dbx

128

dynamic range enhancer and tape noise reduction system

Records deliver only half the dynamics of live music.

What happened to the other half?

dbx gives you

The dbx 128 consists of two completely separate signal processing systems in a single unit. One section is a dynamic range enhancer to increase music dynamics and decrease audible noise from records, tapes or radio broadcasts. The second section is a dbx II® tape noise reduction system which allows wide dynamic range material to be recorded on tape with no audible noise added by the tape recording process. Switching facilities permit a wide variety of convenient applications for the listener, live recordist and tape copyist. dbx 128 also decodes dbx encoded discs.

The dbx 128 dynamic range enhancer section contains a stereo expander (see Figures 1 and 2) which is continuously variable from an expansion factor of 1.0 to 2.0 (0-100% increase in dynamic range). In the expansion mode, using linear expansion (Figure 1), loud passages are made louder (red LED illuminated) and quiet passages are made quieter (amber LED illuminated) increasing the dynamic range. An important by-product of expansion is a dramatic decrease in record surface noise, tape hiss or broadcast noise.

The dbx 128 dynamic range enhancer section also contains a stereo compressor (see Figures 3 and 4). Compression performs the opposite of expansion making loud passages quieter and quiet passages louder. Compression is continuously variable from a factor of 1:1 to infinity. Compression is desirable for decreasing dynamic range when making tapes for background music or for use in an automobile.

How much expansion should be used?

Adjustable expansion is available in the dynamic range enhancer section. The amount of expansion required will vary according to the amount of compression or limiting that was done on the original recorded material and to individual listening tastes. In the linear mode, (see Figure 1), expansion of classical music by 1.2 or 1.3 and popular or rock music by 1.4 or 1.5 is suggested. Too much expansion can result in audible variation in the background noise level (sometimes referred to as "breathing" or "pumping"). Not every record or tape requires exactly the same degree of expansion (dynamic enhancement) because there is no industry standard for the amount of compression or limiting used in the recording process.

When should peak expansion be used? (above threshold mode)

Some record companies use little if any compression, but do use "peak limiting" (high compression ratios applied above a certain threshold to reduce the level of only the loudest signals).

If expansion is used on such discs (typically classical recordings), the above threshold mode (see Figure 2) may be more desirable than the linear mode. The user listens to a loud passage and adjusts the level control to the point where expansion takes place. This is indicated by the "above threshold" front panel LED illuminating.

Above the threshold, loud passages are made louder while medium and low level signals are unaffected. Higher expansion ratios, such as 1.5 and above, can be used in the above threshold mode without the effect of pumping or breathing during quiet passages that would result from high expansion ratios in the linear mode. The above threshold LED indicator will illuminate when the 128 dynamic range enhancer section is expanding. When the below threshold LED is illuminated, no expansion is taking place.

Figure 1 — Linear expansion operates over the entire dynamic spectrum of music irrespective of frequency (20-20,000 Hz), making loud passages louder and quiet passages quieter, reducing audible noise. Expansion ratios are adjustable. For example, 1.0 = 0% increase in dynamic range; 1.2 = 20%; 1.5 = 50%; 2.0 = 100%.

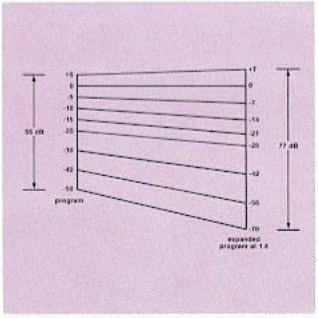


Figure 2 — Above threshold expansion is used to make loud passages louder above a user adjustable threshold level when no low level dynamic alteration is desired.

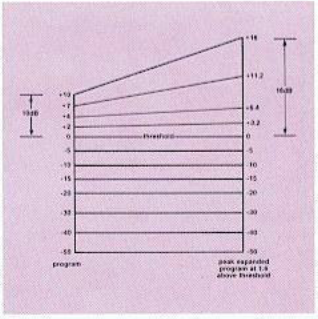
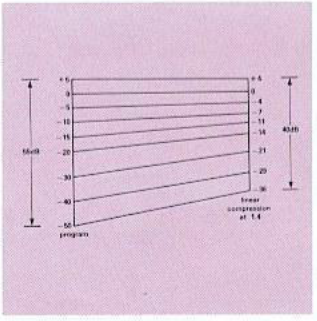


Figure 3 — Linear compression reduces the entire dynamic range of the music irrespective of frequency (20-20,000 Hz).



more from rec

How to use the compression section.

Two types of compression are available: linear compression and above threshold compression. Linear compression reduces the entire dynamic range of the music program making loud passages quieter and quiet passages louder while leaving medium level passages relatively unchanged (see Figure 3). This mode is ideal for background music and making tapes for automobile use. Above threshold compression is used to make loud passages quieter while allowing medium level and low level passages to be unchanged (see Figure 4). LED indicators on the front panel indicate above or below threshold operation. Compression of 1.0 to 4.0 is normally called "compression." Higher compression ratios such as 10.0 or higher are called "limiting." In the above threshold mode, compression or limiting is achieved depending on the ratio selected.

How to make dynamic range enhanced tape copies.

The dbx 128 allows the copyist to make tapes of his record library that sound better than the records. The dynamic range enhancer section is used to increase the dynamic content of the prerecorded material and reduce noise during playback. This dynamically enhanced program is passed through the dbx II tape noise reduction section to copy the increased dynamic range material on tape while eliminating audible tape noise normally added in the tape copying process. This system achieves equally dramatic results with all tape formats whether open reel, cassette or cartridge.

dbx II tape noise reduction is achieved by compressing the signal 2:1 prior to entering the tape recorder and by expanding the signal 1:2 during playback (see Figure 5). This process allows full dynamic range recording and provides broadband tape noise reduction of 30 dB. This tape noise reduction is achieved without "filtering" (frequency subtraction). The compression/expansion process to achieve noise reduction will not eliminate or reduce any noise already present in the source. The dbx true mirror image compressor/expander process allows loud music peaks to be recorded and reproduced while retaining all of the attack and transient characteristics and allows the very quiet passages of music to be recorded without being lost in tape noise. This has never before been possible on tape.

The dbx II tape noise reduction system is notably superior to other noise reduction systems as it provides much more noise reduction and requires no level match tones to provide accurate compression/expansion tracking. As the dbx II system provides the tape recorder with a 30 dB noise cushion and 10 dB additional headroom, recording levels are not critical.

How to copy a Dolby "B" tape or broadcast.

A Dolby "B" encoded source, whether tape or FM broadcast, must first be decoded through a Dolby "B" decoder. The decoded signal is then processed through the dynamic range enhancer section of the dbx 128 to increase the dynamic content and reduce noise in the source. The enhanced program is now recorded on tape through the 128 dbx II tape noise reduction section to preserve all the dynamic range and eliminate audible tape noise added by the tape recording process.

When is the dbx disc button used?

The dbx 128 has the capability of decoding dbx encoded discs (commer-

Figure 4 — Above threshold compression has no effect on low level signals. When signal level reaches the adjustable threshold, the dynamic content of the music is decreased but only above that threshold. Higher compression ratios may be used in above threshold compression than in linear compression; however, all ratios are available.

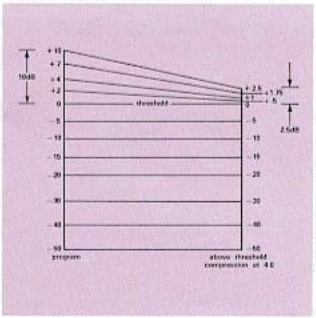
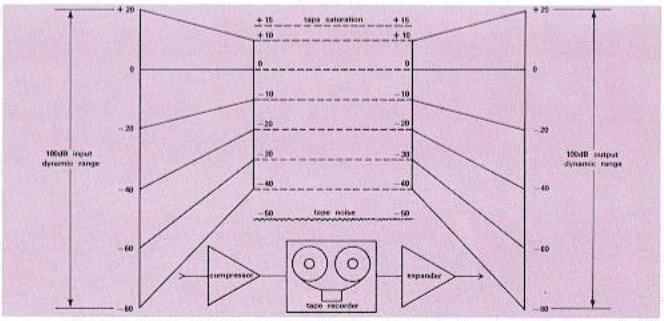


Figure 5 — Loud passages are decreased in level allowing them to be recorded below the level of tape saturation; very quiet signals are placed on tape significantly above the tape noise level.



corded music.

cially available) which provide the listener full dynamic range (up to 100 dB) in the complete absence of audible disc surface noise. The disc playback button is for playing dbx encoded discs only.

What about compatibility?

The tape noise reduction section of the 128 is identical to any other dbx II tape noise reduction system. dbx II tape noise reduction differs from professional dbx used in recording studios throughout the world. Both systems offer the same 30 dB noise reduction and 10 dB increase in headroom but are not compatible with each other.

Tapes recorded with the dbx II tape noise reduction system cannot be played back on Dolby, ANRS or any other devices, but must be played back through a dbx II system. This group includes all dbx II outboard noise reduction systems, as well as onboard dbx II noise reduction systems built into major brands of tape recorders and other high fidelity equipment. Any tape or disc recorded in dbx II format can be properly played back only by a dbx II system.

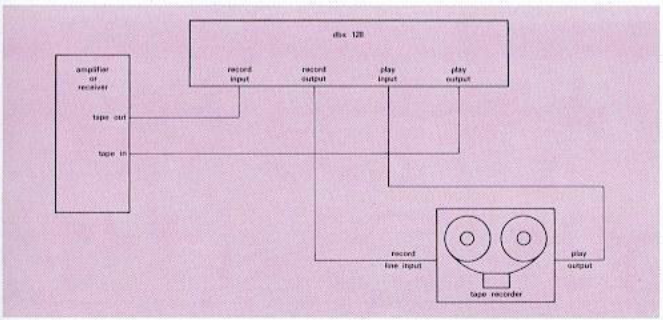
How to connect the dbx 128 to a music system.

The dbx 128 can be connected to any component type stereo system having a tape monitor facility, but it is important to bear in mind that the better the quality of the associated components, the better the results. The 128 system interfaces to the music system at line levels, terminating in RCA type phono jacks. (See Figure 6.)

Can a Dolby "B" encoder be used in addition to dbx II to get more noise reduction?

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

Figure 6 — Connection of the dbx 128 to a music system.



How to monitor off tape while recording with the 128 dbx II tape noise reduction system.

While recording, the dbx II signal processors are in the record (compression) mode. The compressed signal monitored off tape will sound excessively bright and noisy. After recording, the 128 must be switched to "play" to hear the normalized (expanded) signal. dbx manufactures the 124 dbx II tape noise reduction system that allows stereo recording and playback simultaneously for monitoring of the noise reduced signal while recording. Literature on this system is available on request.

How to copy a tape or disc which is already dbx compressed.

You can copy dbx material in its compressed form from one machine to another, or even from one tape format to another, as long as you do not have any tone controls between the output of the playback machine and the input of the copying machine.

Using the 128 dbx II tape noise reduction system for live recording.

The 128 dbx II tape noise reduction section is a line level device, i.e. it will not accept microphone level signals directly. A microphone preamplifier or mixer must be used prior to entering the dbx 128. All equalizing, echo or reverb, etc. must be performed prior to dbx encoding.

For further information on dynamic range enhancement or tape noise reduction, we suggest you ask for any of the following brochures, which are available without charge from your local dbx dealer or from the dbx Customer Service Department.

- dbx 117/119 Dynamic Range Enhancer brochure
- dbx 122/124 Tape Noise Reduction System brochure
- Selection of test reports and article reprints

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 tape saturation "ceiling" and the noise "floor." This is shown graphically in Figure 7. Any signal which is below the tape saturation ceiling and above the noise floor will pass through the tape recorder without being audibly changed or degraded. Some information on the tape saturation 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.

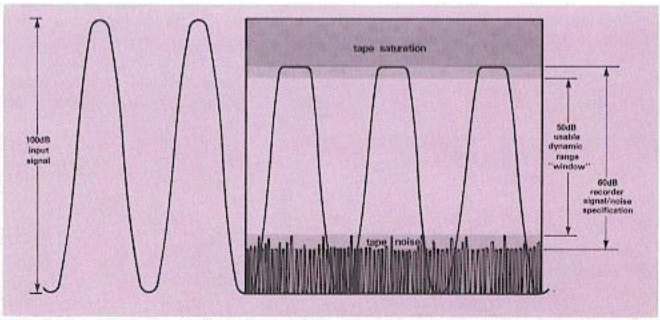
An additional complexity facing the recordist is that most VU meters give only average readings and do not measure peaks. These peaks are loud instantaneous sounds like drumbeats and cymbal crashes which are able to cause distortion but are of such short time duration they do not show up in the meter 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 audiophile tape recorder will nearly double the usable dynamic range capability.

Figure 7 — Dynamic range limitation of the tape recording process.



The ultimate objective of the recording process is to capture the dynamic excitement of the original performance, whether performed in a concert hall, night club or recording studio. The listener expects and deserves repeated enjoyment of recorded musical performances with full dynamic impact and without extraneous noise or distortion.

This objective has remained the same ever since Thomas Edison recorded "Mary had a little lamb" on his crude tinfoil cylinder a century ago. Since that time, technology has improved in records, tapes and FM broadcasts, but recorded music with full dynamics and without audible noise is not yet a commercial reality.

To understand the deficiencies in recorded music, it is necessary to understand dynamic range. The difference between the loudest and the quietest portions of the music is called its "dynamic range" and is expressed in decibels or dB.* In a live performance, the sound level of a symphony or rock group could be as much as 115 dB spl.* In contrast, there are some quiet passages in music that are a full 100 dB quieter than the loudest portions of the music.

To record and play back the full dynamic content of live music without adding audible noise or distortion, every piece of equipment in the record/playback chain must accommodate the entire dynamic range. The inherent background noise level of the recording equipment chain must be 100 dB below the maximum signal level at which distortion becomes audible. All links of this chain are capable of 100 dB dynamic range with the exception of the tape.

Most recorded music that is heard from records, tapes, or radio broadcasts was originally recorded on tape. To understand the dynamic limitations of tape recorded material, it is necessary to understand the limitations of the studio recording process.

Even the best professional studio tape recorders are capable of only a 68 dB dynamic range. The restricting factor is not the tape recorder's electronics but the dynamic limitations of the tape, namely, tape saturation (the level at which the tape will not accept any more recorded signal), and the inherent noise level of the tape. It is the tape that has only 68 dB dynamic range, not the recorder's electronics. Even that 68 dB is not all usable dynamic range. When a recorded signal approaches tape saturation, audible distortion results. When the recorded signals approach the noise level of the tape, these lower level signals become lost in the tape noise. To insure the desired high quality of sound reproduction, it is necessary to subtract 5 dB from the maximum level and add 5 dB to the minimum level. This reduces the usable dynamic range of tape to approximately 58 dB to 60 dB. While future improvements in tape technology may contribute a dB or two, nothing like the required 40 dB improvement for full dynamic range recording can be expected.

Musical dynamics must be altered drastically to record them on a tape which has a usable dynamic range of only 60 dB. If music with greater than 100 dB dynamic range is recorded on a 60 dB dynamic range tape recorder, either the top 40 dB of the music will be saturated and audibly distorted, or the bottom 40 dB of the music will be buried in tape noise and thus obscured, or there will be a compromise of the two.† The studio tape recorder is therefore required to record musical programs with dynamic range in dB of nearly twice its own capability.

The recording industry's traditional solution to this problem has been to intentionally reduce the dynamic content of the music in several different ways. The conductor can instruct the orchestra not to play too loudly or too quietly and thus produce a limited dynamic range for the studio microphones to pick up.

A more widely used method of reducing the dynamic range is for the recording engineer to manually "gain ride" and to use automatic gain alteration devices such as compressors and limiters.

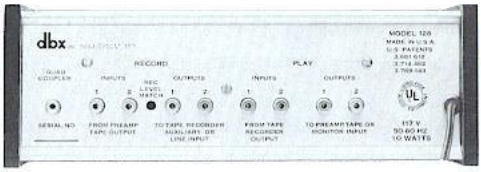
Even if a master tape recording with full dynamic range could be produced, it must ultimately be transferred to a conventional disc which has at best a 65 dB dynamic range. Most records available in stores today have only a 40 to 55 dB dynamic range. Prerecorded tapes in all formats (open reel, cassette or cartridge) also have a limited dynamic range due to the inherent limitations of tape.

The dynamic range of commercially recorded music has been intentionally restricted to accommodate the limitations of the recording and broadcasting media. Dynamic relationships in music have been altered from their original form. Crescendos and variations in loudness have been reduced in scale. Loud signals such as drum beats, cymbal clashes and the sharp attacks of brass instruments lose much of their excitement and vitality. Quiet passages with their harmonic detail are lost in the background noise.

As long as commercially recorded material suffers from greatly reduced dynamics and audible noise still exists, whether it be tape hiss, record surface noise or broadcast noise, some means of retrieving lost dynamics and reducing noise that would allow prerecorded music to more closely approach the live performance is desirable. When using the dbx 128 dynamic range enhancer, the listener is allowed full flexibility to conform the music's dynamics to his own individual tastes.

*The "dB" or "decibel" is a unit of expression for sound level or intensity of sound. One decibel is usually described as the smallest detectable change in sound level. The threshold of human hearing (the faintest sound you can perceive) is approximately 0 dB "spl" (sound pressure level) and the threshold of pain (the point at which you instinctively put your hands over your ears) is about 130 dB spl.

†See box "What is the usable dynamic range of a tape recorder?"



Specifications

dbx II TAPE NOISE REDUCTION SECTION

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 ohms 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 record/playback cycle
Frequency response
±0.5 dB 50 Hz to 15 kHz
±1 db 30 Hz to 20 kHz
single sinewave record/playback 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 playback mode
Level adjustment
100 mV to 3V for unity gain; for convenience in level setting and avoidance of overload in succeeding audio stages; level setting unimportant for record/playback tracking.
Harmonic distortion
2nd harmonic ≤0.1% record/playback
30 Hz to 15 kHz
3rd harmonic ≤0.1% record/playback
100 Hz to 15 kHz
3rd harmonic ≤0.5% record/playback
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 reponse
risetime = ≤20 μs
overshoot = 12 dB for 1 kHz tone burst
release rate = 240 dB/second

DYNAMIC RANGE ENHANCEMENT SECTION

Compression
continuously adjustable to infinity
Expansion
continuously adjustable from 1.0 to 2.0
Input noise
90 dB below 1 volt
Input level
30 volts RMS maximum
Input impedance
50 k ohms
Maximum output level
7 volts RMS at 1 kHz into 5 k ohms load
Level adjustment
adjustable for unity gain for signal levels of 10 millivolts to 2 volts
Frequency response
±0.5 dB 20 Hz to 20,000 Hz
Attack time
12 milliseconds typical; faster for rapidly rising signal level
Release rate
follows signal envelope up to a rate of 180 dB per second. Attack and release times vary with the rise and decay of a musical signal. Time responses optimized to simulate the time response of the human ear.
Total harmonic distortion
0.1% typical 20 Hz to 20,000 Hz at 1.0 expansion setting
Power line requirements
117 VAC, 50 to 60 Hz
Power consumption
10 watts
Dimensions
11"W x 3¾"H x 10¼"D
(27.9cm x 95.2cm x 26.0cm)
Weight
8 lbs. (3.6 kg)

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