise-free live tape recording. Records, tapes and FM broadcasts can be recorded which preserve the original dynamic content and add no audible noise in the recording process.

It is important to point out that these systems are identical to the original dbx professional system except for certain differences in the level sense circuitry. Both audiophile and professional systems provide the same amount of noise reduction and headroom improvement. The dbx 120 system is optimized to meet the specific requirements of the audiophile and home recordist.

How to use the dbx 120 system

The dbx 120 series of audiophile noise reduction systems is designed for use with any reel-to-reel, cassette or cartridge tape recorder of reasonably good quality. While the dbx noise reduction system enhances the performance of any sound system with which it is used, the better the quality of the associated components, the better will be the audible result. The dbx units in this family interface with any component audio system operating at line level and having single-ended lines terminated by RCA type phono jacks.

dbx 120 audiophile noise reduction units may be used for original recording of live programs, for dubbing or duplication of tapes from one machine to another or one medium to another, for taping broadcasts off the air, for transferring material from discs to cassettes, etc. The dbx 120 series does not remove noise present in the source, but allows copying with absolutely no noise added by the tape recorder.

How to connect the dbx 120 system

For tape dubbing and duplication and recording off the air, the dbx system is normally connected to the tape monitor inputs and outputs of the audio system preamp or receiver. The dbx unit may also be connected directly between one recorder and another, or between tuner and recorder without going through the preamp or receiver. For live recording, microphones may not be plugged into the dbx system directly. A separate microphone preamp or mixer is required to boost the microphone level to properly drive the inputs of the dbx noise reduction system.

Model 122 is a two-channel switchable record or play noise reduction system. It is used for compression during recording or expansion during playback, but not both at the same time. When properly connected to the preamp or receiver, it can easily be switched from record to play by the front panel controls without changing cords or connectors.

Model 124 is a four-channel switchable system and when installed in a four-channel system functions similarly to the 122. It also has additional capability when installed in a two-channel system, however. Since the 124 contains four independent channels of noise reduction, two may be used for compression during recording, while the other two are used for simultaneous playback of the expanded signal for monitoring purposes from three-head machines while recording is in progress.

In the dbx 120 series, channels are switched only in pairs. Where the application requires the switching of individual channels, the dbx 150 series should be used.

Use of the dbx 120 to reproduce dbx encoded "noiseless discs"

An additional feature of the 120 series is its ability to reproduce dbx encoded discs. The inherent limitations in the disc and tape recording process make it impossible to manufacture a conventional

record capable of reproducing the full dynamic range of music played live. dbx encoded discs (commercially available) provide the listener with the full dynamic range of the original performance and totally eliminate disc surface noise. Only when tape hiss and disc surface noise are completely eliminated via the dbx noise reduction system does one realize how pervasive background noise has been in recorded music.

Can I use a dbx 120 in addition to Dolby B?

Yes, you can, but why bother? Dolby B achieves some 7 to 10 dB of noise reduction, but introduces audible changes to the sound. dbx achieves more than 30 dB of noise reduction with 10 dB extra headroom and doesn't alter the sound, so the use of the Dolby B in addition to dbx is superfluous. Furthermore, Dolby B requires precise level matching for satisfactory operation which the dbx system does not require. Inasmuch as dbx reduces noise to inaudibility, we discourage the use of Dolby B in addition to dbx.

Copying Dolby B tapes or broadcasts on the dbx system is another matter. In this situation the Dolby B material must be decoded first, then dbx encoded prior to entering the recorder.

How do I combine or mix dbx encoded channels?

The general rule regarding this is that you must decode all channels independently before mixing, equalizing, limiting, introducing echo or reverb, or doing any type of signal processing. You can record and playback as much as you want from one tape format to another and even from one medium to another, as long as you do not have any frequency discriminative signal processing components within the encoding loop. The tape recorder should, of course, have as flat frequency response as possible.

How do I copy a tape or disc which is already dbx encoded?

As stated above, you can copy dbx material in its encoded form from one machine to another provided there are no frequency discriminative components, i.e., tone controls, between the output of the playback machine and the input of the recording machine.

Can I use the dbx 120 with a dbx or other dynamic range enhancer?

Yes, definitely, although it probably would not be necessary for material originally recorded in dbx format where full program dynamics are preserved. Programs origin-

ating from commercial records or broadcasts can be successfully enhanced using a dbx dynamic range enhancer either before or after copying. We suggest that you use dynamic range enhancement prior to copying, so you can play your enhanced recordings without having to use the dynamic range enhancer during playback.

What is the disc button for?

The disc playback button is for playing of dbx encoded discs only. The disc button activates additional circuitry which prevents audible alteration to the music resulting from disc warpage, turntable rumble, etc. while playing dbx encoded discs.

Can I use the dbx 120 to decode SQ, QS, or CD-4 records?

No.

Can I use the dbx 120 to remove noise from conventional records?

No. The dbx 120 may be used only with discs which have been dbx encoded during the manufacturing process. For noise removal from conventional discs, a dbx dynamic range enhancer such as the dbx 117 or 119 should be used.

For the technically inclined: Compressor theory

A compressor comprises a compressor and an expander (Figure 1). The signal is compressed after the mike preamp or mixer and prior to tape recording to decrease the dynamic range of the original signal to pass through the usable dynamic range "window" of the recorder, i.e., to keep the quietest signal above the noise floor, and the loudest signal below the level of distortion or tape saturation. Upon playback, the signal is expanded to precisely recreate the dynamic range of the original program material. For a compressor to operate properly the compressor and expander must operate as exact mirror images. To control the compression/expansion operation each must have a signal detector (see Figure 2). There are three types of signal detection: peak, average, and RMS.

Important differences between dbx and Dolby "B"

All tape recorders introduce substantial amounts of phase shift. As the Dolby "B" system uses a combination of peak

and average detection that is sensitive to phase errors introduced by the tape recorder, it is bound to introduce some tracking errors in playback, and is inadequate for demanding tape recording applications. RMS detection, as developed by dbx for its compressors, measures the sum of the frequencies/energies present in the signal and is insensitive to the inherent phase shift introduced by the tape recorder. In this way the dbx compressor operates as a true mirror image compression/expansion system.

The Dolby "B" system operates only in the high frequency portion of the audio spectrum and is based on the psycho-acoustic observation that what is subjectively called tape hiss is most annoying at higher frequencies. This approach ignores the fact that noise is a broadband phenomenon present at all the frequencies at which there is musical information. To eliminate all the noise, the dbx noise reduction system covers the entire audio frequency spectrum.

The Dolby "B" system reduces high frequency tape noise by approx-

imately 7 to 10 dB, which is a noticeable reduction, but which still leaves the hiss plainly audible during the quieter passages of music. The dbx system achieves over 30 dB of noise reduction over the entire frequency spectrum so that absolutely no hiss is audible at any listening level even when a playback is heard through the most revealing reproducing system.

The Dolby "B" system does not compress and expand the program at high levels, and acts on low level signals only at high frequencies. The result is that, while hiss is reduced in the quiet passages, the dynamic range of the total program is not compressed and there is no improvement in "headroom." The ever present tendency to tape saturation and overload distortion is as great with the Dolby "B" as with no noise reduction at all. By contrast, the dbx system compresses the entire program, all frequencies and levels, so that headroom is increased by some 10 dB, and the risk of tape overload distortion is virtually eliminated. The dbx system also preserves the full dynamic range of the original signal.

The Dolby "B" system is inherently non-linear and operates above a certain threshold which must be identical during recording and playback if the compression and expansion functions are to "track" properly. Although most Dolby "B" systems can be "level-matched", this step is difficult and bothersome at best, and is impossible on some Dolby "B" equipped units due to manufacturers' failure to include level matching controls. By contrast, dbx companders operate linearly over the complete dynamic range making complex level match and alignment procedures unnecessary.

How the dbx system operates

The dbx 120 system uses a linear decibel form of compression/expansion at a factor of 2:1 (see Figure 3). Unlike competitive systems, the dbx linear-decibel approach has no threshold at which the compression takes place as does Dolby B. With dbx, all levels and frequencies are compressed over a range in excess of 100 dB. For convenience in operation, a specific input level has been selected as the unity gain point shown as 0 dB on Figure 3. Notice that the entire signal is compressed to half its original value, or by a factor of 0.5. It can be observed that with this approach high level signals are decreased in value which allows at least a 10 dB increase in tape recorder headroom (the margin above peak VU meter reading before distortion occurs). Notice also that the low level signals are raised to a level above the noise contributed by the tape recorder.

Upon playback, the signal goes into an expander that operates at a precisely complementary factor of 2. Note that the expander output is an exact reconstruction of the original compressor input (see Figure 3). Level setting for this system is not critical for accurate record/playback tracking. The dbx system has level adjustments for user convenience in setting levels for compression/expansion, but these adjustments are not necessary for accurate reproduction.

Signal pre-emphasis and de-emphasis

Historically, other compander systems exhibited audible variations in background noise as the signal level increased or decreased.

To minimize this effect a high frequency pre-emphasis is applied during compression and a reciprocal de-emphasis is used in expansion. (see Figure 4).

This pre-emphasis and de-emphasis reduces audible variations in background noise (widely known as high frequency "breathing" or "pumping") by 12 dB. The amount of pre-emphasis and de-emphasis in relation to frequency are shown in Figure 5.

This large amount of pre-emphasis could cause high frequency tape saturation. To prevent tape saturation, a like-pre-emphasis is added to the RMS level detector (see Figure 6).

The dbx approach effectively lowers the noise floor by 30 dB and increases the headroom by 10 dB without introducing audible breathing or pumping.

Compander tracking

Expanders must accurately track the compressor's operation. dbx uses RMS signal detection to avoid tracking errors due to inherent tape recorder phase shifts. It is also possible for an expander to mistrack due to subsonic signals. To prevent this, bandpass filters are placed in the signal path and also in the signal detection path (see Figure 7).

The bandpass filters used in the compressor and expander signal path pass 20 Hz to 20 kHz. It is important to note that the signal detector needs to operate only in the frequency range where most of the musical signal energy exists. Therefore, the bandpass filter in the detector functions only from 30 Hz to 10 kHz. The frequency response of the system is the full audio spectrum of 20 Hz to 20 kHz; however, the signal detectors are activated only by energy in the 30 Hz to 10 kHz range. This allows live recording of the full range of musical sounds without errors due to passing trucks, subways, ventilating fans, etc., and copying from warped phonograph records without causing mistracking in the compander operation.

In summation

The dbx 120 compression/expansion noise reduction system elegantly accomplishes the elimination of audible tape hiss in original recordings and prevents the build-up of noise normally associated with copying or taping off-the-air. The system accomplishes these benefits without annoying side effects and with no level setting or adjustments necessary by the user.



fig. 1

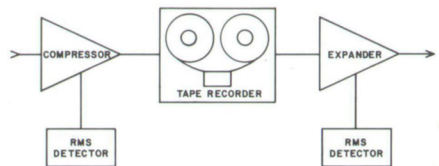


fig. 2

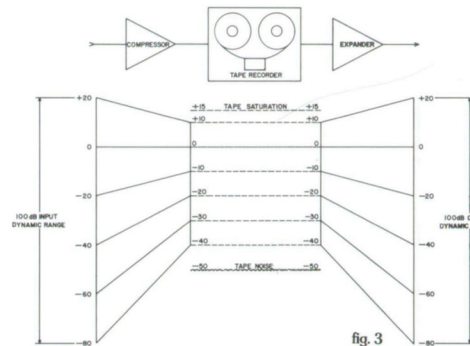


fig. 3

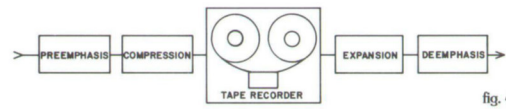


fig. 4

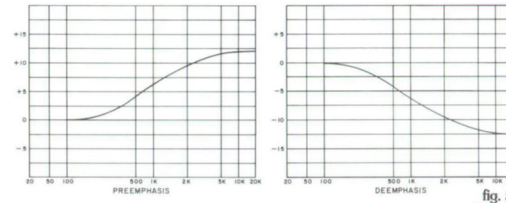


fig. 5

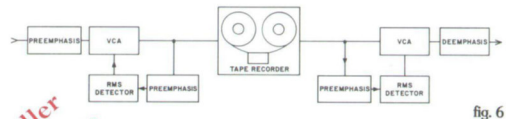


fig. 6

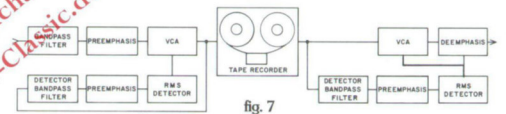


fig. 7

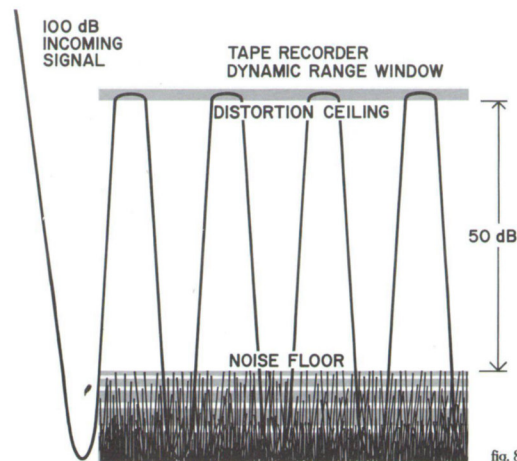


fig. 8

specifications

Dynamic range (weighted background noise to peak signal ratio)
110 dB

Input impedance
50 k ohms

Output impedance
Designed to feed tape recorder inputs
5 k ohms or greater

Maximum output level
7 volts RMS at 1 kHz into 5 KΩ load

Effective noise reduction
30 dB for tape recorders with S/N ≥45 dB
40 dB for dbx encoded discs
(A weighted)

Compression-expansion slope
2:1 constant linear decibel

Tracking accuracy
± 1 dB/20 dB for complete code-decode cycle

Frequency response
± 0.5 dB 50 Hz to 15 kHz
± 1 dB 30 Hz to 20 kHz
single sinewave code-decode cycle
± 0.25 dB 30 Hz to 20 kHz for complex music program
-3 dB at 20 Hz for tape noise reduction
-3 dB at 27 Hz for disc decode mode

Harmonic distortion
2nd harmonic ≤0.1% code-decode
30 Hz to 15 kHz
3rd harmonic ≤0.1% code-decode
100 Hz to 15 kHz
3rd harmonic ≤0.5V code-decode
30 Hz to 100 Hz

IM distortion (60 Hz and 7 kHz 4:1 per SMPTE)

0.15% typical; 0.3 maximum
Note: Above measurements at 1 volt RMS input and output

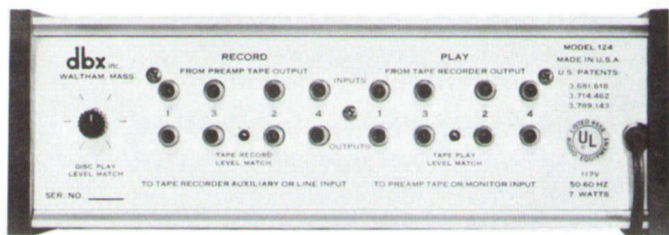
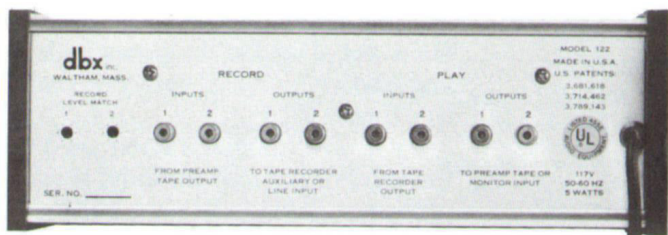
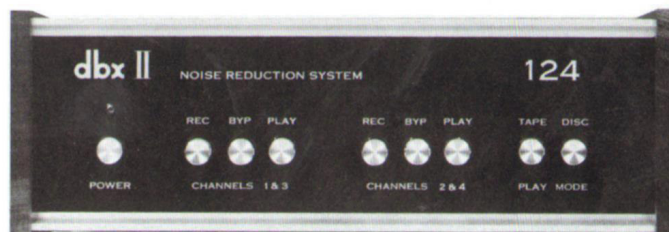
Impulse response
Risettime = < 20 μs
Overshoot = 12 dB for 1 kHz tone burst
Release rate = 240 dB/second

Level match range
100 mV to 3 V for unity gain; individually adjustable each channel, for convenience in level setting and avoidance of overload in succeeding audio stages; level match setting unimportant for code-decode tracking

Specifications subject to change without notice. Manufactured under one or more of the following U.S. patents: 3,681,618; 3,714,462; 3,789,143. Other patents pending.

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What is the usable dynamic range of a tape recorder?

The characteristic of usable dynamic range is one of the most important qualitative aspects of a tape recorder. It is generally not specified on manufacturers' data sheets, but it is roughly equivalent to the machine's signal-to-noise ratio, which usually is stated. Unfortunately, there is presently no accepted industry standard for defining or measuring signal-to-noise ratio in tape recorders and it may be years before there is such a standard.

In practical terms, the usable dynamic range of a tape recorder is a measure of the difference between the loudest and quietest passages of music which may be recorded on the tape and played back without audible noise or distortion. Usable dynamic range may be illustrated as a "window" of limited height through which the musical signal passes on its way through the tape recorder.

The height of this window is determined by the location of the distortion "ceiling" and the noise "floor." This is shown graphically in Figure 8. Any signal which is below the distortion ceiling and above the noise floor will pass through the tape recorder without being audibly changed or degraded. Some information on the distortion ceiling and the noise floor will help to define the signal window and relate it to everyday reality in tape recording.

As the signal level (loudness) presented to a tape record head is increased, a point is reached where any additional increase in level overloads the tape and audible distortion results. The point at which 3% harmonic distortion occurs is generally accepted as the maximum recording level by most tape and recorder manufacturers. The problem for the recordist is that he has no good way of determining when this ceiling has been reached, short of hearing distortion played back off the tape.

Unfortunately, there is no industry standard to relate the 3% distortion point to the recorder's VU meters or "overload" indicators. Tape recorders may

go into audible distortion at anywhere from 2 to 12 dB* above 0 VU, depending on the quality of the machine and the conservatism of its manufacturer in attaching performance specifications to it. The difference between the maximum VU meter reading and the 3% distortion point is a measure of the recorder's "headroom", or safety margin. One of the recordist's major problems is not knowing, and not being able to determine in advance with any reasonable degree of certainty, the headroom of the recorder.

An additional complexity facing the recordist is that most VU meters give only average readings and do not measure peaks. These peaks are loud instantaneous sounds like drumbeats and cymbal crashes which are able to cause distortion but are of such short time duration they do not show up in the meter readings. The extent to which the peaks exceed the VU meter reading has been observed to be as high as 20 dB. Thus, it is possible to use all the recorder's headroom and drive it into severe distortion on program peaks, even though the VU meter readings never exceed +3 VU.

Headroom is a critical factor determining the practical ceiling for distortion-free recording. Overestimating the recorder's headroom will result in 1. tape overload distortion, 2. the loss of the sharp edge of percussive attacks, 3. a smearing of peak transient sounds, and 4. a general muddying of the loud passages when many instruments are playing together.

Underestimating headroom and

recording at too low a level results in using less of the recorder's dynamic range and places the recorded program where the quieter portions of the music may be below the noise floor of the recorder.

The noise floor is the restricting factor on the quiet end of a tape recording and is defined as the level at which the recorded program signal is equal to the total hiss and background noise of the recorder. If a tape with nothing recorded on it is played back, there will be a noticeable sound coming off the tape. This sound is subjectively characterized as tape hiss. The reasons for this hiss are beyond the scope of this brochure, but they are explained in any book on tape recording theory. This hiss plus any electronic noise contributed by the tape recorder circuitry defines the noise floor, which is the lowest level at which a signal may be recorded on the tape and played back without being covered or masked by noise.

The usable dynamic range, or "window", then, of any given tape recorder is the number of dB difference between the audible distortion level on the "loud" end and the inherent electronic noise level plus tape hiss on the "quiet" end. For the very best professional studio recorders the theoretically attainable dynamic range is about 68 dB at 15 inches per second tape speed, but this performance is seldom, if ever, met in practice. A more realistic dynamic range for professional recorders is approximately 60 dB. For good quality audiophile reel-to-reel recorders of contemporary manufacture operating at 7½ inches per second this number is typically 50 dB. For cartridge and cassette recorders, even fairly good ones, this number is typically 45 dB, because of limitations imposed by slower tape speed, narrower track width and other considerations. The addition of dbx noise reduction to any tape recorder will nearly double the usable dynamic range capability.

dbx

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dbx 120 series

noise reduction system
and dbx disc decoder

professional quality
noise reduction
for the audiophile

description

dbx, Incorporated has perfected a tape noise reduction system which allows the input signal to be reproduced with full dynamic range while effecting a 30 dB reduction of noise contributed by the tape recording process. (We do not, however, attempt to remove noise present in the original input signal.)

Like dbx professional noise reduction systems, the 120 series (although incompatible with the professional series) uses 2:1 linear decibel compression and expansion over the entire dynamic range. High frequency pre-emphasis and de-emphasis are employed to minimize mid-frequency distortion and tape modulation noise and minimize high frequency tape saturation. The 120 series achieves 10 dB improvement in headroom and in excess of 30 dB of noise reduction. This compander system uses compression in recording and expansion during playback.

For companders to work effectively, the expander must be able to exactly restore on playback the dynamics which were originally compressed during recording. All recorders introduce phase shifts which make it difficult for conventional compander systems to properly re-create the input signal. The dbx system precisely reproduces the original sound regardless of recorder phase shifts over a 100 dB range even on music containing percussive peak transients. The unique simplicity of the system eliminates the need for level match tones.

An additional feature of the 120 series is its ability to reproduce dbx encoded discs. The limitations in the disc and tape recording process make it impossible to manufacture a record capable of reproducing the full dynamic range of music played live. dbx encoded discs (commercially available) provide the listener with the full excitement of the original performance and totally eliminate disc surface noise. Only when tape hiss and disc surface noise are completely eliminated via the dbx noise reduction system does one realize how pervasive background noise has been in recorded music.



Model 122 features

Two channel record or playback noise reduction system (with channels switched in tandem) and dbx disc decoder.

Model 124 features

Four channel record or playback noise reduction system (with channels switched in pairs) and dbx disc decoder. Can also be used as a two channel simultaneous record and playback noise reduction system.

application

The dbx 120 series of audiophile noise reduction systems is designed for use with any reel-to-reel, cassette or cartridge tape recorder of reasonably good quality. While the dbx noise reduction system enhances the performance of any sound system with which it is used, the better the quality of the associated components, the better will be the audible result. The units in this family interface with any device operating at line level and having single ended lines terminated by RCA type phono plugs.

dbx 120 audiophile noise reduction units may be used for original recording of live programs, for dubbing or duplication of tapes from one machine to

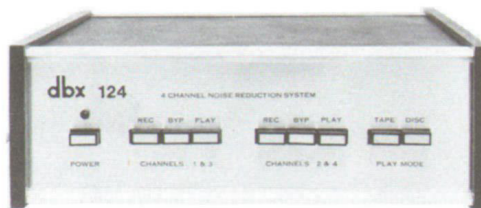
another or one medium to another, or for taping broadcasts off the air, for transferring material from discs to cassettes, etc.

For tape dubbing and duplication and recording off the air, the dbx system is normally connected to the tape monitor inputs and outputs of the audio system preamp or receiver. The dbx unit may also be connected directly between one recorder and another, or between tuner and recorder without going through the preamp or receiver. For live recording, a separate microphone preamp or mixer may be required to drive the line level inputs of the dbx noise reduction system.

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dbx 120 series noise reduction systems

specifications



how it works

The dbx noise reduction system uses dynamic range compression to encode the signal before recording and a matched expander to restore the original dynamics on playback. The compression and expansion factor is 2:1 and is linear in decibels over a 110 dB range. A 20 dB change in the program is recorded as a 10 dB change on the tape. Thus, a recording medium capable of only 55 dB signal to noise ratio can record and reproduce the full dynamic range of live music which often exceeds 100 dB. Level matching on playback is unnecessary for proper decoding as this factor is the same at all levels. The adjustments provided for playback level are only for convenience and prevention of overload of succeeding audio stages.

Frequency weighting networks are used on both the signal and level sensing circuits in the encoder and decoder. This optimizes performance in terms of mid-frequency distortion, tape modulation noise, the audibility

of phonograph mistracking, and high frequency overloading of recording media.

The dbx compression-expansion noise reduction system consists of two voltage controlled amplifiers and two level sensors, there being one of each in the encoder and decoder. If the two level sensors track, the gain change instructions given to the encode and decode voltage controlled amplifiers will be equal and opposite.

All recording systems have some frequency dependent phase shift which changes waveforms considerably even though the sound is not audibly degraded. dbx gets around this problem by using wide range RMS (root-mean-square) level sensing circuits which calculate the sum of the signal energies, regardless of their phase relationships. This results in excellent code-decode gain tracking even with extremely fast transient rise times and a wide range of input levels.

Dynamic range (weighted background noise to peak signal ratio)
110 dB

Input impedance
50 k ohms

Output impedance
Designed to feed tape recorder inputs 5 k ohms or greater

Maximum output level
7 volts RMS at 1 kHz into 5 K Ω load

Effective noise reduction
30 dB for tape recorders with S/N \geq 45 dB

40 dB for dbx encoded discs (A weighted)

Compression-expansion slope
2:1 constant linear decibel

Tracking accuracy
 \pm 1 dB/20 dB for complete code-decode cycle

Frequency response
 \pm 0.5 dB 50 Hz to 15 kHz,
 \pm 1 dB 30 Hz to 20 kHz
single sine wave code-decode cycle
 \pm 0.25 dB 30 Hz to 20 kHz for complex music program
-3 dB at 20 Hz for tape noise reduction
-3 dB at 27 Hz for disc decode mode

Harmonic distortion
2nd harmonic \leq 0.1% code-decode 30 Hz to 15 kHz
3rd harmonic \leq 0.1% code-decode 100 Hz to 15 kHz
3rd harmonic \leq 0.5% code-decode 30 Hz to 100 Hz

IM distortion (60 Hz and 7 kHz 4:1 per SMPTE)

0.15% typical; 0.3% maximum
Note: Above measurements at 1 volt RMS input and output

Impulse response
Risetime = $<$ 20 μ s
Overshoot = 12 dB for 1 kHz tone burst
Release rate = 240 dB/second

Level match range
100 mV to 3 V for unity gain; individually adjustable each channel, for convenience in level setting and avoidance of overload in succeeding audio stages; level match setting unimportant for code-decode tracking

Manufactured under one or more of the following U.S. patents:
3,681,618; 3,714,462; 3,789,143.

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