dbx 180

TYPE I TAPE NOISE REDUCTION SYSTEM
OWNER'S MANUAL

dbx®

TABLE OF CONTENTS

1.0 Introduction to the dbx Model 180
- 1.1 The dbx Model 180 ... 2
- 1.2 Front Panel Features of the Model 180 ... 3
- 1.3 Rear Panel Features of the Model 180 ... 3

2.0 Installation
- 2.1 Unpacking and Inspection ... 4
- 2.2 Mounting ... 4
- 2.3 Power ... 4
- 2.4 Connections to the Model 180 Inputs and Outputs ... 4
  - 2.4.1 Connecting balanced and unbalanced input signal sources to the Model 180 ... 4
  - 2.4.2 Connecting the Model 180's standard unbalanced outputs to balanced and unbalanced loads ... 6
  - 2.4.3 Installing isolation transformers in the Model 180 to obtain balanced, isolated outputs ... 7
  - 2.4.4 Connecting the Model 180's transformer isolated outputs to balanced and unbalanced loads ... 8
- 2.5 Where the Model 180 Belongs in the Signal Chain ... 8

3.0 Operation
- 3.1 The Level Adjust Controls ... 11
  - 3.1.1 Tape machine setup ... 11
  - 3.1.2 PLAY LEVEL ADJUST procedure ... 11
  - 3.1.3 RECORD LEVEL ADJUST procedure ... 11
- 3.2 Recording a dbx Encoded Tape ... 11
- 3.3 Playing a dbx Encoded Tape ... 11
- 3.4 Recording and Playing non-dbx Encoded Tapes ... 12
- 3.5 Copying a dbx Encoded Tape in Encoded Form ... 12
- 3.6 Making a non-dbx Encoded Copy From a dbx Encoded Tape ... 12
- 3.7 Hints ... 12
  - 3.7.1 The recorder's VU meters ... 12
  - 3.7.2 Recording levels ... 12
  - 3.7.3 Elevated level tapes ... 13
  - 3.7.4 Mixing with dbx encoded tapes ... 13
  - 3.7.5 Alignment tones ... 13
  - 3.7.6 Background noises ... 13
  - 3.7.7 Infrasonics (subsonics) and interference ... 13
  - 3.7.8 Labeling tapes ... 14

4.0 Special Applications
- 4.1 Improving Sound Effects, Music Backup and Intermission Recordings for Theatrical Productions and Concerts ... 14
- 4.2 Quieter Echo/Delay/Reverberation Effects ... 14

5.0 Theory of Operation
- 5.1 Overview ... 15
- 5.2 Technical Analysis ... 16
  - 5.2.1 Level detection ... 16
  - 5.2.2 Pre-emphasis and de-emphasis ... 16
  - 5.2.3 Signal filtering ... 17
  - 5.2.4 The two systems: dbx Type I and dbx Type II ... 18

6.0 Specifications and Schematic Diagram
- 6.1 Specifications ... 19
- 6.2 Schematic Diagram ... 20

7.0 dbx Product Warranty and Factory Service ... 21

1.1 INTRODUCTION TO THE dbx MODEL 180

The dbx Model 180 is a Type I tape noise reduction system which provides *two channels of encode and two channels of decode processing.* It is thus capable of simultaneous recording and off-tape monitoring of a stereo program (or two independent single-channel programs).

The Model 180 provides *in excess of 30 dB broadband tape noise reduction with a simultaneous 10 dB improvement in headroom* in the tape recording process. dbx processing dramatically improves the quality of live tape recordings. It not only preserves the quality of dbx encoded multi-track master tapes through remixing and dubbing operations, the Model 180 avoids the addition of tape noise or distortion during mixdown or dubbing of any high quality analog or digital master recording. The 180 is useful for making two-track copies, whether for safety or multiple releases. It will not remove hiss which is already present on an existing recording, and it will not reduce hiss on a tape which has previously been recorded without Type I encoding.

The 180 will drive *600 ohm or greater impedance lines to +24 dBm* for proper interfacing with virtually all studio equipment. It has *balanced, differential amplifier inputs and unbalanced outputs which may be balanced and isolated by means of a user installed output transformer.* (The 180's main circuit board accepts PC-mount style Jensen output transformers for easy field installation.)

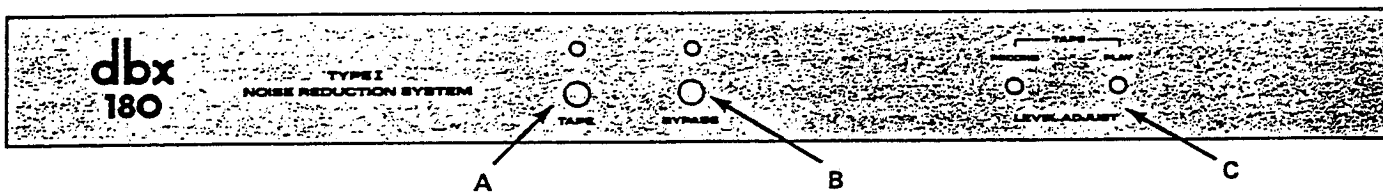
This compact unit occupies a single 1-3/4 in (44.5 mm) rack space. Connections to the mixing console and tape recorder are made via rear panel barrier strips.

No special calibration procedures or test tones are required to use dbx noise reduction. Primarily for monitoring convenience, to ensure that record and play levels remain roughly the same whether or not dbx processing is in use, a pair of *recessed, front panel accessible LEVEL ADJUST trimmers* are provided. A front panel *hard-wire BYPASS switch* connects the inputs directly to the outputs, for the recording or playback of non-dbx encoded tapes.

When a tape is recorded with dbx Type I processing, there is no need to use any other noise reduction system on that tape; the dbx system provides more than 100 dB of dynamic range. Audible tape hiss is completely absent, and distortion is significantly reduced because the recorder is seldom, if ever, pushed to the point of tape saturation. In fact, the signal-to-noise and headroom are equal to or greater than that available from any commercially sold or currently proposed digital audio recorder. The dbx Model 180, along with our other dbx tape noise reduction systems, thus provides a proven, highly cost-effective alternative to the expense and complexity of "going digital."

1.2 FRONT PANEL FEATURES OF THE MODEL 180

Fig. 1-1 — dbx Model 180 Front Panel



A. TAPE switch and indicator
Depress the TAPE switch when you want to make a dbx encoded tape from a normal, non-encoded program, or when you want to play a dbx-encoded tape. The green LED above the switch button will be illuminated.

B. BYPASS switch and indicator
Depress the BYPASS switch when making a conventional, non dbx-encoded program, when dubbing directly from a Type I encoded source, or when playing a conventional, non-dbx encoded tape. The red LED above the switch button will be illuminated.

C. LEVEL ADJUST controls
The RECORD and PLAY controls are recessed, screwdriver-adjustable trimmers that adjust the gain of the 180's encoders (RECORD) and decoders (PLAY). These simple, non-critical adjustments usually need be done just once in a given installation (refer to Section 3.1, page 3-1).

1.3 REAR PANEL FEATURES OF THE MODEL 180

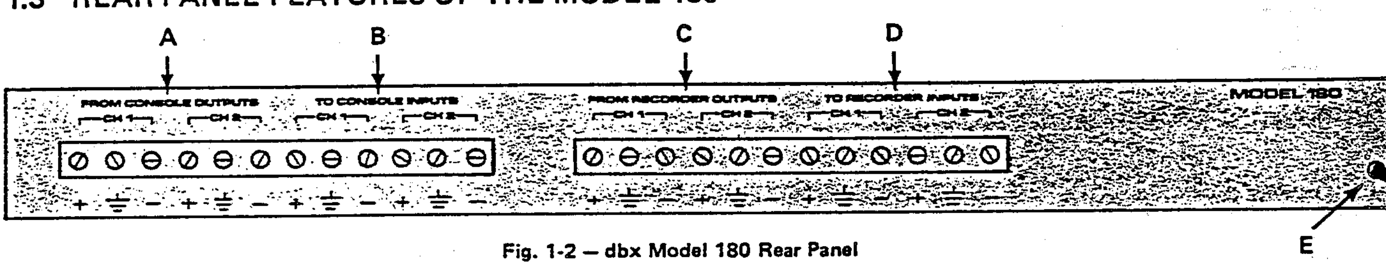


Fig. 1-2 — dbx Model 180 Rear Panel

A. FROM CONSOLE OUTPUTS terminals
These are the *input* terminals to the *encoder* circuitry. They connect to the mixing console's appropriate bus, line or tape outputs.

B. TO CONSOLE INPUTS terminals
These are the *output* terminals from the *decoder* circuitry. They connect to the mixing console's appropriate line or tape inputs.

C. FROM RECORDER OUTPUTS terminals
These are the *input* terminals to the *decoder* circuitry. They connect to the tape recorder's line outputs.

D. TO RECORDER INPUTS terminals
These are the *output* terminals from the *encoder* circuitry. They connect to the tape recorder's line inputs.

E. AC mains connection
Connect this cord to a 117 V AC, 50 or 60 Hz AC power source only. Models for use with other power sources are available outside the continental United States. Contact the dbx factory for information.

NOTE: The Model 180 is not equipped with a power ON/OFF switch, but instead is designed to be connected to a switched outlet on your equipment rack. Since the 180 draws very little AC power, it can be plugged into an unswitched AC outlet and left ON all the time.

2.0 INSTALLATION

2.1 UNPACKING AND INSPECTION

The Model 180 was carefully packed at the dbx factory in a carton designed to protect the unit from rough handling. Nevertheless, we recommend careful examination of the shipping carton and its contents for any sign of physical damage which may have occurred during shipment. If damage is evident, do not destroy any of the packing material or the carton, and immediately notify your dbx dealer.

It is a good idea to save all packing materials for effective protection when shipping the unit.

The carton should contain:

The Model 180 Type I Tape Noise Reduction System, ready for rack mounting.

Model 180 Instruction Manual.

Warranty Card.

2.2 MOUNTING

The Model 180 chassis has integral brackets for mounting into a standard 19 inch (483 mm) wide equipment rack. No special ventilation or cooling is required since the unit itself does not generate appreciable heat. However, as with all solid-state low-level signal processing equipment, it should not be subject to excess heat. While the chassis and circuitry are well shielded against radio frequency and electromagnetic interference, extreme RFI/EMI fields should be avoided.

2.3 POWER

The Model 180, as delivered in the U.S.A., may be operated from nominal 117 V AC mains (50 Hz or 60 Hz, single phase).

WARNING:

BE SURE TO VERIFY BOTH THE ACTUAL LINE VOLTAGE AND THE VOLTAGE FOR WHICH YOUR MODEL 180 WAS WIRED, AS INDICATED ON THE REAR PANEL OF THE UNIT. CONNECTION TO AN INAPPROPRIATE POWER SOURCE MAY RESULT IN EXTENSIVE DAMAGE WHICH IS NOT COVERED BY THE WARRANTY.

2.4 CONNECTIONS TO THE MODEL 180 INPUTS AND OUTPUTS

2.4.1 Connecting balanced and unbalanced input signal sources to the Model 180

All Model 180 inputs are balanced electronically by means of differential amplifiers. As such, they will not unbalance a balanced source, and they may be used with unbalanced sources as well.

NOTE: In this manual, a *balanced* line is defined as one that utilizes two-conductor shielded cable, wherein both center conductors carry the signal, oppositely polarized, and both have equal but opposite potential difference from ground. An unbalanced line generally utilizes single-conductor shielded cable, with the center conductor carrying the signal while the shield remains at ground potential.

Figure 2-1 illustrates the connection of balanced signal sources to the Model 180's FROM CONSOLE OUTPUTS terminals, and Figure 2-2 shows unbalanced sources connected to these inputs. Also, as shown, similar connections would be used for the Model 180's FROM RECORDER OUTPUTS terminals.

NOTE: For proper operation when feeding the 180 from an *unbalanced* source, each (—) terminal at the 180's inputs must be connected to a (⏚) terminal as shown.

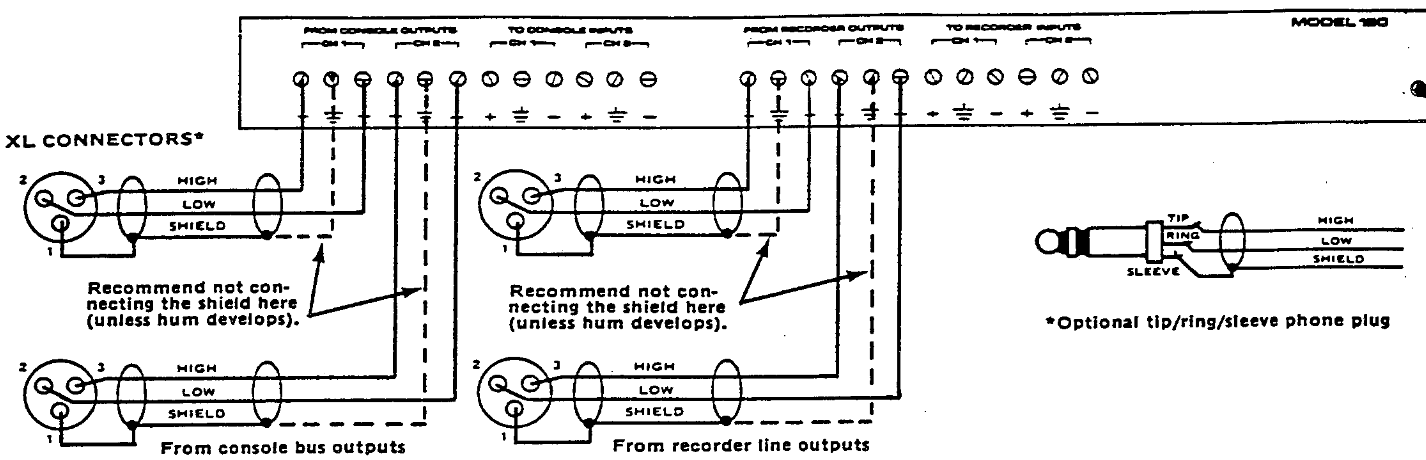


Fig. 2-1 — Connecting Balanced Sources to the Model 180

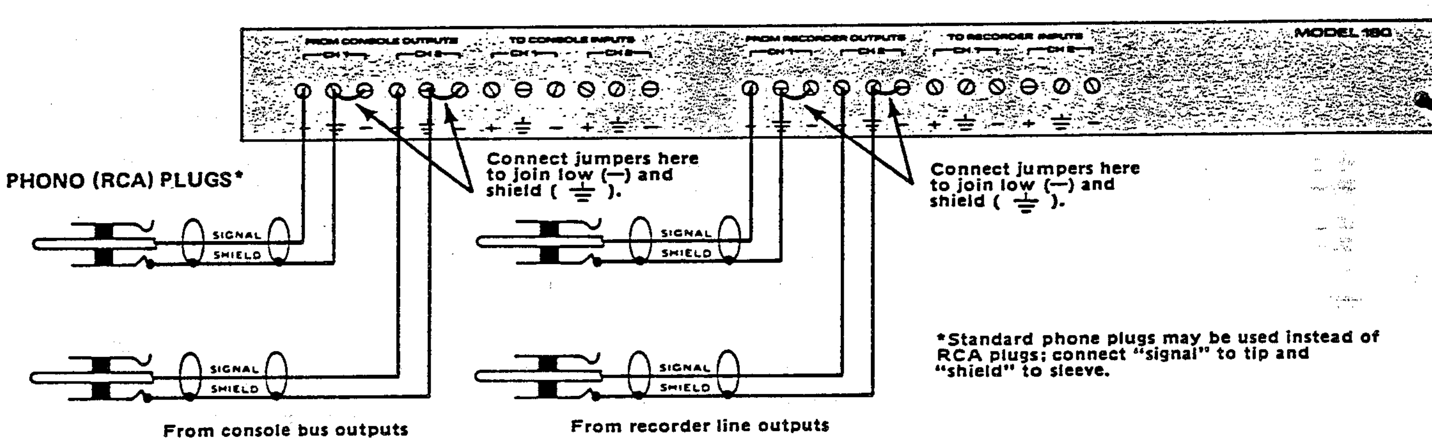


Fig. 2-2A — With single-conductor shielded cable

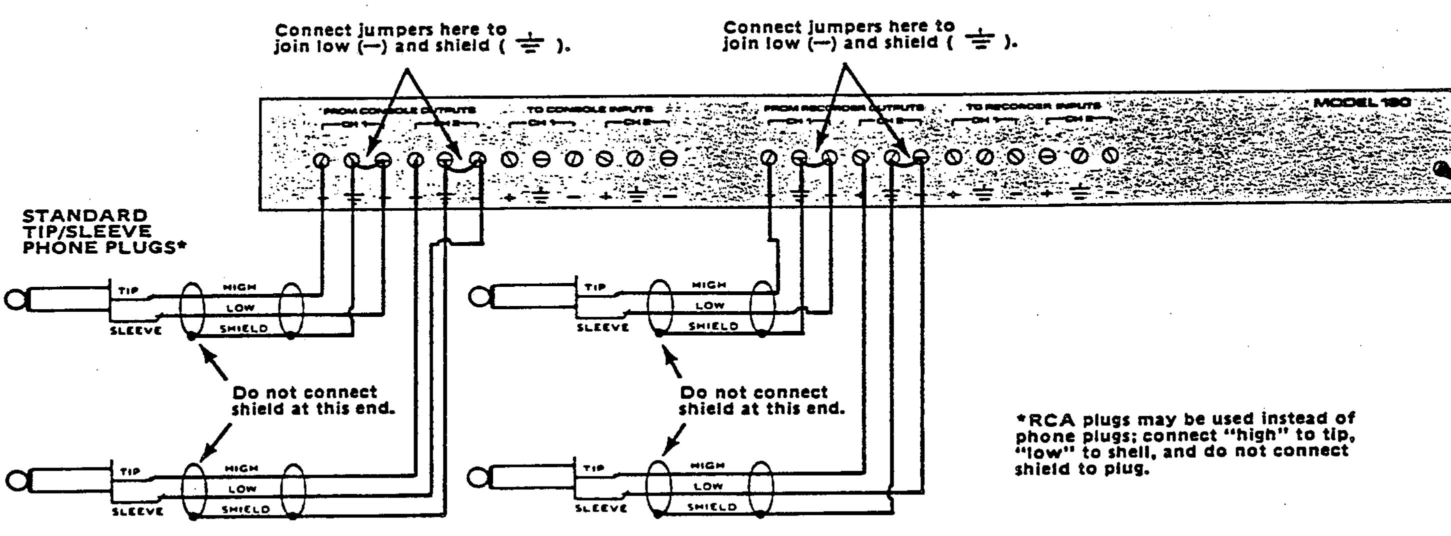


Fig. 2-2B — With dual-conductor shielded cable

Fig. 2-2 — Connecting Unbalanced Sources to the Model 180

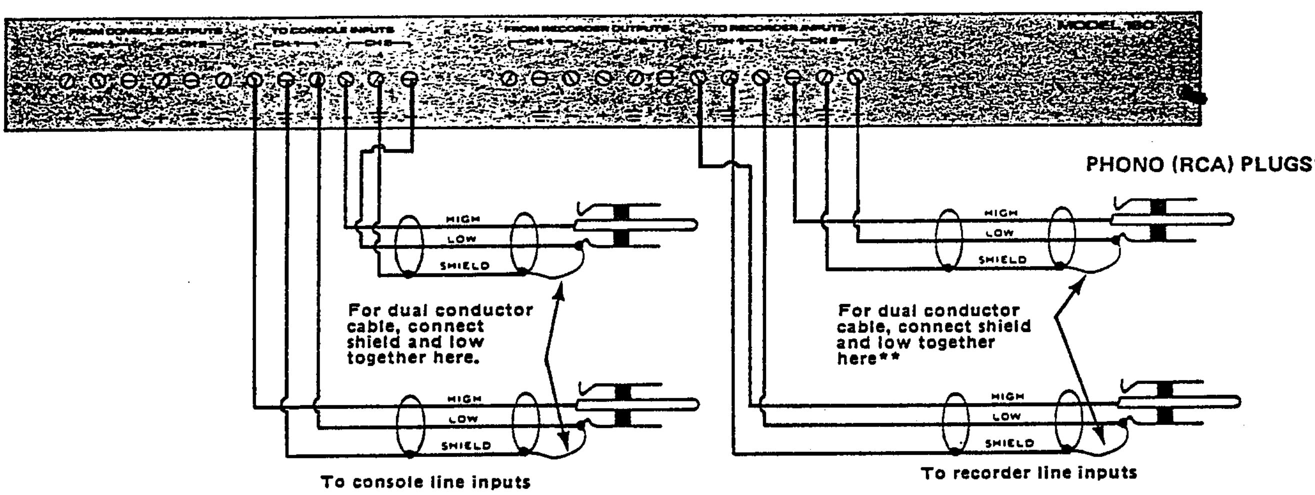
2.4.2 Connecting the Model 180's standard unbalanced outputs to balanced and unbalanced loads

All Model 180 outputs are driven by unbalanced, single-ended line amplifiers when the unit is in TAPE mode (i.e., when the encoders and decoders are processing the signals). These outputs are suitable for connection to most studio equipment, balanced or unbalanced.

NOTE: When using long interconnecting cables between the 180 output and the recorder or console, in very high RFI/EMI environments or in tricky grounding situations, balanced, isolated outputs may be desirable or necessary. In these cases, isolation/balancing transformers may be user installed in the Model 180, as described in Section 2.4.3.

Fig. 2-3 illustrates the unbalanced connection of the Model 180's TO CONSOLE INPUTS terminals to unbalanced inputs, and Fig. 2-4 to balanced inputs. Also, as shown, similar connections would be used for the Model 180's TO RECORDER INPUTS terminals.

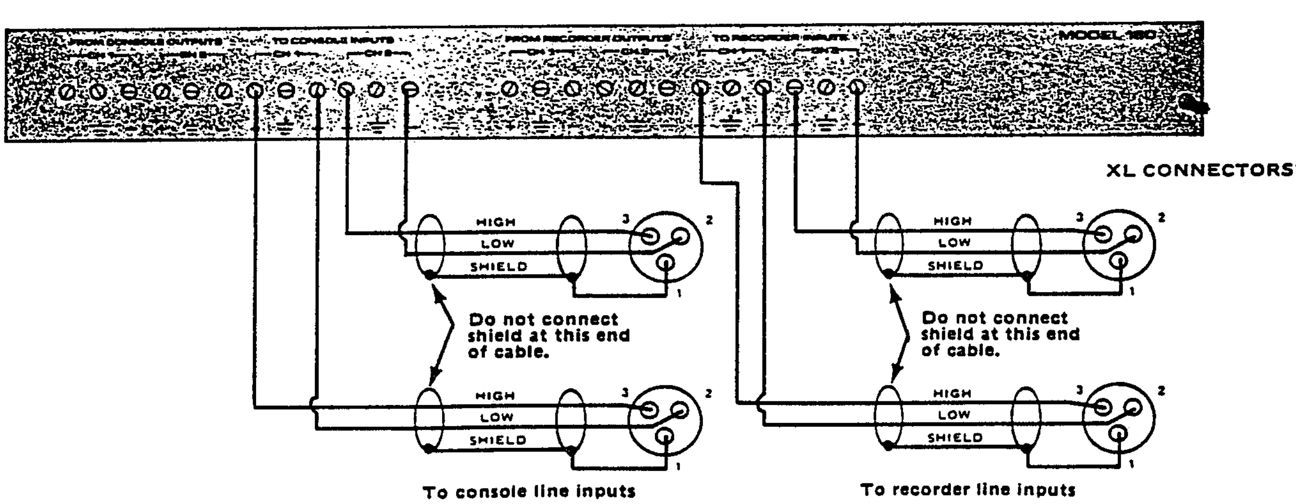
Notice that each output has signal high (+), low (—) and ground (⏚) terminals, just as with the balanced inputs. The 180's outputs are connected directly to its inputs in BYPASS mode, so these terminals permit a balanced input to remain balanced at the 180's output when the unit is bypassed. Further, when output isolation transformers are installed (Section 2.4.3), the terminals provide standard balanced connections. As delivered from the factory (without output transformers), the low (—) terminals and ground (⏚) terminals of each output are internally connected when the Model 180 is in TAPE mode.



*Standard tip/sleeve phone plug may be used instead of RCA plugs; connect "high" to tip and both "low" and shield to sleeve.

**If single conductor shielded cable is used, connect jumper between shield (⏚) and low (—) terminals on 180 output. Then connect to center conductor to tip and shield to shell (or sleeve).

Fig. 2-3 — Connecting the Model 180's Unbalanced Outputs to an Unbalanced Load



*Tip/ring/sleeve phone plug may be used instead of XL connector; connect "high" to tip, "low" to ring, and shield to sleeve.

Fig. 2-4 — Connecting the Model 180's Unbalanced Outputs to a Balanced Load

2.4.3 Installing isolation transformers in the Model 180 to obtain balanced, isolated outputs

The 180 main circuit board is drilled to accept four Jensen Model JE-123S-PC or JE-123S-LPC transformers. These were selected because they do not degrade the Model 180's outstanding electrical performance. Both models have a 1:1 turns ratio; however, the JE-123S-PC has a steel core and is capable of handling slightly higher maximum levels before saturation, whereas the somewhat more costly JE-123S-LPC has a nickel core which handles a bit less level but which keeps distortion very low. Under worst case conditions (saturation at 20 Hz) the JE-123S-LPC handles +24 dBm maximum level (1% THD), dropping to less than 0.03% THD at 20 Hz below saturation. Distortion is further cut roughly by 1/2 for each octave higher in frequency. The bandwidth is greater than 350 kHz (350,000 Hz) and there is less than 200° of phase shift at 20 kHz. These transformers are manufactured and available directly from Jensen Transformers (for address and phone see the Specifications Section).

The addition of these transformers provides a balanced, floating output stage. *dbx recommends installing transformers only when an isolated output is needed*; therefore, install transformers only on the appropriate 180 outputs. To do so, follow the procedure in the adjacent column.

CAUTION: DANGEROUS AC VOLTAGES EXIST INSIDE THE MODEL 180. ONLY QUALIFIED SERVICE TECHNICIANS SHOULD PERFORM THE FOLLOWING PROCEDURE.

1. Unplug the Model 180 from the AC mains.
2. To open the unit for access to the main circuit board, remove the screws securing both rack ears, and set them aside.
3. Pull the top and bottom covers out sideways; slide them from the lips of the extrusions along the front and rear panels to expose the main circuit board.
4. Referring to Figure 2-5, find the locations on the 180's circuit board for those outputs on which you wish to install transformers. Within each of the transformer-mounting areas are jumpers; cut or unsolder these jumpers wherever a transformer will be installed.
5. Insert the transformers from the top side of the board, and solder the pins in place on the bottom of the board. The JE-123S-PC and -LPC are symmetrical (primary and secondary windings are identical , so orientation on the 180 circuit board is not critical); if the pins line up, they are correctly installed.
6. Slide the top and bottom covers back on, taking care not to snag the foam tape along the front and rear extrusion flanges, and screw the end panels in place securely.
7. Those Model 180 outputs which have transformers installed are now balanced and floating, since there is no ground reference. It is suggested that the rear panel be labeled accordingly, indicating that a balanced, floating output is installed.

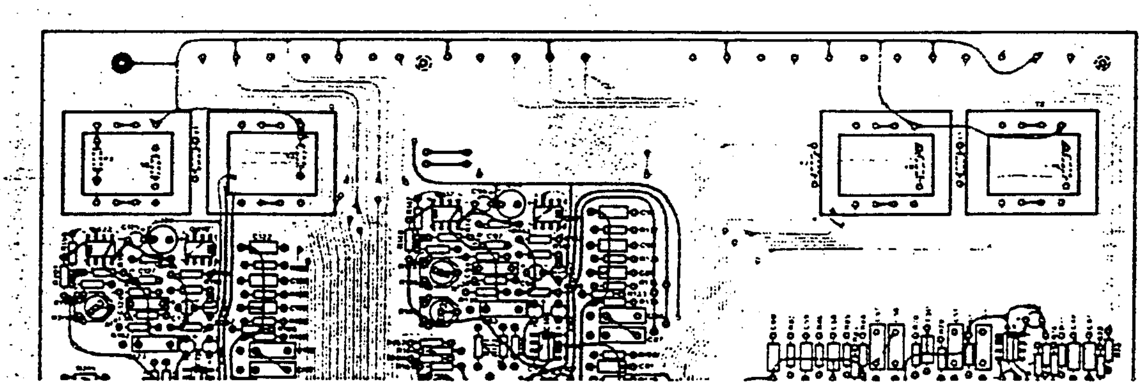


Fig. 2-5 — Model 180 Main Circuit Board
Note predrilled locations for mounting Jensen JE-123S-PC or JE-123S-LPC transformers.

2.4.4 Connecting the Model 180's transformer isolated outputs to balanced and unbalanced loads

Figure 2-6 illustrates the connection of the Model 180 TO CONSOLE INPUTS terminals to unbalanced or balanced inputs. Also, as shown, similar connections would be used for the Model 180's TO RECORDER INPUTS terminals.

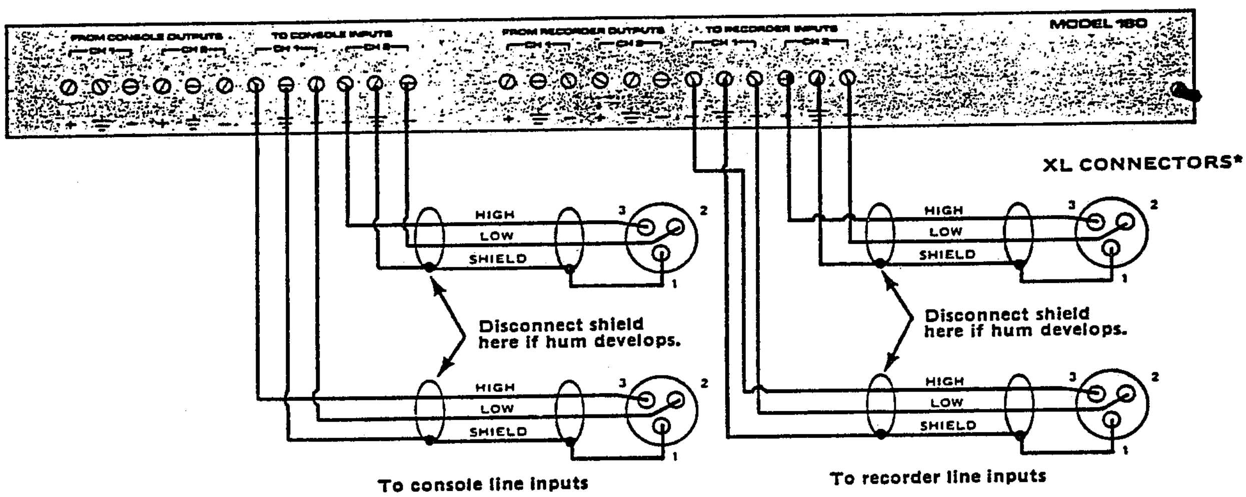


Fig. 2-6 – Connecting the Model 180's Transformer Isolated Outputs to Balanced Loads

*Tip/ring/sleeve phone plug may be used instead of XL connector; connect "high" to tip, "low" to ring, and shield to sleeve.

2.5 WHERE THE MODEL 180 BELONGS IN THE SIGNAL CHAIN

The Model 180 should be the *last* processor through which signal flows *before reaching* the tape recorder and the *first* processor through which signal flows *when leaving* the tape recorder. The only exception to this rule is the use of dedicated equalizers between the output of the tape machine and the 180's FROM RECORDER OUTPUTS for the purpose of correcting frequency response non-linearities which cannot be effectively removed by the tape recorder's own equalization circuitry. The key criterion is maintaining perfect linearity between the Model 180 and the tape recorder.

In a studio where the Model 180 is likely to be used with a variety of recorders, it may be desirable to wire its inputs and outputs to a patch bay, or to wire short XLR cables to its barrier strips for quick plug-in installation.

The following illustrations, Figures 2-7 through 2-10, depict Model 180 installation for a variety of typical applications. Information concerning the special applications can be found in Section 4.

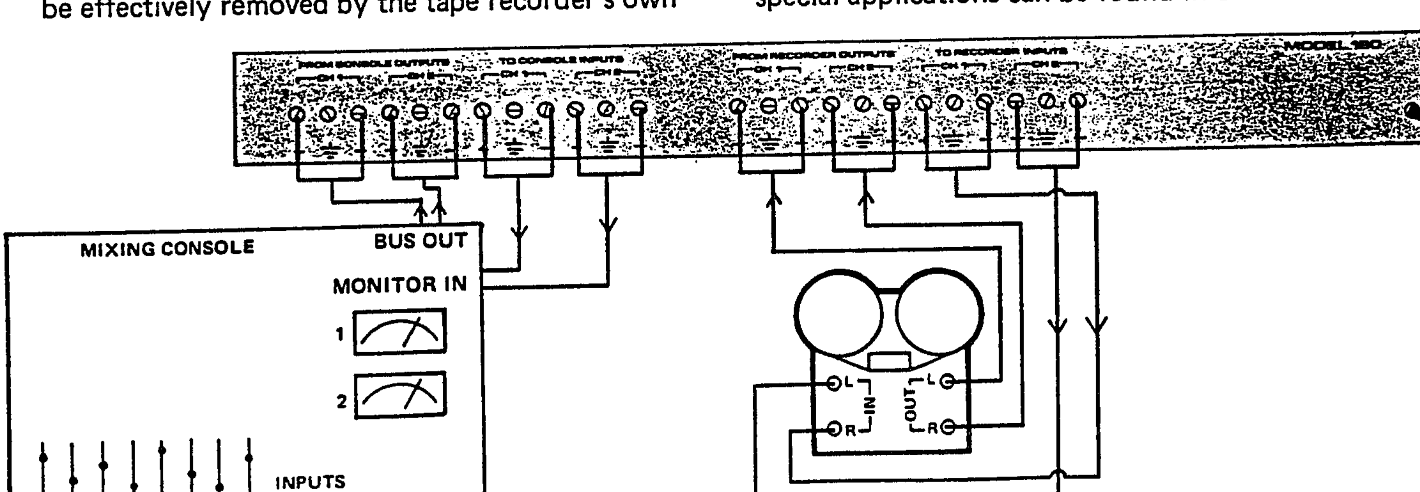


Fig. 2-7 – Recording and monitoring a dbx-encoded 2-track master during mixdown of a multitrack master.

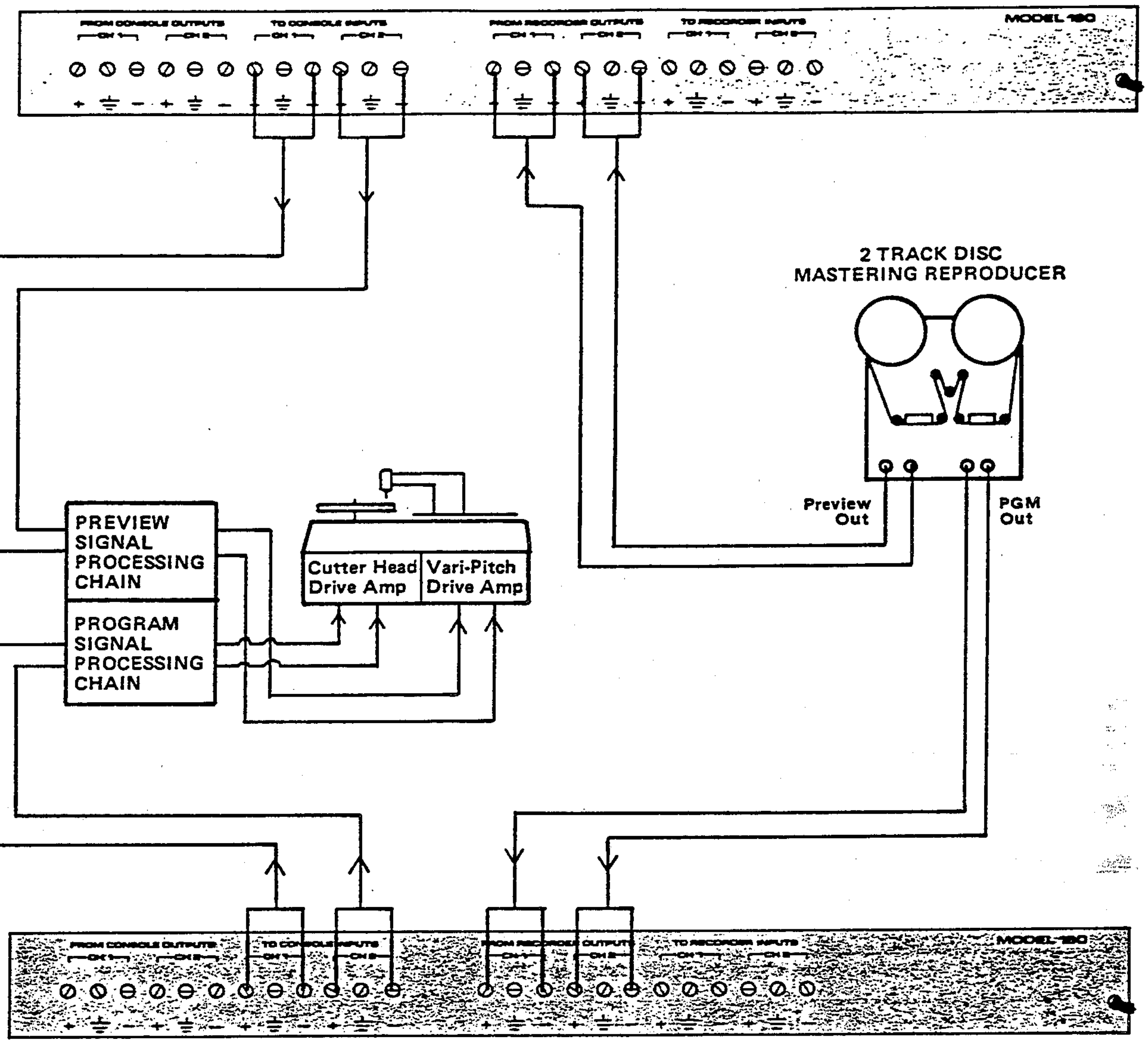


Fig. 2-8 — Decoding a dbx-encoded 2-track master for disc mastering.

NOTE: Two 180's are used here, one for the preview chain and one for the cutting chain.

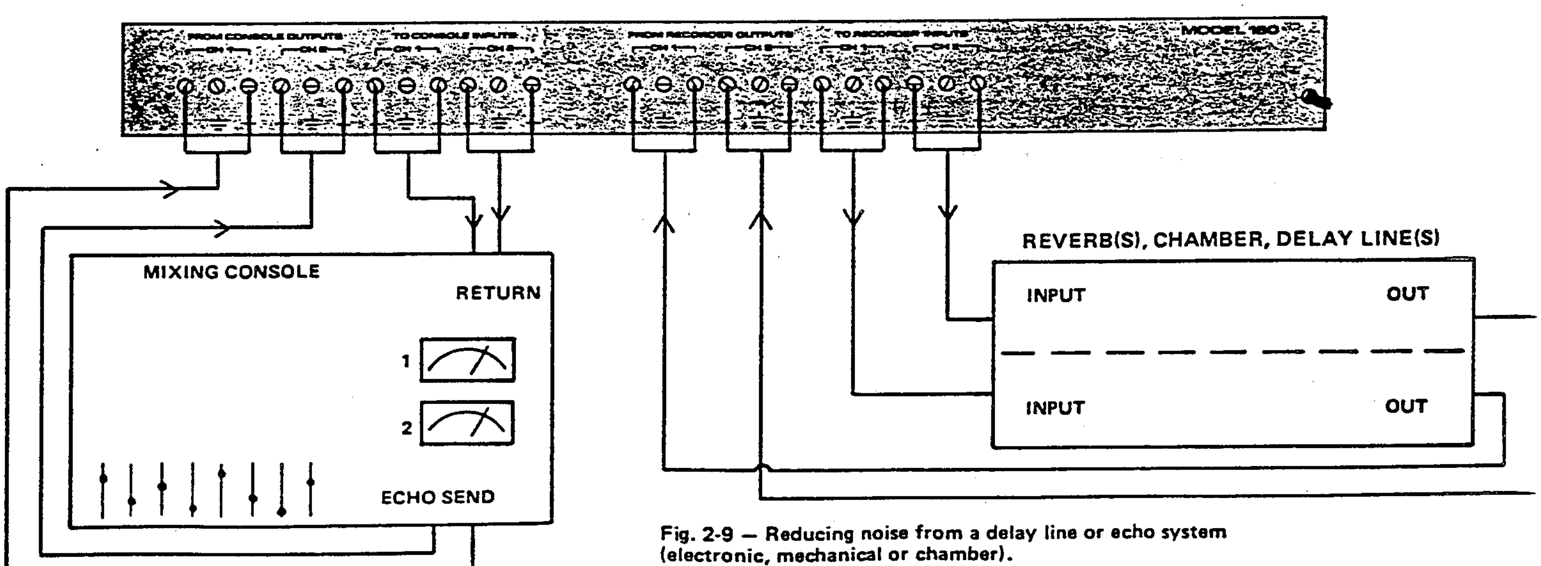


Fig. 2-9 — Reducing noise from a delay line or echo system (electronic, mechanical or chamber).

NOTE: In this application, the decay time of the delay line or echo system is decreased by the dbx process. See Section 4 for further information on this setup.

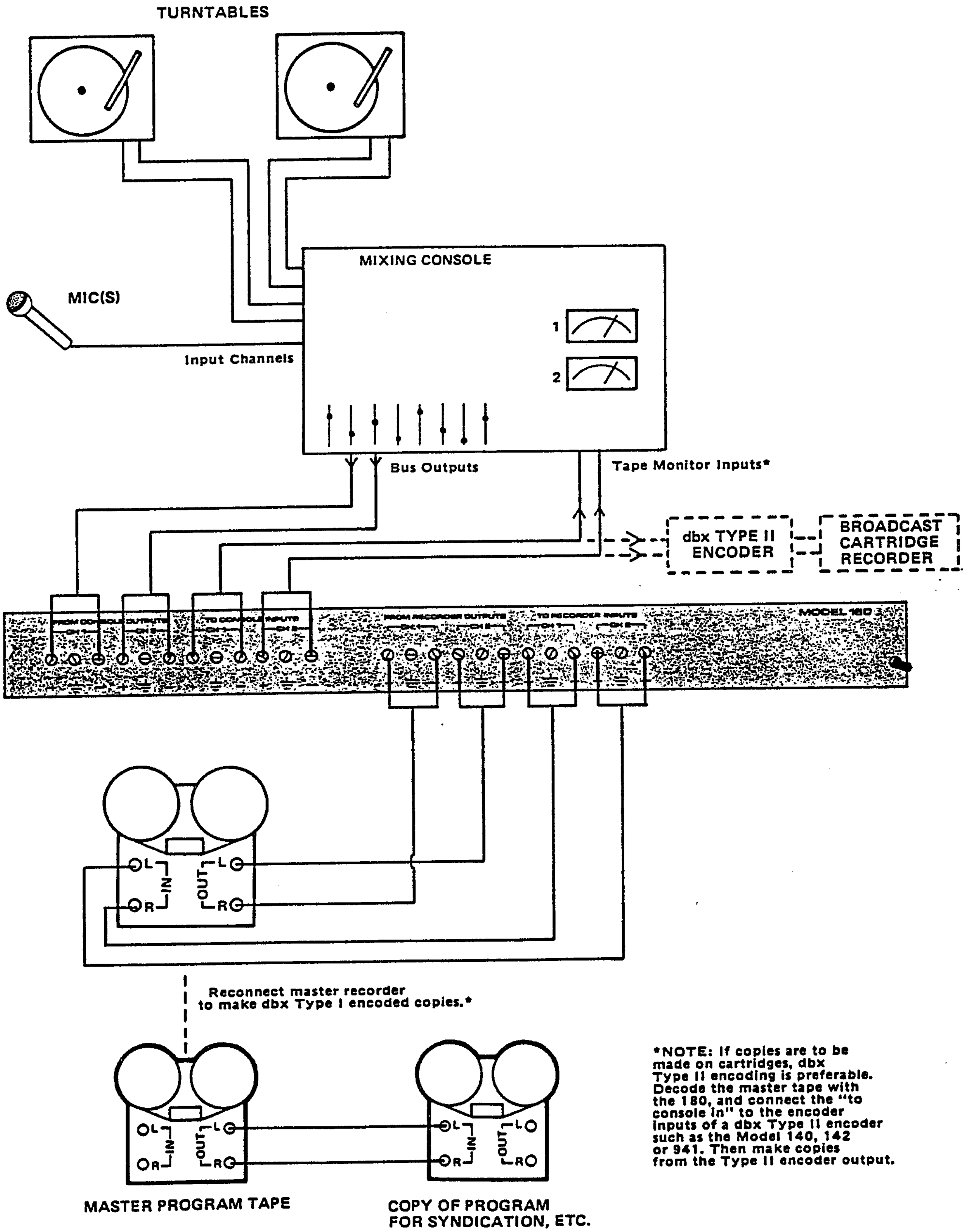


Fig. 2-10 – Avoiding tape noise in production of 2-track reel-to-reel broadcast programming.

NOTE: The 180 is not required to make additional copies once the dbx-encoded 2-track master has been recorded; make the trans-

3.0 OPERATION

3.1 THE LEVEL ADJUST CONTROLS

For listening convenience, two screwdriver-adjustable controls are accessible through holes in the front panel. They are intended to keep the RECORD and PLAY levels about the same, to minimize monitoring level differences between dbx-encoded tapes and BYPASS mode (for non-dbx encoded tapes), and to optimize output levels to the console and recorder for the best headroom and lowest noise. The LEVEL ADJUST controls set the unity gain through the Model 180 encode and decode processors. Each control adjusts two channels simultaneously, so the correct image is maintained in stereo programs. The processing itself is independent, so two totally discrete channels of information may be processed. In no case do the LEVEL ADJUST settings affect the linearity of the dbx encode/decode process.

3.1.1 Tape machine setup

Because the dbx decoder can mistrack if there are significant frequency response errors in the tape recorder, it is recommended that the recorder be warmed up and carefully aligned with a standard calibration tape (with the 180 BYPASS switch engaged) prior to adjusting the Model 180. Try to maintain record/play frequency response accuracy of ±1 dB or better. Record bias levels may require some minor adjustment in order to achieve minimum modulation noise. (Modulation noise is always present, but may become audible for the first time once noise reduction has eliminated the masking effect of steady state background noise.) Consult the tape manufacturer's specifications and/or experiment.

3.1.2 PLAY LEVEL ADJUST procedure

This procedure sets the output level to the console from the 180's PLAY (decode) electronics. Remember, the LEVEL ADJUST controls affect the 180 output level only in the TAPE mode; they have no effect on levels in the BYPASS mode.

1. Depress the 180's BYPASS switch and play the 1 kHz tone from your standard alignment tape. The tape recorder meters should indicate 0 VU (assumed to be the studio's standard reference level).
2. The console's VU meters that monitor the recorder output signal should also indicate 0 VU. If your console does not have a monitor section or tape input VU meters, you may wish to assign the tape input channels to obtain a incoming signal to output channels to obtain a meter reading. Alternately, connect a high impedance voltmeter (DVM or VTVM) across the 180's TO CONSOLE INPUTS (+) and (−) terminals to check levels.
3. Depress the 180's TAPE switch while continuing to play the 1 kHz tone from the standard alignment tape.
4. Adjust the 180's PLAY LEVEL ADJUST trimmer until the console VU meters (or the voltmeter) read 0 VU.

3.1.3 RECORD LEVEL ADJUST procedure

This procedure sets the output level to the tape machine from the 180's RECORD (encode) electronics.

1. Using an oscillator, feed a 1 kHz tone at 0 VU (assumed to be the studio's standard reference level) from those console outputs which are connected to the 180's FROM CONSOLE OUTPUTS terminals. Alternatively, connect the oscillator directly to the 180's FROM CONSOLE OUTPUTS terminals, and verify that the oscillator output is at the "0 VU" standard reference level.
2. Depress the 180's BYPASS switch.
3. Adjust the tape recorder's Record Level controls for 0 VU on the recorder's meters.
4. Depress the 180's TAPE switch. If the tape recorder's VU meters now indicate a level other than 0 VU, adjust the 180's RECORD LEVEL ADJUST control to obtain 0 VU on the tape recorder meters.

3.2 RECORDING A dbx ENCODED TAPE

Once the system is set up as described in the installation section, the procedure for making a dbx encoded recording is essentially the same as that for making a conventional recording, except that the recorder's VU meters should not be used to critically judge the recording levels. As a result of the 2:1 compression which is part of the dbx encoding process, they will show only about half the deflection of the meters on the console output. (See Sections 3.7.1 and 3.7.2)

To record a dbx encoded tape, depress the Model 180 TAPE switch. Since the Model 180 simultaneously encodes and decodes, off-tape monitoring of the recording will sound normal (the encoded signal is being decoded).

3.3 PLAYING A dbx ENCODED TAPE

In order to play back a dbx encoded tape, depress the Model 180's TAPE switch and play the tape. If an encoded tape is played back *without* decoding, it will sound thin (deficient in bass), noisy, and highly compressed. If a conventional (non-encoded) tape is played back *with* dbx encoding, it will sound muffled (deficient in high frequencies), and the volume will surge unnaturally.

3.4 RECORDING AND PLAYING NON-dbx ENCODED TAPES

Switch the Model 180 to BYPASS mode and operate the console and recorder conventionally.

3.5 COPYING A dbx ENCODED TAPE IN ENCODED FORM

A dbx encoded tape may be dubbed onto another recorder without decoding by depressing the BYPASS switch on the Model 180 during the transfer. Set the recorder's levels so the meter deflections match those on the unit which is playing the encoded master tape. The resulting copy may then be decoded with the Model 180 or any dbx Type I decoder.

3.6 MAKING A NON-dbx ENCODED COPY FROM A dbx ENCODED TAPE

Sometimes a non-dbx encoded copy of a dbx encoded master tape is required — perhaps for demo or reference use where a dbx decoder is not available. This is done by depressing the 180's TAPE switch, playing the dbx-encoded master, and feeding the decoded output to another recorder (through the console or directly from the 180's TO CONSOLE INPUTS terminals).

When making a non-encoded copy, be aware that the original dbx encoded tape may have substantially greater dynamic range than a non-encoded tape can accommodate. To prevent saturation (distortion) of peaks, and/or loss of quieter program passages due to the non-encoded tape's noise floor, it may be necessary to reduce the dynamic range of the program by using compression, limiting or gain riding. Such signal manipulation can be done anywhere between the 180's TO CONSOLE INPUTS terminals and the recorder on which the copy is being made; it *must not* be done between the dbx-encoded tape and the 180's FROM RECORDER OUTPUTS terminal (refer to Figure 3-1).

3.7 HINTS

3.7.1 The recorder's VU meters

Due to the encoding process, the recorder's VU meters show less deflection than the console's meters. The recorder's meters can be used to verify that a signal is being recorded, and they will indicate the approximate average level of the recorded signal. Loud peaks will not deflect as high above average, nor will quiet passages drop as low in level as they do on the console meters.

NOTE: The tape recorder's levels should *not* be raised so its maximum meter levels equal that of the meters on the console, since this will defeat the headroom advantage offered by the dbx processing. As a guide, the recorder meters should not be allowed to exceed "+1" or "+2" levels (see 3.7.2 below).

3.7.2 Recording levels

Record at levels that average between −10 and 0 VU on the console's output meters. Experiment with different levels to determine what is optimum for each instrument. All companding noise reduction systems work on the psychoacoustic phenomenon called "masking": that is, if you have a loud enough signal, you won't notice the noise. The 180 permits recording at levels well above the noise floor of the tape machine, but it is possible to record at average levels so low that even the 180 can't stop the quietest recorded passages from being nearly lost in the noise. The result will be noise, breathing, or "swishing" behind the music. A nominal operating level somewhere between −10 and 0 VU at the output of the console is generally most effective. 0 VU should, as a rule, not be exceeded except during program peaks. Although recording at high levels will eliminate noise pumping, other mistracking problems (e.g., level shifting effects) will occur if the high levels cause tape satuation or clipping of the electronics.

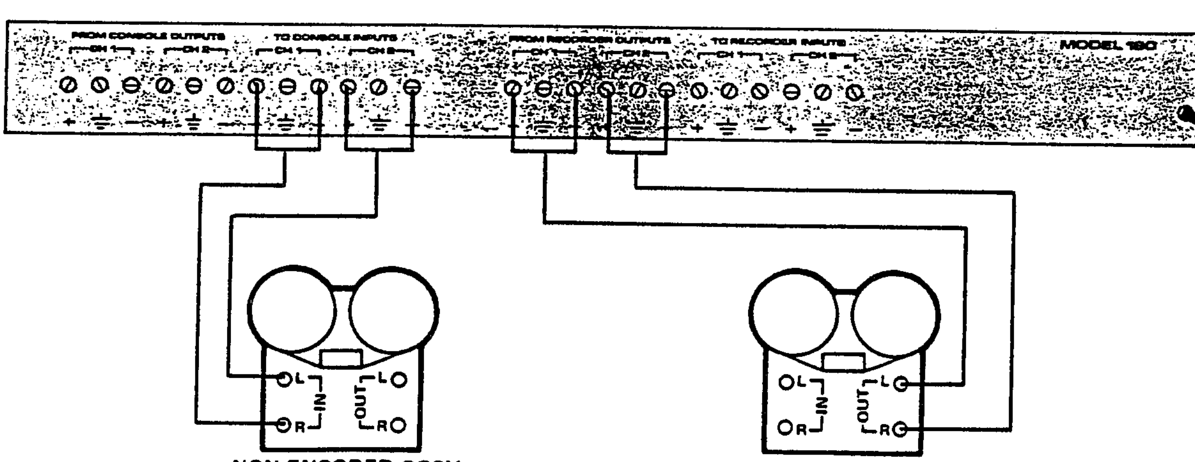


Fig. 3-1 — Making a non-dbx encoded copy from a dbx-encoded master tape.

The instruments which will require the most attention to level are those with the highest peak to average signal ratios, such as pianos, horns and drums. When in doubt, start with the console faders at their normal levels, and experiment with a particular instrument, raising or lowering the faders for optimum results.

With dbx noise reduction, no compression or limiting is required during recording or mixdown; for the most part, such processing can be reserved for achieving sustain on string instruments, for fattening drums, and for other special effects. Limiting is not necessary in order to "get the signal" onto the tape.

3.7.3 Elevated level tapes

It is not necessary to increase record levels to take advantage of elevated level—high output, low noise—tapes. Instead, it is desirable to retain normal record and play levels (as described in Section 3.7.2), providing extra headroom for truly accurate transient response. The extra few dB of recorded level are not necessary because with dbx there is no audible tape noise even with standard tapes. However, we do recommend using tape that has inherently low noise.

3.7.4 Mixing with dbx encoded tapes

Individual tracks which have been dbx encoded cannot be mixed together unless they are first decoded. Encoded audio must be decoded before limiting, equalization, or any other signal processing is used (except for machine response correction; see Section 2.5). Following the mixing and/or signal processing, the program is dbx-encoded and re-recorded. In this manner, several generations of mixing and re-mixing can be done without any audible noise buildup attributable to the recording process.

3.7.5 Alignment tones

It is always a good idea to record standard reference tones on a tape so that, upon subsequent playback or further recording, the tape machine can be properly aligned. In addition to any low and high-frequency EQ tones and azimuth-adjust tones, there should be a 0 VU reference level tone at 1 kHz. These tones should NOT be encoded (record and play them with the 180's BYPASS switch depressed). The non-encoded 1 kHz tone also can be used to adjust any dbx decoder's PLAY LEVEL ADJUST controls (see Section 3.1.2 for the adjustment procedure).

3.7.6 Background noises

Coughs, shoe scuffs, air conditioning noises, and similar sounds which may never have been audible in conventional recordings can become an annoyance when captured on a quiet dbx recording, so the ambient room noise in the studio should be held to an absolute minimum.

3.7.7 Infrasonics (subsonics) and interference

The Model 180 incorporates very effective high-pass filters that maintain full frequency response throughout the audible spectrum (−3 dB at 22 Hz). Their purpose is to reduce infrasonic frequencies to prevent them from introducing errors into the encode or decode process. However, in some instances during live recording, rumbles from passing trains, trucks, aircraft, or even air conditioning may be picked up by your microphones and fed to the dbx 180.

Bear in mind that the Model 180 will faithfully decode an encoded signal arriving at its FROM RECORDER OUTPUTS terminals (i.e., its decoder inputs). Problems could arise, however, if the signal "code" is changed at some point after it leaves the dbx encoder. To illustrate the concept with an extreme example, suppose a tape machine will not record any signal below 60 Hz, yet a musical signal with 30 Hz components is encoded and recorded. The encoder responds to the 30 Hz components, changing the gain affecting the overall signal, but since those 30 Hz components are missing upon playback (due to the recorder's shortcomings), the decoder has no information for accurate restoration of the original gain. The modified signal will be improperly decoded, with the audible result being inexplicable level changes.

Obviously, an "ideal" tape machine would result in a perfectly reproduced encoded signal, guaranteeing perfect decoding for accurate reproduction. Since "real world" tape machines have a finite bandwidth, dbx places high and low pass filters at inputs to the RMS level detectors. These filters prevent the encoder from acting on any low or high frequency information which might not accurately survive the record/play process. (These filters do not affect the recorded signal itself, only the encoder's gain-altering reaction to the signal.) In dbx Type I noise reduction, the filters are set at 30 Hz and 21 kHz, are relatively steep, and permit optimum noise reduction performance over the entire audio bandwidth when used with any of today's high quality reel-to-reel tape recorders. If the Type I noise reduction system is to be used with a tape recorder having an unusually limited bandwidth, then appropriate high or low pass filtering should be used to restrict the bandwidth of the signal applied to the encoder to match that of the tape recorder itself (see Figure 3-2).

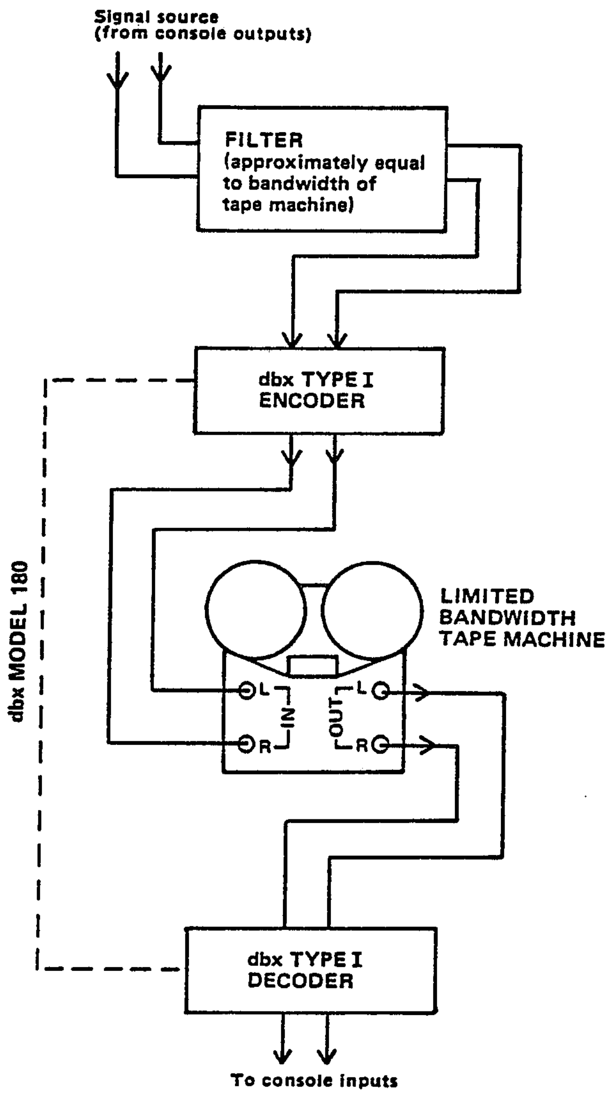


Fig. 3-2 – Bandpass filter inserted in signal chain to ensure proper Type I encoder tracking when used with a limited bandwidth recorder.

3.7.8 Labeling tapes

Tapes that have been recorded with the Model 180 should be labeled as "dbx Type I encoded." This will guide other engineers in playing them properly, and will avoid the possibility of dbx Type II being accidentally used for decoding.

4.0 SPECIAL APPLICATIONS

4.1 IMPROVING SOUND EFFECTS, MUSIC BACKUP AND INTERMISSION RECORDINGS FOR THEATRICAL PRODUCTIONS AND CONCERTS

A live theatrical or concert production presents a unique challenge to recorded effects of music; the contrast between the live microphones and a less than perfect recording becomes evident to the audience, however unsophisticated their ears may be. When making reel-to-reel tapes for sound effects, the Model 180 prevents noise and distortion from "giving away" the effect – the audience hears the sound on cue, but not the pre-roll or post-roll tape hiss. Similarly, when the musicians are pre-recorded to accompany a live vocalist, dbx encoding helps preserve the "live" quality of that musical performance. Actors, directors and musicians who have, with good reason, objected to the use of tape recordings to augment their performances may be pleasantly surprised when they hear the improvements offered by the Model 180.

4.2 QUIETER ECHO/DELAY/REVERBERATION EFFECTS

While the 180 was designed as a tape noise reduction system, it may be used for noise reduction in time delay/reverb type devices. This compander processing will shorten the decay time somewhat, and may be less desirable on systems that feature output-to-input feedback to achieve multiple echoes. Because the output signal of a delay/reverb device generally contains less high frequency information than the input signal to the device, there may be some decoder mistracking. However, since the signal is being mixed into the program for effect, this may not be objectionable. Experimentation is suggested. With many delay/reverb units, dbx Type II noise reduction is more suitable because Type II RMS detection is less sensitive to high frequency deficiencies. (Overall program frequency response through the encode/decode process is flat on both Type I and Type II systems.)

5.0 THEORY OF OPERATION

5.1 OVERVIEW

To reduce tape noise, the dbx 180 utilizes a sophisticated version of the classical compressor/expander (compander) concept. The RECORD processor compresses the input to the tape recorder by a 2:1 ratio, linear over more than a 100 dB range. Upon playback, the PLAY processor provides 1:2 expansion of the recorder's output. The expansion is a mirror image of the compression, so the retrieved audio cannot be distinguished from the original audio source, and virtually no audible tape noise has been added.

Consider a 100 dB program (see Figure 5-1) which might have loud peaks at +20 dBm and quiet passages as low as —80 dBm. If the tape recorder has a maximum input level of +15 dBm before distortion and a residual noise level of -50 dBm — in other words, a 65 dB S/N ratio typical of many good multi-track tape machines — the original program dynamics cannot be captured on tape; peaks will be lost due to saturation, quiet passages will be lost in the noise, or a combination of both will occur. dbx encoding will solve this problem by compressing the 100 dB program to a maximum 50 dB dynamic range. That is, the dbx encoding will bring the maximum signal level from +20 dBm down to +10 dBm and raise the minimum level from —80 dBm to —40 dBm, which will allow the recorded program to fall within the usable dynamic range of the tape recording system. The quietest signal will remain above the noise and the loudest signal will remain below the point of distortion.

NOTE: Maximum input levels on tape recorders are specified at the 3% harmonic distortion point; because dbx encoding lowers maximum recorded levels, it greatly lowers distortion at the same time it eliminates audible noise.

When the encoded recording is played through the dbx PLAY circuitry, expansion increases the level of the louder passages and decreases the level of quieter ones. In the preceding example, the +10 dBm recorded level would be restored to +20 dBm, the —40 dBm level would be restored to —80 dBm, and all other levels in between would be proportionately restored. The tape noise is also subject to expansion, and it drops from —50 dBm to —100 dBm (to inaudibility).

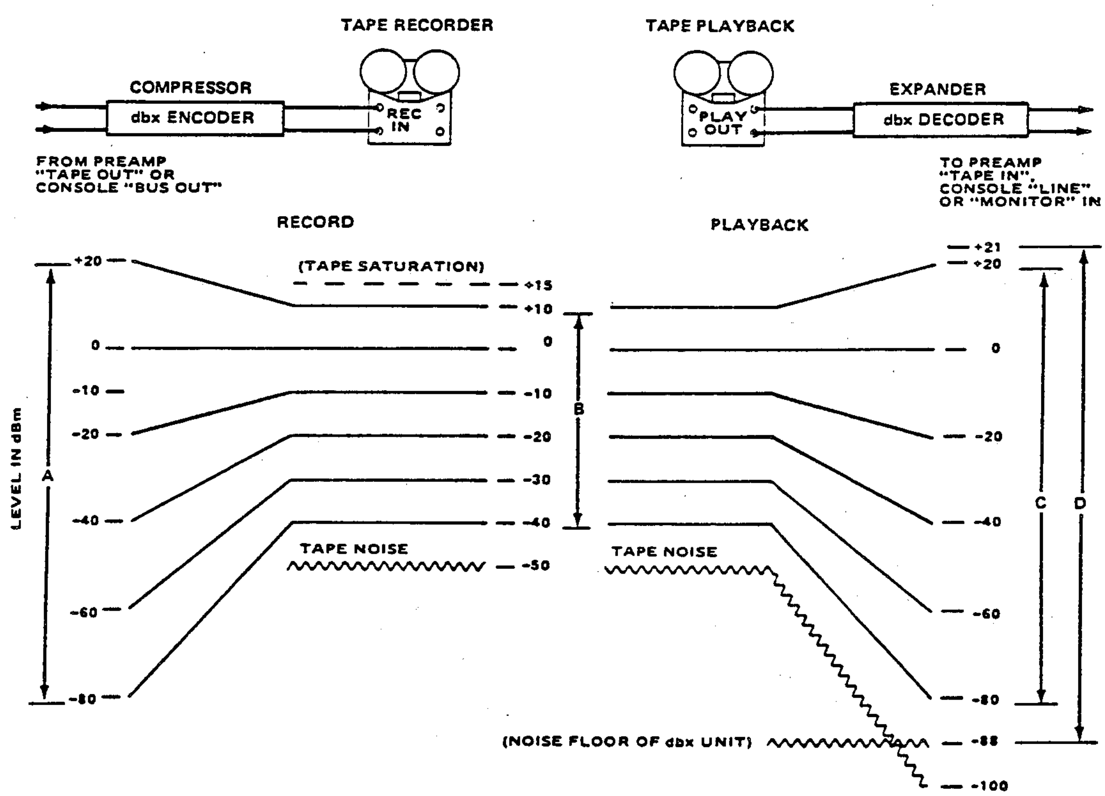


Fig. 5-1 — How the dbx System Works
A. Typical program of wide dynamic range (about 100 dB).
B. 2:1 compressed program (encoded) reduces dynamic range by half, so that signal can be placed below the tape saturation level and above the tape noise level.
C. 1:2 expanded program (decoded) restores the original dynamic range (100 dB). Tape noise is always well below the quietist part of the program.
D. Dynamic range of the dbx compressor and expander is over 100 dB.

5.2 TECHNICAL ANALYSIS

5.2.1 Level detection

Regardless of the specific techniques employed by a given compander-type noise reduction system, some method must be used to sense the audio input level to the compressor when recording and to the expander when playing back. This level detection circuitry tells the compressing or expanding amplifier what the actual input signal level is, causing the amplifier's gain to increase or decrease to provide the required expansion or compression. The basic principle of operation is simple in theory, but in practice it is difficult to maintain precise mirror image during encoding and decoding. To operate properly, whatever degree of compression takes place during the encoding must be precisely matched by the same degree of expansion during decoding — and at the same point in time with respect to the program.

There are several ways to detect signal level. Other attempts to create compander-type tape noise reduction systems have utilized peak and average level detection, each of which is sensitive to program waveforms. Phase related waveform distortions are inherent in tape recording due to characteristics of the record heads, electronics and tape, so level detection schemes which are waveform sensitive are subject to mistracking errors upon decoding. That is, the amount of expansion does not correspond with the original compression, so the retrieved program would not sound like the original one. Unlike peak and average level detection systems, the RMS method sums the squares of the instantaneous energy of all frequency components present. RMS detection is, of all the detection systems, least affected by phase shift-induced waveform distortions. However, true RMS detection has been very complex and expensive. dbx equipment uses our own patented analog techniques to achieve excellent RMS detection at a moderate cost.

5.2.2 Pre-emphasis and de-emphasis

On some recordings of solo bass instruments, even with dbx processing, faint noise bursts can sometimes be heard around the recorded signal. This "tape modulation noise" is a phenomenon that occurs with all tape recordings. It consists of noise sidebands which appear on either side of the signal which is being recorded, and it is caused by inherent characteristics of the tape (see Figure 5-2). Modulation noise levels are significantly higher than the residual background noise (asperity noise*) of the tape, although the modulation noise falls off as the frequency moves away from the recorded signal.

The recorded signal masks modulation noise components that lie nearby in frequency, but it does not mask noise which is several octaves above. For this reason, modulation noise is most often noticed when a strong, low frequency signal is recorded.

To negate or reduce modulation noise effects, dbx applies pre-emphasis to the signal before recording and de-emphasis upon playback. The de-emphasis starts at 400 Hz and reaches a maximum weighting of −12 dB at 4,000 Hz (see Figure 5-3). The net result is a reduction in modulation noise of nearly 12 dB with strong low fre-

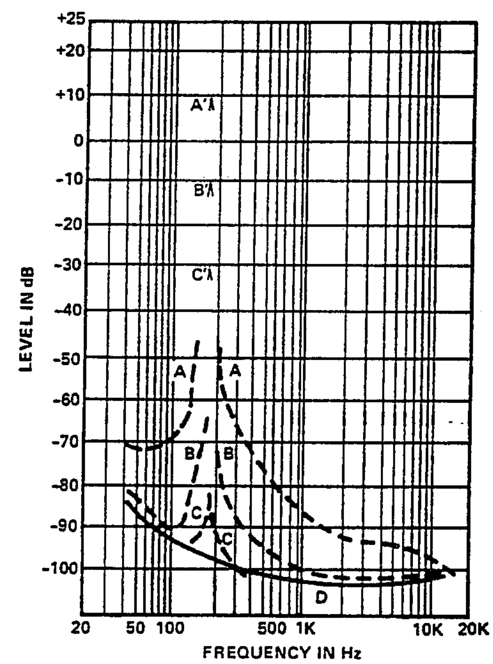


Fig. 5-2 — Tape Noise Characteristics

Asperity noise yields the curve shown by "D." The recorded signals (A', B' and C') are all sine waves at 180 Hz. The noise sidebands created by these signals are illustrated by curves A, B and C. Observe that the higher the recorded signal level, the higher the noise sideband level. This level-dependent noise is known as "tape modulation noise."

The noise sidebands are masked partially by the recorded signal, but only for about two octaves on either side of the signal. This masking is depicted by the shaded box in the chart. The ear is less sensitive to lower frequencies, as the lower sidebands are masked sufficiently by the signal. Notice the upper sideband of the +10 dB recorded signal (curve A) extends beyond the masked area, and at a level which would be audible in a program of 100 dB dynamic range.

The shaded line at −65 dB indicates the level of steady state background noise which would be required to mask modulation noise if pre-emphasis and de-emphasis (or signal weighting) were not used. With signal weighting, there is no need for this "noise perfume."

**Asperity noise is a random noise that is caused by minute imperfections in the magnetic coating of the tape. These surface irregularities cause tape to be lifted slightly off the record head at irregular intervals, causing a random noise to be superimposed on the recorded signal. The noise due to this non-homogeneous coating cannot be subtracted from the signal by compander processing. However, improvements in tape manufacturing processes are reducing asperity noise. To draw a rough analogy, asperity noise is to a recorded tape what grain is to a photograph.*

quency recorded signals, while the overall record/ play response is flat. (Noise "pumping" is a recording level problem — see 3.7.2.)

Modulation noise components can be masked, almost completely, by a steady *hiss.* The required level of this "noise perfume" is about -65 dBm. It is no coincidence that noise reduction systems such as Dolby A, Dolby B and A.N.R.S., which claim "absolutely no audible effect," have this residual noise present in the output (dbx output noise is below -85 dBm).

5.2.3 Signal filtering

To further optimize the performance of the dbx system, filters are placed in the signal path and the RMS level detection path restricting the response to the audible frequency spectrum so that subsonic (infrasonic) and supersonic (ultrasonic) signals, such as air conditioning noise or tape bias noise, are less likely to create encode/decode mistracking.

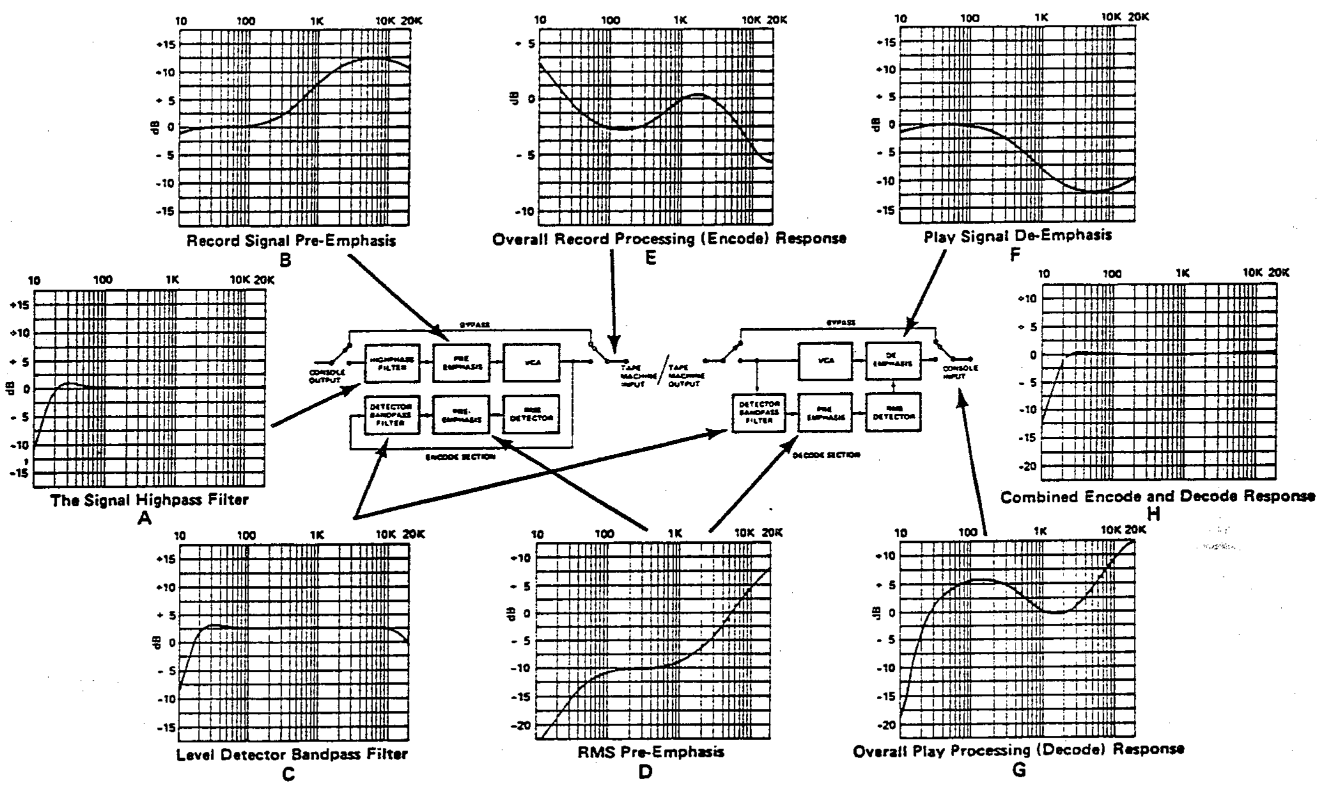


Fig. 5-3 — Block Diagram of dbx Noise Reduction.(The functions are explained in the following paragraphs.)

A. The Signal Highpass Filter

This filter has a 12 dB/octave slope which, in conjunction with the 6 dB/octave slope in the record signal pre-emphasis (B), provides a 3 dB down point at 17 Hz with an ultimate attenuation slope rate of 18 dB/octave. The filter prevents non-recordable signals from entering the dbx record processor. It does not affect the audible frequency spectrum but it does prevent encode/decode mistracking.

B. Record Signal Pre-Emphasis

A high frequency boost that matches reciprocal high frequency reduction upon decoding, thereby reducing modulation and asperity noise. (Includes a 6 dB/octave roll-off at low frequencies, as described in "A" above.)

C. RMS Level Detector Bandpass Filter

The same filter is used for encoding and decoding and has an 18 dB/octave slope with 3 dB points at 16 Hz and 20 kHz. The filter affects only the RMS level detection, preventing expansion and compression circuits from reacting to subsonic or supersonic signals or from being misled by poor frequency response in the tape recorder at the extremes of the audio spectrum. This avoids encode/decode mistracking without affecting overall signal frequency response.

D. RMS Level Detector Pre-Emphasis

The same RMS Level Detector pre-emphasis curve is used for encoding and decoding. It complements the signal pre-emphasis and de-emphasis curves, avoiding excessive high frequency levels which might otherwise cause tape saturation or self erasure.

E. Overall Record Processing (Encode) Response

This is the single sine wave response of the encoding circuitry. Given a nominal signal level at the dbx 180's encoder input (a sine wave signal swept across the audible spectrum), this is what will appear at the 180's output to the recorder. Note that the overall encode and decode response (H) is essentially flat.

F. Play Signal De-Emphasis

The complementary curve for the record signal pre-emphasis, containing a high frequency roll off to reduce modulation and asperity noise components by some 12 dB.

G. Overall Play Processing (Decode) Response

This is the single swept sine wave response of the decoding circuitry. Given a nominal level at the dbx 180's decoder input (a sine wave signal swept across the audible spectrum), this is what will appear at the 180's output to the console.

H. Combined Encode and Decode Response

This is the combined effect of encoding and decoding, and shows that the net result of dbx processing does not change the frequency content of the program.

5.2.4 The two systems: dbx Type I and dbx Type II

The original dbx Type I noise reduction system was developed for use in professional recording studios. In response to the demands of consumers and small studios, dbx introduced a variety of Type I units — the 150 series. These units utilize the same signal processing as other Type I professional recording studio models, including the 180, and tapes made with one system may be decoded with the other.

Broadcasters have recognized the potential for improved signal quality which could be obtained if they were to use dbx processing. However, broadcast cartridges and telephone transmission lines do not offer the excellent frequency response available in professional recorders and better hi-fi tape machines; the low end and high end of the spectrum often fall off considerably. This poor frequency response can cause mistracking of the dbx Type I system. Therefore, the dbx II system was developed, represented by dbx consumer models in the 20, 120 and 220 series and the professional 140 series. The basic principle of operation of the two systems is identical, and the amount of noise reduction is the same, yet the two systems, dbx Type I and dbx II, are not compatible. A tape encoded with either system cannot be decoded by the other. Similarly, a dbx encoded disc (see below) cannot be decoded with the dbx Type I system, since it was mastered with the dbx Type II system.

The two systems were optimized for different applications. The Type I system was designed for use with tape machines which have good wide-band frequency response (generally within ±1 dB, 30 Hz to 20 kHz) and which are typically used at 15 ips or greater speeds. The RMS pre-emphasis circuitry was engineered to take advantage of the headroom available when using high-speed record equalization. The Type II system was developed to provide dbx noise reduction for use with storage and transmission media having a more restricted bandwidth and less available headroom. These include cart machines, telephone lines, STLs, cassette machines and vinyl phonograph records. The highpass filter in the signal path in the dbx Type II system is slightly more restrictive, rolling off 1 dB at 24 Hz. In addition, the RMS detection circuitry in dbx Type II units is sensitive only up to 10 kHz, so high frequency losses on the tape or in the transmission lines will not create encode/decode mistracking. The frequency response of dbx Type II processing does not restrict the bandwidth of the audio signal itself.

Both systems offer the same 30 dB of broadband noise reduction, and a 10 dB improvement in headroom for tape recordings. The differences in the detector characteristics between dbx Type I and dbx II processing make it inadvisable to encode with one system and decode with the other because mistracking will occur on many types of program material.

The dbx Type II system is equipped with a NORM/DISC switch that introduces a further low end rolloff (-3 dB at 21 Hz) in DISC mode. This has been provided to permit decoding of special dbx-encoded phonograph records; the rolloff protects the RMS detection from mistracking due to record warp or turntable rumble.

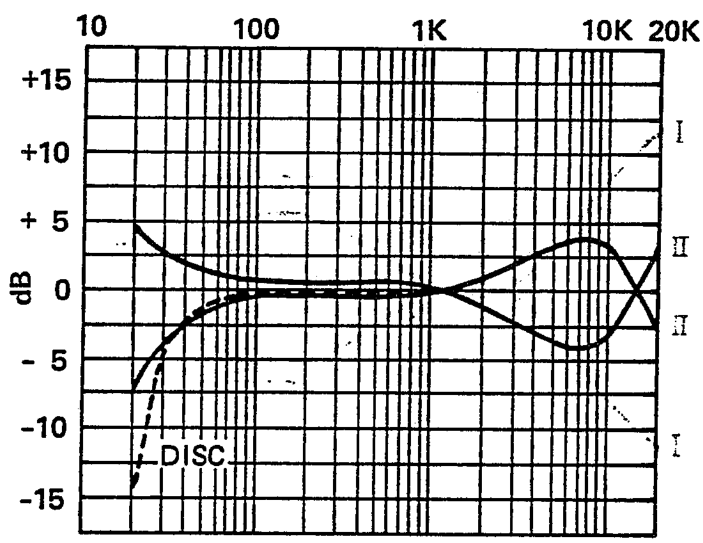


Fig. 5-4 — Type I vs. Type II Encode/Decode Curves (Sine Wave Sweep)

NOTE: Encode curve's vertical scale is corrected for the 2:1 compression factor.

6.0 SPECIFICATIONS AND SCHEMATIC DIAGRAM

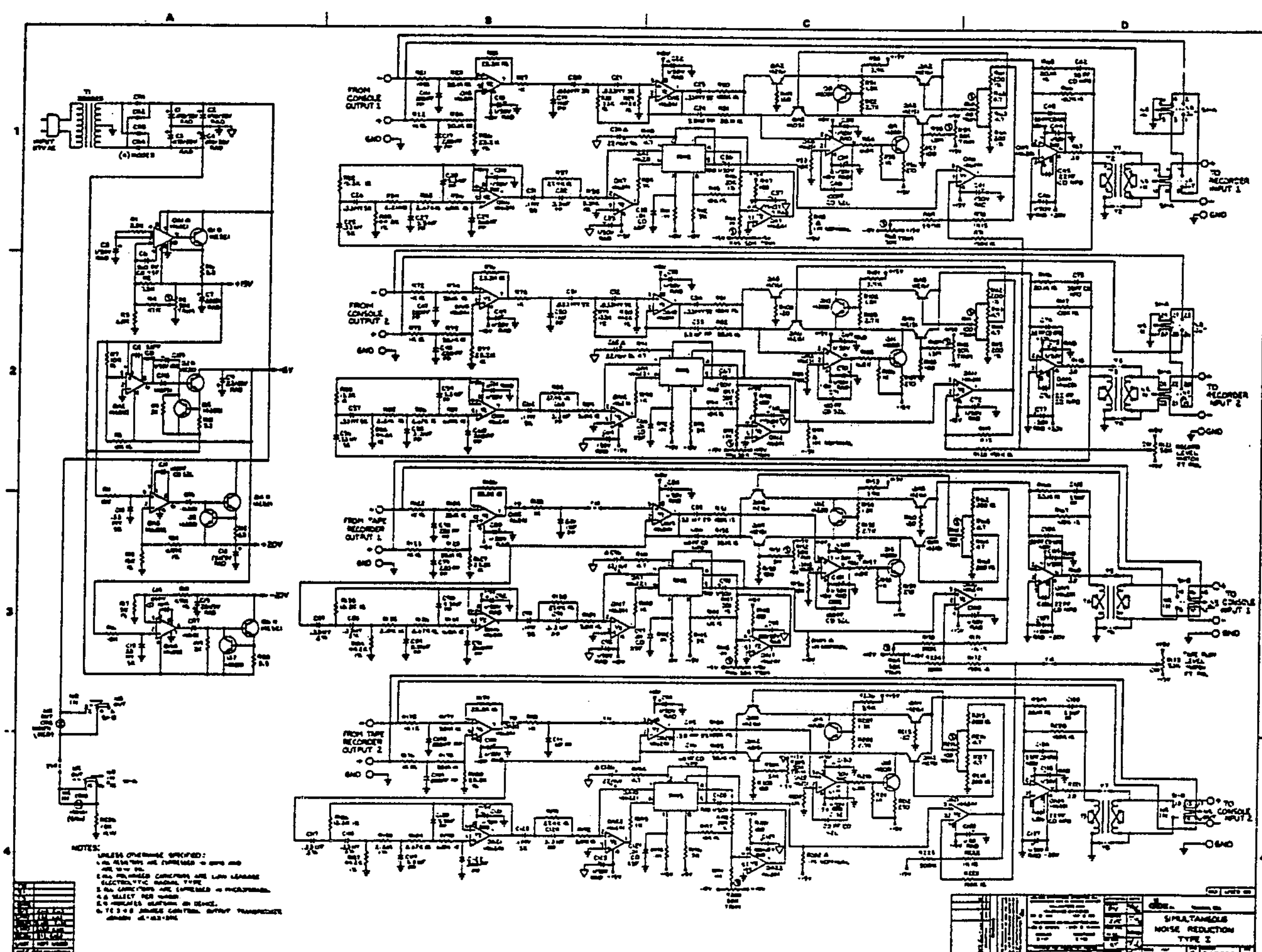
6.1 SPECIFICATIONS

Frequency Response	Conforms to dbx type I decoding curve, ±0.5 dB (30 Hz – 20 kHz). Typical program material tracking.
Total Harmonic Distortion	Less than 0.1% at 1 kHz, measured at decoder output with encoder output directly connected to decoder input.
Signal-to-Noise Ratio	107 dB
Input Type	Balanced, differential amplifiers.
Input Impedance	75 kΩ balanced or 54 kΩ single-ended.
Maximum Input Level	+24 dBm (12.3 V RMS)*
Output Type	Unbalanced; main circuit board is designed to accept four optional Jensen JE-123S-PC or JE-123S-LPC transformers for isolated floating output.**
Output Impedance	Low, designed to drive 600Ω or greater.
Maximum Output Level	+24 dBm (12.3 V RMS) into 600 ohm or higher impedance load.
Level Adjust Range	RECORD sets the unity gain point through the encoder for nominal console output levels ranging from −12 dBm (195 mV) to +16 dBm (4.9 volts). PLAY sets the unity gain point through the decoder for nominal recorder output levels ranging from −12 dBm (195 mV) to +16 dBm (4.9 V).
Connectors	Rear panel barrier strips.
Input Voltage	117 V AC, 50 or 60 Hz (U.S. Models). Other voltages available on export models; see applicable rear-panel labeling.

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

** 0 dBm is referenced to 1 mW (0.775 V RMS across 600 ohms).*
***Available directly from Jensen Transformers, 10735 Burbank Boulevard, North Hollywood, CA 91601; Monday thru Thursday phone (213) 876-0059. Transformer specifications are discussed in Section 2.4.3.*

6.2 SCHEMATIC DIAGRAM



7.0 dbx PRODUCT WARRANTY & FACTORY SERVICE

All dbx products are covered by a limited warranty. Consult your warranty card or your local dealer for full details.

The dbx Customer Service Department is prepared to give additional assistance in the use of this product. All questions regarding interfacing dbx equipment with your system, service information or information on special applications will be answered. You may call during normal business hours — Telephone 617-964-3210, Telex 92-2522, or write to:

dbx, Inc.
71 Chapel Street
Box 100C
Newton, Mass.02195
Attn: Customer Service Department

Should it become necessary to have your equipment factory serviced:

1. Please repack the unit, including a note describing the problem along with the day, month and year of purchase.
2. Send the unit, freight prepaid, to:

dbx, Inc.
224 Calvary Street
Waltham, Mass. 02154
Attn: Repair Department

3. We recommend that you insure the package and send it via United Parcel Service wherever possible.
4. Please direct all inquiries to dbx Customer Service Department.

Outside the U.S.A. — contact your nearest dbx dealer for name and address of the nearest authorized repair center.