

Dolby® Model 363 Two-Channel Unit



The Dolby Model 363 is the first unit to offer Dolby SR Spectral Recording and Dolby A-type noise reduction in switchable form. It contains two channels in a 1-U high frame and is the most compact, economical package available. All audio facilities — music recording, video post production, broadcast and film — will appreciate the advantages of this versatile and practical unit.

Both channels are equipped with built-in record/playback changeover capability allowing a single Model 363 chassis to serve for stereo recording applications. The two independently controlled channels are easily switched between record and playback from the front panel or under command of a tape recorder or remote control device. Front panel toggle switches allow the selection of either Dolby SR, Dolby A-type, or

no processing. A SET-UP button, along with four-element LED calibration displays, allows quick alignment of the Model 363 using internally generated Dolby tone for A-type or Dolby noise for SR. As with all other implementations of Dolby SR, Auto Compare can be used to verify the performance of the audio system.

The Model 363 is also ideal for applications requiring dedicated encode or decode operation. A pair of 363 units can thus be used for simultaneous record and playback on tape recorders, or for transmission systems where the encoder and decoder are physically separated. In single-channel recording applications, a single unit can be used for simultaneous record and playback.

The Model 363 incorporates electronically balanced transformerless input and output circuits. Independent level adjustments for the record and playback signal paths allow accurate matching of existing line levels. A "check tape" switch allows the monitoring of either the "line in" signal or the encoded tape while recording. Individual channel bypass buttons allow the user to remove the entire channel from the audio system for studio alignment.

The Model 363 is normally supplied with two Cat. No. 300 modules which contain both Dolby SR and Dolby A-type processing. The user can optionally order a Dolby SR-only version using the Cat. No. 350 modules or an A-type-only version using the Cat. No. 450 modules. (Cat. No. 22 and Cat. No. 280 modules cannot be used in the Model 363 interface.)

Dolby® Model 363 Specifications



Signal Processing:

All signal processing circuitry is contained on two separate plug-in modules. These may be either Cat. No. 300 for switchable Dolby SR and A-type, Cat. No. 350 for Dolby SR, or Cat. No. 450 for A-type. Modules may be mixed, or only one channel may be fitted. Selection of type is by front panel switches which are interlocked with module logic and indicators to provide unambiguous indication of selection and availability.

Signal Connections:

XLR connectors for audio. 9-pin D-connector for remote rec/play switching. 15-pin D-connector for other remotes (see below).

Operating Controls:

Individual channel controls for:

A/OFF/SR:

Allows selection of Dolby A-type noise reduction, no processing, or Dolby Spectral Recording.

NORMAL/CHECK TAPE:

Allows checking of the non-decoded signal from tape during recording or playback.

RECORD/PLAY:

Gives front panel control of record/play switching.

BYPASS:

Provides relay-controlled "hard" bypass of all circuitry.

LEVEL CONTROLS:

Four multi-turn level controls are provided on each channel for setting levels to and from the console, and to and from the tape recorder.

Common control for:

SET-UP:

For use during alignment and calibration.

Remote Controls:

9-pin male D-connector for:

Remote record/play control; individual channel record/play changeover designed for remote control by the tape recorder. The opto-isolator on the logic input requires +4 V to +24 V DC differential at approximately 5 mA (independent of voltage) to activate the changeover logic. The remote connector may be wired to allow only remote operation, or combined local and remote control.

15-pin female D-connector for:

Remote control of Processing in/out and Set-up functions. Also provides a remote indication of A/SR status and status of Auto Compare function.

Record/Play Changeover Time:

3 ms maximum.

Calibration Display:

Four LED display for each channel permits accurate adjustment of Dolby level (within 0.1 dB if desired) by matching the intensity of LED pairs.

Generators:

Built-in Dolby tone and Dolby noise generators for calibration and identification.

Signal Levels:

Input and output line levels in the range -10 dBu to +10 dBu can be adjusted to give Dolby level.

Input Circuits:

Electronically balanced, 20 kohm substantially resistive. Common mode rejection, better than 55 dB, 50 Hz to 10 kHz. Maximum input level, +27 dBu balanced, +21 dBu unbalanced.

Output Circuits:

Electronically balanced, approximately 20 ohm output impedance. Output balance, within 1 dB into symmetrical 600 ohm load. Output float¹, better than -40 dB, 50 Hz to 1 kHz. Maximum signal level into 600 ohm or greater, +26 dBu balanced, +21 dBu unbalanced. Either leg of the output can be grounded for unbalanced operation with no change in level.

Processor Headroom:

+21 dB above Dolby level.

Overall Frequency Response²:

20 Hz to 20 kHz ± 1 dB, encode-decode, at any level.

Overall Harmonic Distortion²:

0.2% maximum total harmonic distortion at Dolby level.

Overall Dynamic Range² (SR):

105 dB — clipping level to CCIR/ARM noise level.

105 dB — clipping level to NAB A-weighted noise level³:

95 dB — clipping level to unweighted noise level, 20 Hz to 20 kHz⁴:

Overall Dynamic Range² (A-type):

104 dB — clipping level to CCIR/ARM noise level.

105 dB — clipping level to unweighted noise level, 20 Hz to 20 kHz.

Typical Obtainable Dynamic Range, 38 cm/s/ 15 ips:

90-95 dB for SR, 75-80 dB for A-type.

Matching Between Units:

± 1 dB at any level and any frequency 20 Hz to 20 kHz.

Crosstalk:

Channel to channel, better than -100 dB, 20 Hz to 20 kHz, any operating modes.

Signal Delay:

6 μ s for a single channel, or 12 μ s for overall encode-decode system.

Stability:

System is highly stable — does not require routine alignment (no adjustable internal user controls).

Power Line Input:

User-selected voltage ranges (50-60 Hz, single-phase) nominally 100 V, 120 V, 220 V, and 240 V covering ranges 85-115 V, 102-132 V, 187-242 V, 204-264 V. Power consumption with two Cat. No. 300 cards, 40 VA.

Fuses:

500 mA for 100 V and 120 V; 250 mA for 220 V and 240 V; slow-blow to be used; unit accepts either 1.25" or 20 mm version

Size:

44 x 483 mm rack mounting (1.75 x 19"); maximum projection behind mounting surface 285 mm (10.2"); a further 65 mm (2.5") required for standard XLR connectors.

Weight:

6.3 kg (14 lb), including two Cat. No. 300 modules.



Dolby Laboratories Inc., 100 Potrero Avenue, San Francisco, CA 94103-4813, Telephone 415-558-0200, Telex 34409, Facsimile 415-863-1373.
346 Clapham Road, London SW9 9AP, Telephone 01-720-1111, Telex, 919109, Facsimile 01-720-4118.

"Dolby" and the Double-D symbol are trademarks of Dolby Laboratories Licensing Corporation. ©Dolby Laboratories Inc., 1988 S88/8505.

All specifications apply with input and output controls set for Dolby level equal to +4 dBu = 1.23 V rms, balanced source and load. 0 dBu is defined as 0.775 V without regard to impedance.

¹ Output float is the level across a balanced load relative to an interfering signal injected at one end of the load.

² Two units back-to-back, encode-decode.

³ Weighting filter supplemented by 25 kHz 4-pole low-pass filter to ensure that only audible noise is measured.

⁴ Average-responding or rms meter, 4-pole filters.

SECTION 4

LEVEL STANDARDIZATION AND OPERATION

4.1 Level standardization for Dolby systems

Dolby A-type and Dolby SR are complementary noise reduction systems; that is, the processing applied during playback is a mirror image of that applied when recording. In addition, the processing is dependent on both the level and frequency of the signal being recorded. This gives great flexibility in the way that the processing adapts to the incoming signal, but it means that for correct operation the levels in the playback processor must be the same as those in the record processor. In most studios all this really means is that the tape recorder should be at unity gain, which is the normal situation.

To ensure that the play processor gets the same signal level as the original record processor (which often is in a different studio), it is necessary to record a test signal onto the tape to indicate how the Dolby processing was set when the recording was made. For Dolby A-type this signal is called Dolby tone, and for Dolby SR it is called Dolby noise.

4.2 Level standardization for Dolby A-type noise reduction

Every Dolby A-type noise reduction unit contains an oscillator that produces a distinctive reference signal at a closely defined internal level (called Dolby level) and a calibration display to indicate this Dolby level. When the Set-up button is pressed, Dolby tone is fed into the record signal path and the calibration display indicates the level in the play processor. (In products designed before the introduction of Dolby SR, the Set-up function is controlled by a button labelled Dolby tone.) Dolby tone is made distinctive by frequency modulating the basic 850 Hz frequency upward by 10% for 30 ms every 750 ms. This easily recognized signal indicates that the tape has been recorded with Dolby A-type noise reduction, and also represents the tape fluxivity corresponding to Dolby level used on the recording.

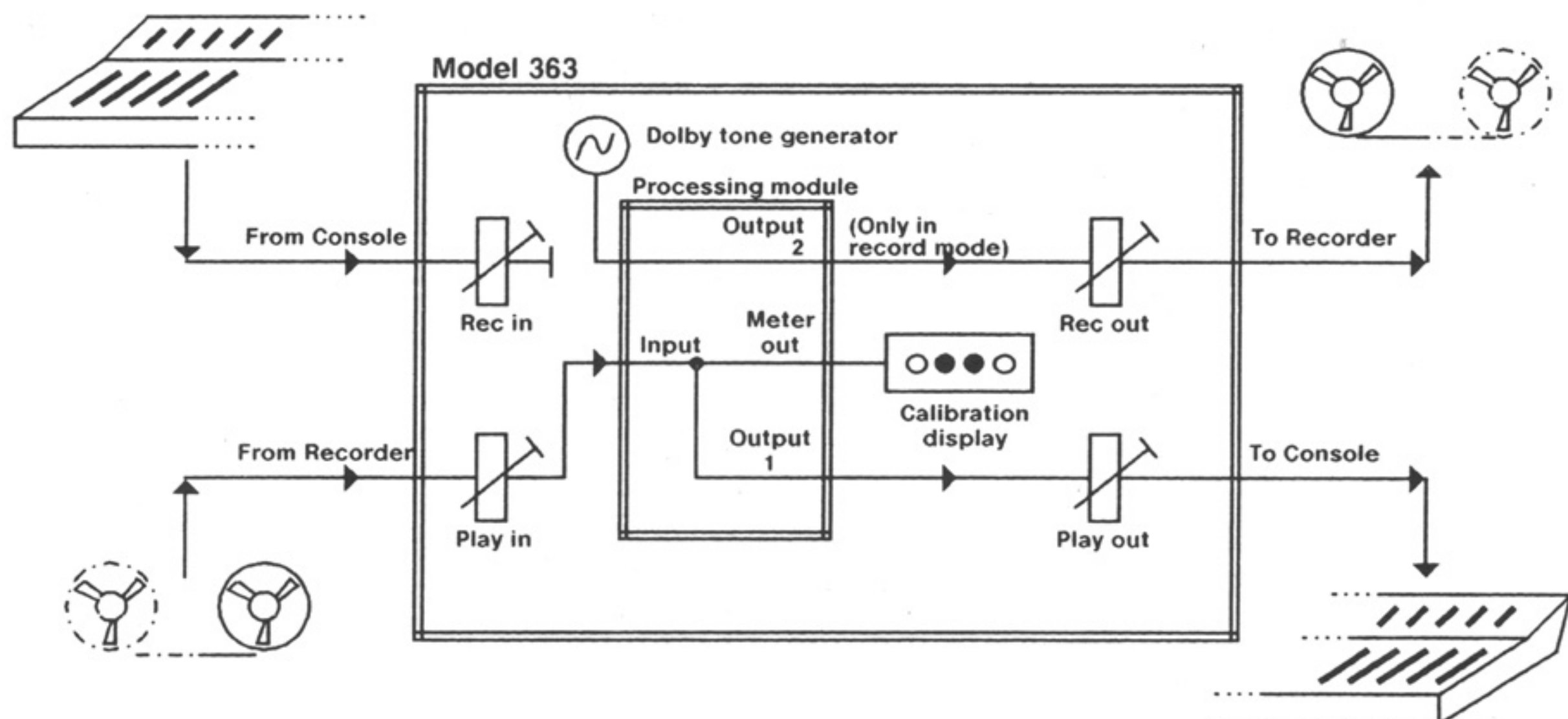
For correct operation, Dolby tone recorded on tape should produce a reading of Dolby level on the calibration display when the Set-up button is pressed. Many different parts of the audio industry have standardized their Dolby levels to ease interchange of material. The list below gives some examples.

Typical Dolby levels

Application	-----Dolby level-----	
	Meter reading	Level
Recording Studio, Europe	0 VU	320 nWb/m
Recording Studio, USA	0 VU	250 nWb/m
Most video formats	----	100 nWb/m
35mm Magnetic film	----	185 nWb/m
35mm Optical film		50%

If no standard is listed for your application, please contact Dolby Laboratories for discussions on an appropriate Dolby level. The choice of Dolby level is influenced by system noise, system headroom, type of metering systems, and type of transmission or recording method. If you have to make a quick decision, check with other possible local users, or choose a level which is easy to read on your studio meters.

4.2.1 When the SR/off/A switch is in the A position, the signal paths in Set-up are:



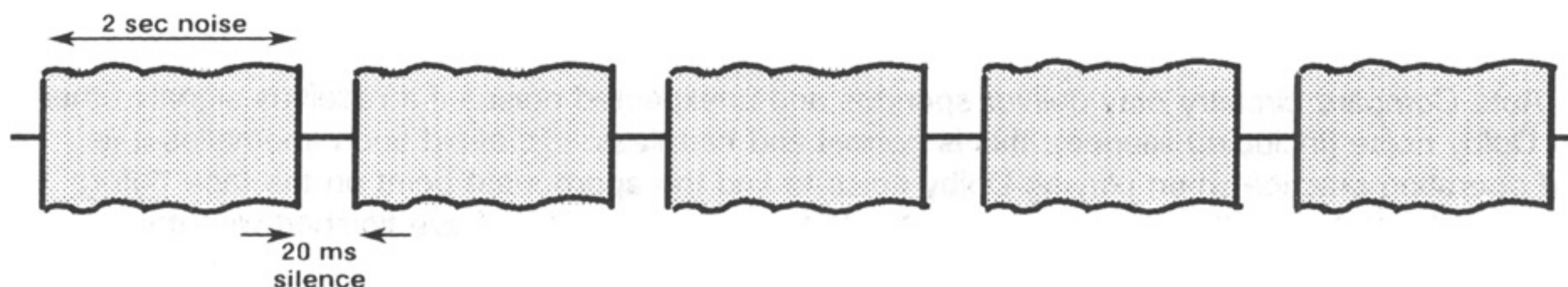
The calibration display will read the level returning from the tape recorder, and, if the Model 363 is switched to **record**, Dolby tone will be the output to the recorder.

This mode is also used to align the Model 363 to Dolby tone played back from a previously recorded tape.

4.3 Level Standardization for Dolby Spectral Recording

Dolby SR also has its own distinctive calibration signal called "Dolby noise." Dolby noise, like Dolby tone, not only serves as a reference level but also indicates that a recording was encoded with Dolby SR.

As with Dolby tone, Dolby noise has been made distinctive. It consists of pink noise interrupted every two seconds by 20 ms gaps, as shown diagrammatically below (note actually the nick is much shorter than shown, and also noise is a much less regular signal than in the diagram).



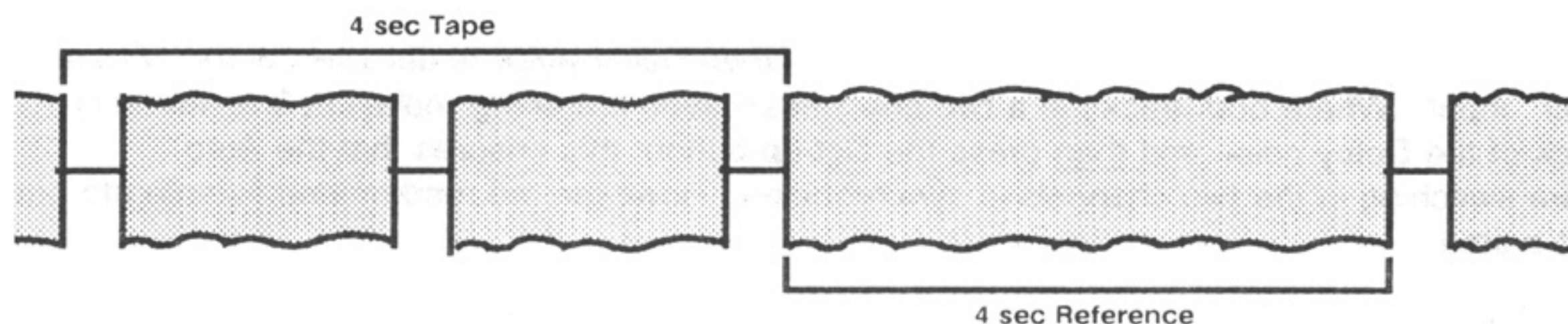
Dolby noise is used in a similar way to Dolby tone for calibration and alignment. Dolby noise recorded on tape should produce a reading of Dolby level on the calibration display when the Set-up button is pressed.

Unlike Dolby tone, Dolby noise is not recorded on the tape at Dolby level but at 15dB* below Dolby level. Dolby level is usually around 0 VU; recording Dolby noise at this level would risk saturation at both high and low frequencies (especially at low tape speeds or when using thin oxide tapes). Thus the noise recorded on the tape would not be a true reflection of the response of the recorder. To prevent these errors, Dolby noise is recorded at a lower level.

When the **Set-up** button is pressed **and SR** is selected on the Model 363, the calibration display circuit gain is increased so that Dolby noise will still read Dolby level on the Model 363 display even though it is not recorded at Dolby level on the tape. (In addition the Dolby noise is filtered in the meter circuit only to remove the low-frequency components of the pink noise which would otherwise give a display signal which would be difficult to read.)

As well as providing level information, Dolby Noise also makes checking the frequency response quick and easy. Audibly comparing the Dolby noise recorded on tape with a Dolby noise generator will show up any differences caused by either gain or frequency response errors in the complete record-replay chain; this test is remarkably easy to perform, and is extremely critical.

This comparison is made even easier by a feature called Auto Compare. During Auto Compare, the monitor output of the Model 363 switches between the the signal replayed from tape and the internal Dolby noise generator, in the sequence shown below. In general, if Auto Compare sounds OK, all aspects of the complete recorder/Model 363 chain are operating and are calibrated correctly. Note that the noise from tape is Dolby noise and so has 20 ms gaps, whereas the reference noise from the generator has no gaps. This pattern makes it easy to tell the difference between "Tape" noise and "Ref" noise.



* Note that, due to the nature of pink noise, the level indicated on any meters in the studio will depend critically on the type of meter used. Do not try to read the level of Dolby noise with your studio meters.

The Auto Compare sequence will start whenever

..... Dolby noise is being replayed from tape;

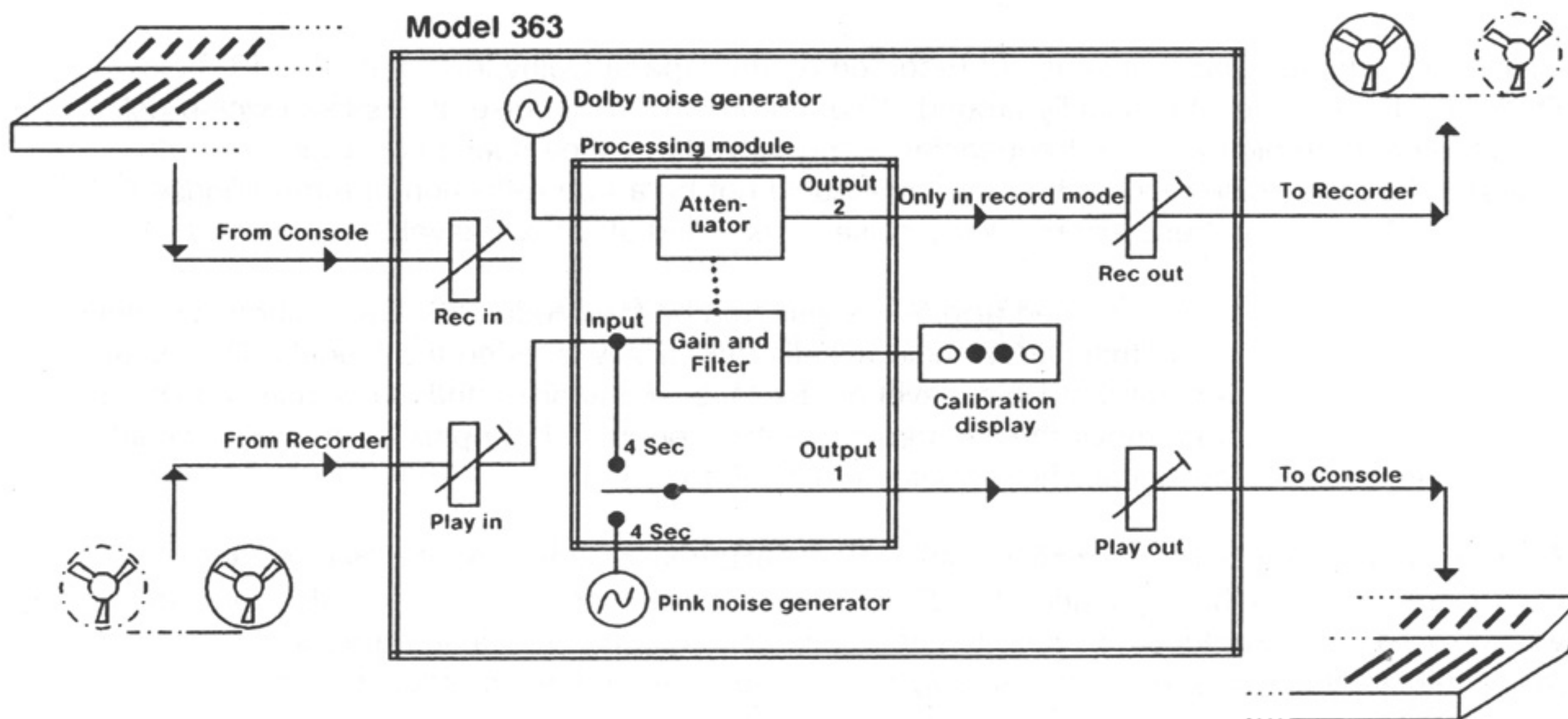
AND SR processing is selected;

AND the "Set-up" button is pressed.

LEDs on the front of each module indicate the source of the noise being heard. (Remote indicating LEDs can also be connected; see section 2.) The red LED indicates the internal reference noise, and the green LED indicates Dolby noise from the tape recorder.

The Auto Compare circuitry may deliver spurious and unexpected noises if it receives signals other than Dolby noise (including silence); this is normal and harmless. To avoid such anomalies it is good operating practice when playing Dolby noise to find the appropriate point on the tape before you press the Set-up button, and to release the button as soon as you have finished with the Auto Compare sequence.

4.3.1 **When the SR/off/A switch is in the SR position, the signal paths in Set-up are:**



The calibration display will read the level returning from the tape recorder, and, if the Model 363 is switched to record, Dolby noise at low level will be the output to the recorder. The gain of the calibration display is increased so that Dolby noise at the correct level will give an Dolby level indication.

This mode is also used to align the Model 363 to Dolby noise played back from a previously recorded tape.

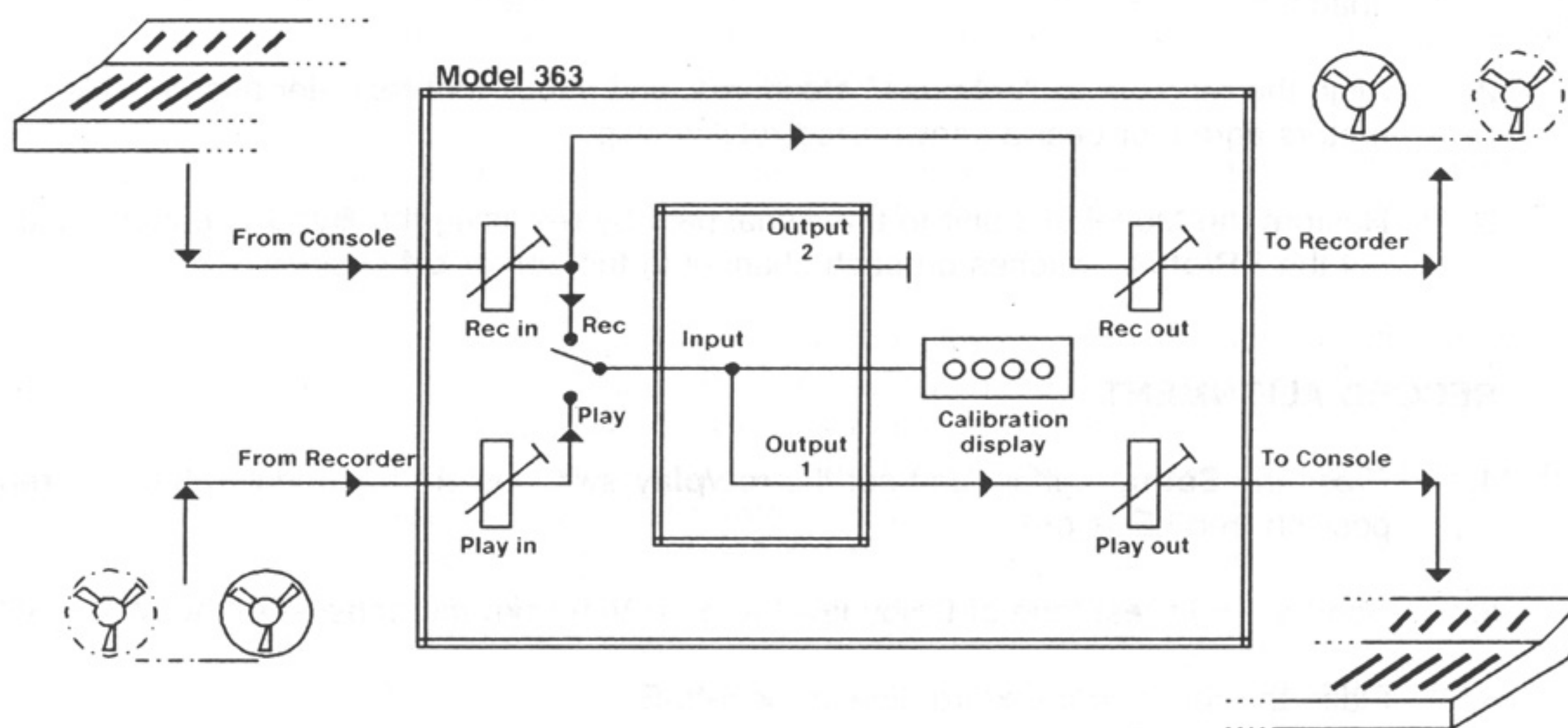
The Model 363 will start an auto-compare sequence when Dolby noise is detected at the "From recorder" input. Where both tracks in a two-channel situation are being replayed, first start the playback of the Dolby noise and then press the Set-up button; this ensures that the Auto Compare switching in the two channels is synchronized. However, we recommend listening to one track at a time.

4.4 Set-up

To help alignment of the Model 363, a Set-up button is provided. Pressing the Set-up button will set the unit to the correct alignment mode (which depends on the setting of the **SR/off/A** switch).

Initially, the Model 363 must be aligned to the normal signal levels present in the studio. To help this alignment, a special mode is selected if the **Set-up** button is pressed when noise reduction is in the **off** position.

4.4.1 When the SR/off/A switch is in the off position, the signal paths in Set-up are:



The calibration display may be switched between the record and play signal paths using the front panel **rec/play** switch. Any **remote rec/play** switching is disabled. This mode is used to align the Model 363 to standard studio line levels.

4.5 Alignment

During initial or routine alignment, it is simplest to send a tone at Dolby level from the console and align for unity gain through the system.

When aligning to a tape from another studio, it is necessary to take the Dolby noise or Dolby tone recorded on the tape as the starting point, and set up the unity gain structure from there. For this reason there are two alignment procedures set out here; the first sets Dolby level to a tone from the console (Console Level Reference), the second to Dolby noise or tone recorded on a tape from another studio (Tape Level Reference).

These instructions assume that the Model 363 record/play switching is being controlled manually at the front panel. Should the record/play switching be controlled automatically by the tape recorder, the manual switches must be used when both "**Set-up**" and "**off**" have been selected, since under these conditions the remote record/play switching is purposely disabled. (The various controls are shown in Figure 4.1 on page 4.11) .

The two procedures start on the following page.

CONSOLE LEVEL REFERENCE Routine in-house alignment**A: INITIAL STEPS**

The following alignment steps involve sending 1 kHz tone from the console at Dolby level. In many studios this will be the normal studio line level (for example, 0 VU).

If you are not sure what your Dolby level is, read section 2.1 for more information.

1. Remove the Model 363 from the signal path by pressing the **Bypass** button for each channel.
2. Align the recorder to "in-house" standards, and check that recorder and console meters agree, or bear a known fixed relationship.
3. Restore the Model 363 unit to the signal path by releasing the **Bypass** buttons and set the **SR/off/A** switches on each channel to the center **off** position.

B: RECORD ALIGNMENT

4. Press the **Set-up** button, and set the **rec/play** switches on the Model 363 to the **rec** position (red LEDs on).
5. Send a 1 kHz test tone at Dolby level (e.g., 0 VU) from the console to the Model 363.
6. Place the recorder in record, line in, or E-to-E.
7. Adjust the **rec in** trimmers for Dolby level on the calibration displays (equal brightness of the green LEDs).
8. Adjust the **rec out** trimmers on the Model 363 for the correct reading (e.g., 0 VU) on the tape recorder meters. As a quick check, you may switch the Model 363 in and out of **Bypass** at this point and make sure the tape recorder meters don't change.

C: PLAYBACK ALIGNMENT

9. Switch console meters to read the return signal from the tape recorder.
10. Set the **rec/play** switches on the Model 363 to **play** (green LEDs on) and adjust the **play in** trimmers for Dolby level on the calibration displays (equal brightness of the green LEDs).
11. Adjust **play out** trimmers on the Model 363 for Dolby level (e.g., 0 VU) on the console meters. As a quick check, you may switch the Model 363 in and out of **Bypass** at this point and make sure the console meters don't change.
12. Release the **Set-up** button, and make sure the unit is out of **Bypass**.

The alignment is now complete.

D: PREPARING FOR A RECORDING

13. Select **A** or **SR** on the individual 3-position switches as appropriate.
14. Record a section of Dolby tone or noise on tape by putting the recorder into record and pressing the **Set-up** button on the Model 363 unit. (Remember that Dolby noise is recorded on tape at -15 dB below Dolby level (e.g., 0 VU), and so will read

low on console and recorder meters. However, this level difference is automatically compensated in the Model 363 calibration display when **Set-up** is selected.)

Under these conditions, when using Dolby SR, the Cat. No. 300 or the Cat. No. 350 modules will go into the **Auto Compare** mode. **Auto Compare provides the user with an accurate audible verification that both the tape recorder frequency response and the calibration levels are set properly regardless of the indication shown on the tape recorder meters and Dolby calibration displays.** Listen for level differences between the pink noise signal coming from the output of the tape and internal Dolby noise generator in the **Auto Compare** mode. The two LEDs on the front of the Cat. No. 300 and Cat. No. 350 modules indicate whether the monitors are receiving the internal reference signal (red LED) or the Dolby noise from the tape recorder (green LED). The alignment procedure is correct when the levels between the tape and reference levels audibly match.

Note: Dolby level on tape will now have a fixed flux level which may be compared with the magnetic reference tape used for the recorder alignment: e.g., "Dolby Level is +4 dB above 185 nWb/m."

15. It is possible that the level of Dolby noise or Dolby tone recorded on the tape in this last step will produce a slightly different reading on the calibration display from that observed in step (10) above. This is due to the tolerance of many parts of the complete audio chain, the accuracy to which the recorder calibration adjustments can be made (particularly if automatic setting of these controls is used), and the agreement between meters or displays in the console, recorder, and the Model 363. If a small difference is observed (as evidenced by the two green LEDs on the Model 363 calibration display not being equally bright), we recommend that the **rec out** trimmers on the Model 363 be slightly adjusted to compensate for this build-up of tolerances.

TAPE LEVEL REFERENCE **Aligning to Tapes Recorded in Other Studios**

A: INITIAL STEPS

1. Remove the Model 363 from the signal path by pressing the **Bypass** button for each channel.
2. Align the recorder using the tones on the incoming tape, and check that recorder and console meters agree, or bear a known fixed relationship. If you also need to record on the tape, be sure to align the record section of the recorder as well.
3. Restore the Model 363 unit to the signal path by releasing the **Bypass** buttons.

B: PLAYBACK ALIGNMENT

4. Set the **rec/play** toggle switches on each channel to the **play** position (green LEDs on).
5. Set the **SR/off/A** toggle switches to **SR** or **A** as appropriate for the incoming tape. Replay the Dolby noise (SR) or Dolby tone (A-type) from the tape, and then press the **Set-up** button.

When using Dolby SR, the Cat. No. 300 or the Cat. No. 350 modules will go into the **Auto Compare** mode. **Auto Compare provides the user with an accurate audible verification that the playback frequency response and decode calibration levels are set properly regardless of the indication shown on the calibration displays.** Listen for level differences between the pink noise signal coming from the tape and the internal Dolby noise generator in the **Auto Compare** mode. The two LEDs on the front of the Cat. No. 300 and Cat. No. 350 modules indicate whether the monitors are receiving the internal reference noise signal (red LED) or the Dolby noise from the tape recorder (green LED).

6. Adjust the **play in** trimmer on each channel of the Model 363 unit until the tape and reference levels audibly match in the **Auto Compare** mode or for equal brightness of the green LEDs.
7. Release the **Set-up** button and set the **SR/off/A** toggle switches to the **off** position.
8. Switch the console meters to read the return signal from the tape recorder.
9. Replay the 1 kHz alignment tone from the incoming tape and adjust the **play out** trimmers on the Model 363 for the correct reading (e.g., 0 VU) on the console meters. As a quick check, you may switch the Model 363 in and out of **Bypass** at this point and make sure the console meters don't change.
10. Reset the **SR/off/A** switches to the proper NR type for the incoming tape.

For playback only purposes the alignment is now complete. Should you be required to drop into record (overdub), continue with the following steps.

C. RECORD ALIGNMENT

11. Set the **rec/play** toggle switches on each channel to the **rec** position (red LEDs on).
12. Set the **SR/off/A** to **SR** or **A**, for the NR type being used.
13. Place the recorder in record, line in or E-to-E on an appropriate section of blank tape. Press the **Set-up** button. Dolby noise (SR) or Dolby tone (A-type) is now being sent to the tape recorder.

14. Adjust the **rec out** trimmer on each channel on the Model 363 for equal brightness of the green LEDs.
15. Set the **SR/off/A** switches to the **off** position.
16. Send a 1 kHz test tone at a convenient level (e.g., 0 VU) from the console to the Model 363.
17. Adjust the **rec in** trimmers on the Model 363 for the correct reading (e.g., 0 VU) on the tape recorder meters. As a quick check, you may switch the Model 363 in and out of **Bypass** at this point and make sure the tape recorder meters don't change.
18. Release the **Set-up** button and set the **SR/off/A** switches to the proper NR type for the recording.

The alignment is now complete.

SECTION 5

PRINCIPLES OF NOISE REDUCTION AND SPECTRAL RECORDING

5.1 Introduction

The Model 363 may contain Dolby A-type noise reduction (using the Cat. No. 450 module), Dolby Spectral Recording (Cat. No. 350), or both (Cat. No. 300). There are two other analog Dolby systems, B-type and C-type. All employ some principles in common: for completeness, the following contains brief descriptions of all. More detailed descriptions of A-type and SR can be found in the appendices in Section 8.

5.2 General

In sound recording or transmission the higher audio frequencies are often pre-emphasized to improve the signal to noise ratio (see Figure 5.1). However the equalization characteristic must be chosen so that even in the worst cases there are no detrimental effects: material rich in high frequencies must not cause distortion. Therefore the allowable boost with fixed equalization is limited and the degree of noise reduction is modest.

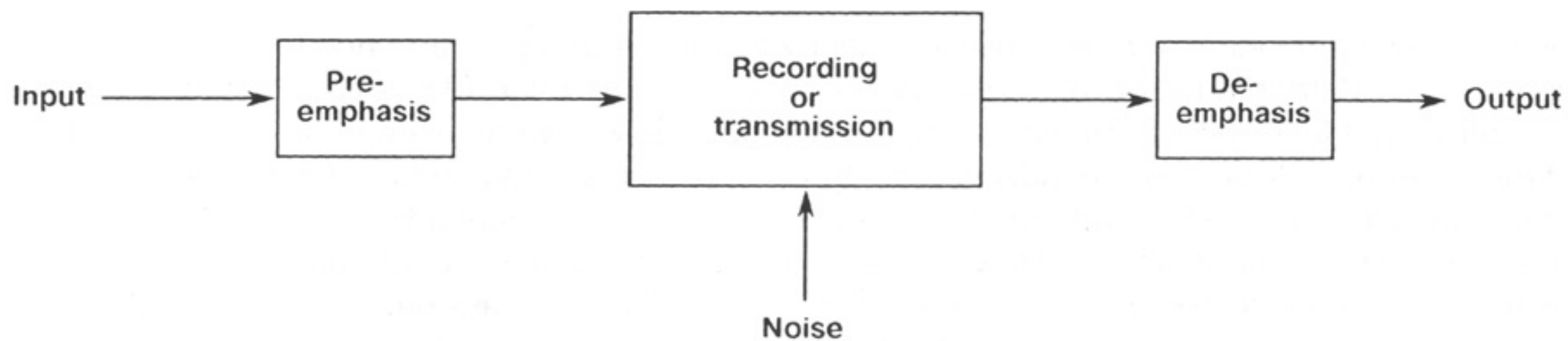


Figure 5.1 Fixed pre- and de-emphasis

Systems which improve the signal to noise ratio by compression in the encoding mode followed by expansion in subsequent decoding are known generally as companders. Figure 5.2 shows the block diagram of a typical system.

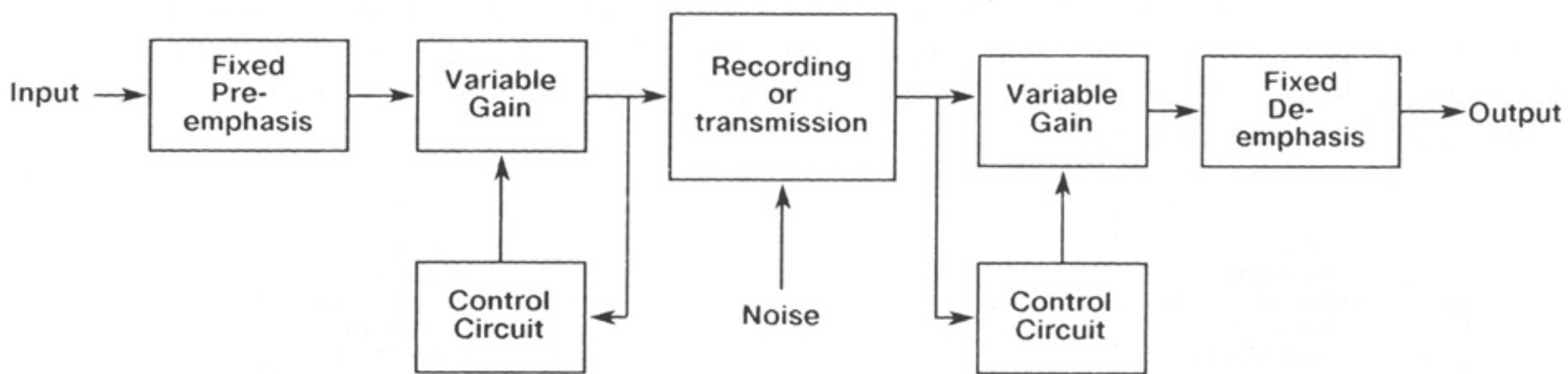


Figure 5.2 Typical compander

The variable gain blocks change gain under the control of the signal level, most commonly with a straight-line relationship when the compressor output is plotted against its input using decibel scales; such a system is known as a constant slope compander. The noise level at the output of the expander rises as the signal level rises. A loud signal in one area of the spectrum will mask noise in that same area, but the variation in noise in other areas may be audible. Companders of this type are inherently susceptible to this audible variation in noise level, called noise modulation.

Noise modulation can only be eliminated by ensuring that the gains of the encoder and decoder in any particular part of the spectrum are fixed except when signals are present in that part of the

spectrum at levels above a defined threshold. The output noise will then be constant in all parts of the spectrum except those where signals are present to mask the changes in noise.

A system with this property must be capable of changing gain in any one area of the spectrum without changing at others. Clearly in a conventional compandor (such as in Figure 5.2), any change in gain occurs at all frequencies equally, so that a signal at any one frequency must inevitably alter the noise level at other (unmasked) frequencies.

Constant slope compandors have no upper or lower thresholds, and hence possess the virtue that there is no need to ensure that the absolute signal levels in the compressor and expander are equal. A superficially attractive idea is to use several constant slope compressors each fed by a separate band splitting filter. Unfortunately because of the practical limits on filter slopes and the absence of compressor thresholds, each band compressor receives signals (albeit attenuated) from the other bands and responds with gain changes. It can be shown that a change in input signal at any particular frequency that causes x dB gain change in one band causes exactly x dB change in all the other bands. Thus constant slope split band compandors also inevitably lead to audible noise modulation.

The solution is to employ a defined low-level input threshold below which the frequency dependent gain or loss of the processor is constant. Together with appropriate frequency response adaptation it is then possible for the processor to keep its sub-threshold gain or loss except in those areas of the spectrum where high level signals mask the noise. If the gain or loss in unmasked regions of the spectrum is constant, then there can be no noise modulation. Such a response adaptation and low-level threshold are features of all the Dolby systems.

If the level of an input signal at a particular frequency increases abruptly, an encoder must reduce its gain in response to that new level. This gain reduction occurs over a finite time during which the encoder output level will be excessive: this excess level is known as overshoot. In general the magnitude of an overshoot corresponds to the degree of gain reduction and its duration to the response ("attack") time. Provided the overshoot does not lead to overloading of the recording or transmission system, it is harmless. However for high level signals overshoot can cause transient distortion and non-complementary behavior in the decoder. (Note in passing that it is possible to use instantaneous or near-instantaneous attack to eliminate overshoot, but such an approach can be disastrous subjectively because of wide-band modulation products.)

The Dolby systems use a dual-path configuration in which the input signal passes directly from input to output; the processing consists of the addition or subtraction of a further signal whose maximum amplitude is small compared with the maximum amplitude of the input. This method imposes an upper threshold above which gain reduction ceases (see Figures 5.3 and 5.4); note the fixed gains at low and high levels. This shape of characteristic permits overshoot suppression within the further path. The result is that overshoots resulting from high level signals are much smaller than the degree of gain reduction, and there is little danger of transient overload of the recording or transmission system.

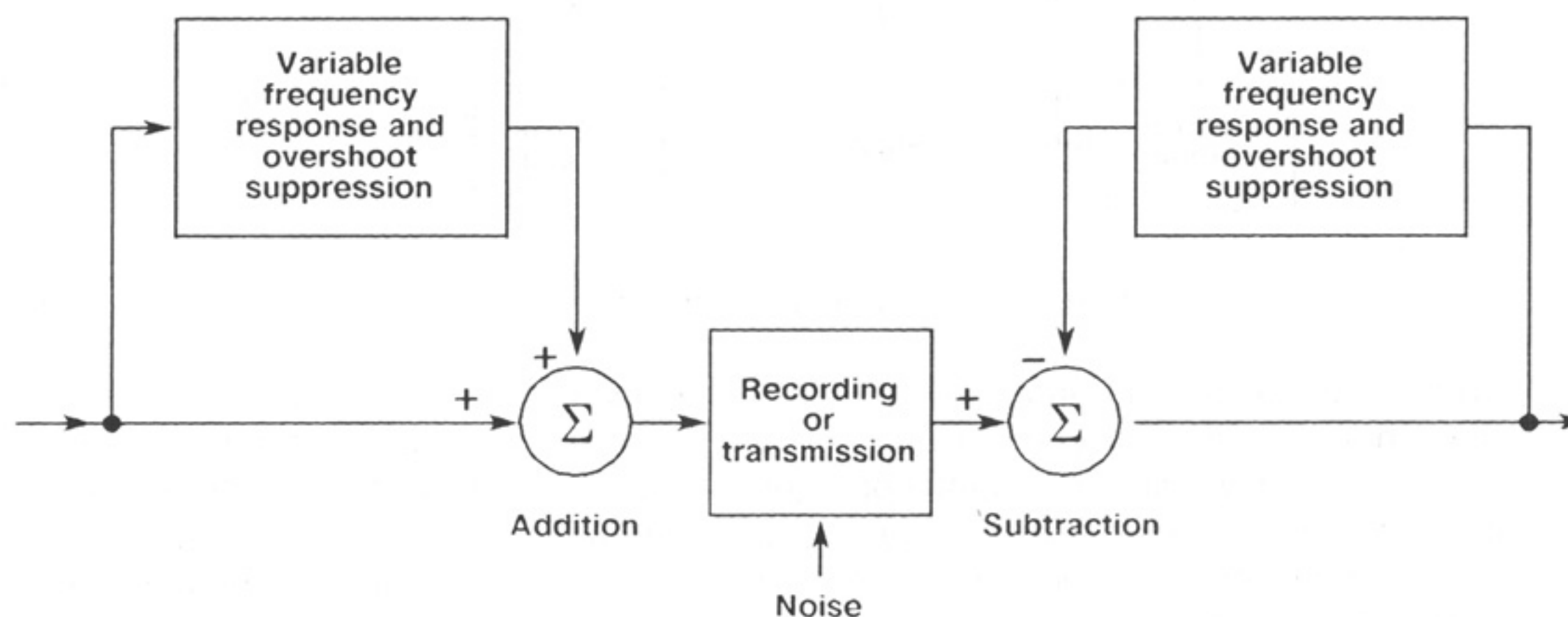


Figure 5.3 Dual-path configuration of all Dolby systems



Figure 5.4 General form of compression and expansion characteristic of all Dolby systems

5.3 Dolby A-type noise reduction

A-type noise reduction (nr) is a professional system introduced in 1966, and manufactured only by Dolby Laboratories. It provides 10 dB of nr over most of the audio spectrum rising to 15 dB at very high frequencies. The requirement for variable frequency response is met by dividing the frequency range into four bands, each with its individual compressor (see Figure 5.5). A high-level signal in one band does not affect the other bands, where noise may not be masked, and hence in general the system does not give audible noise modulation.

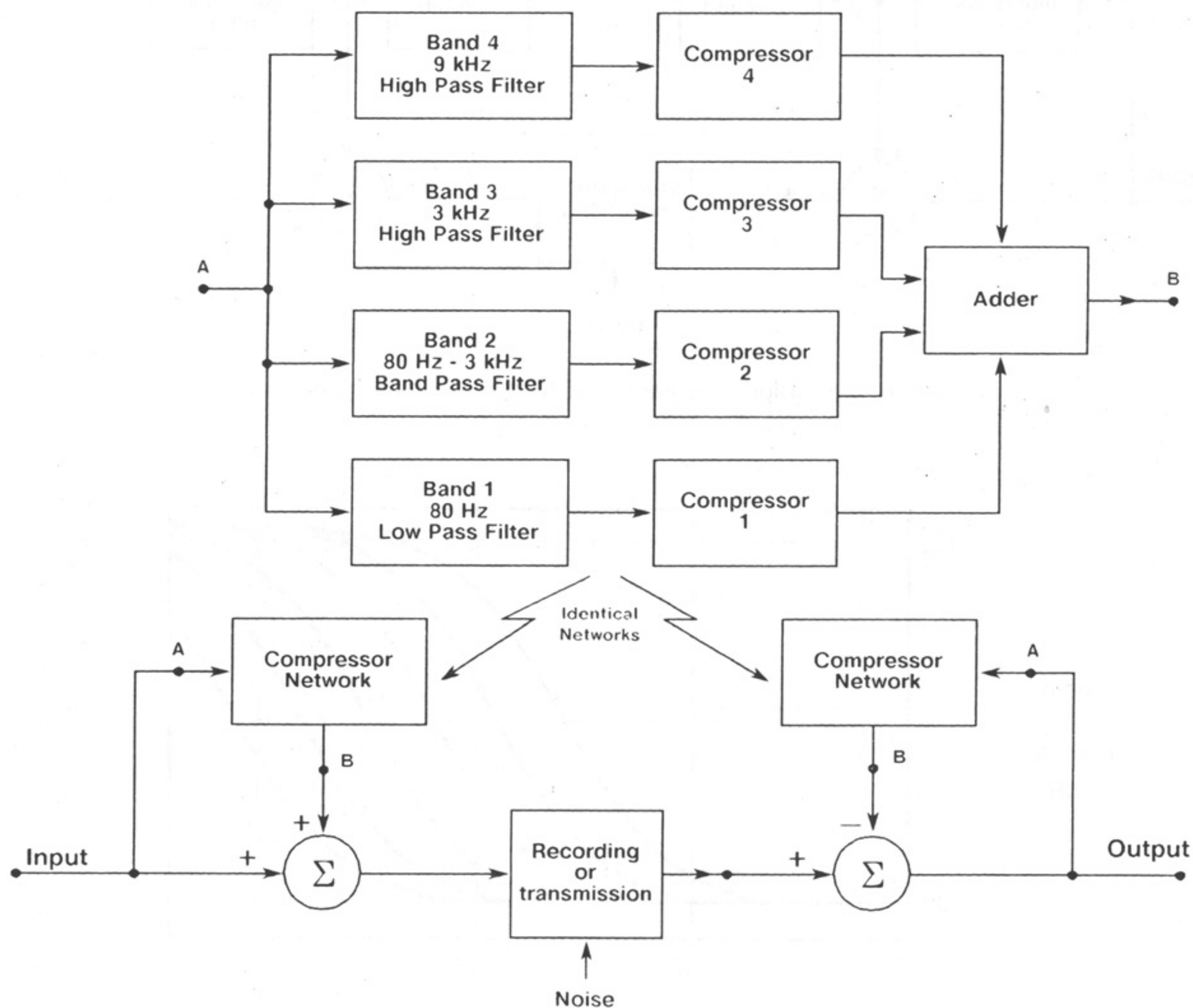


Figure 5.5 Block diagram of A-type noise reduction

A-type nr is in widespread use throughout the recording, broadcast and film industries. It is an essential ingredient in the film release format known as Dolby Stereo.

5.4 Dolby B-type noise reduction

B-type nr is a consumer system intended primarily for use with low-speed tape, especially the Philips compact cassette. It was first introduced in 1969. It reduces tape hiss by 10 dB. Unlike A-type nr, it uses only one frequency band: instead of providing variable gain within a fixed range of frequencies it provides fixed gain (or cut in the decoder) within a band of variable width. It can be considered as a high frequency emphasis of fixed magnitude whose start and stop frequencies slide upwards along the frequency axis so as not to boost the dominant, high level spectral components of the input while providing a fixed 10 dB of nr at frequencies above those dominant components (see Figures 5.6 and 5.7). At any one frequency the output/input characteristic of the encoder displays gentle compression, permitting complementary expansion in the decoder. The fixed magnitude ensures that noise not masked by the input signal has a fixed level, and therefore no noise modulation is perceived.

The vast majority of B-type circuits are built under license from Dolby Laboratories Licensing Corporation by over 250 world-wide licensees who include all the major manufacturers of consumer tape recorders. Dolby Laboratories manufactures small numbers of professional B-type processors for use in the preparation of pre-recorded tapes (audio cassettes and VHS video cassettes).

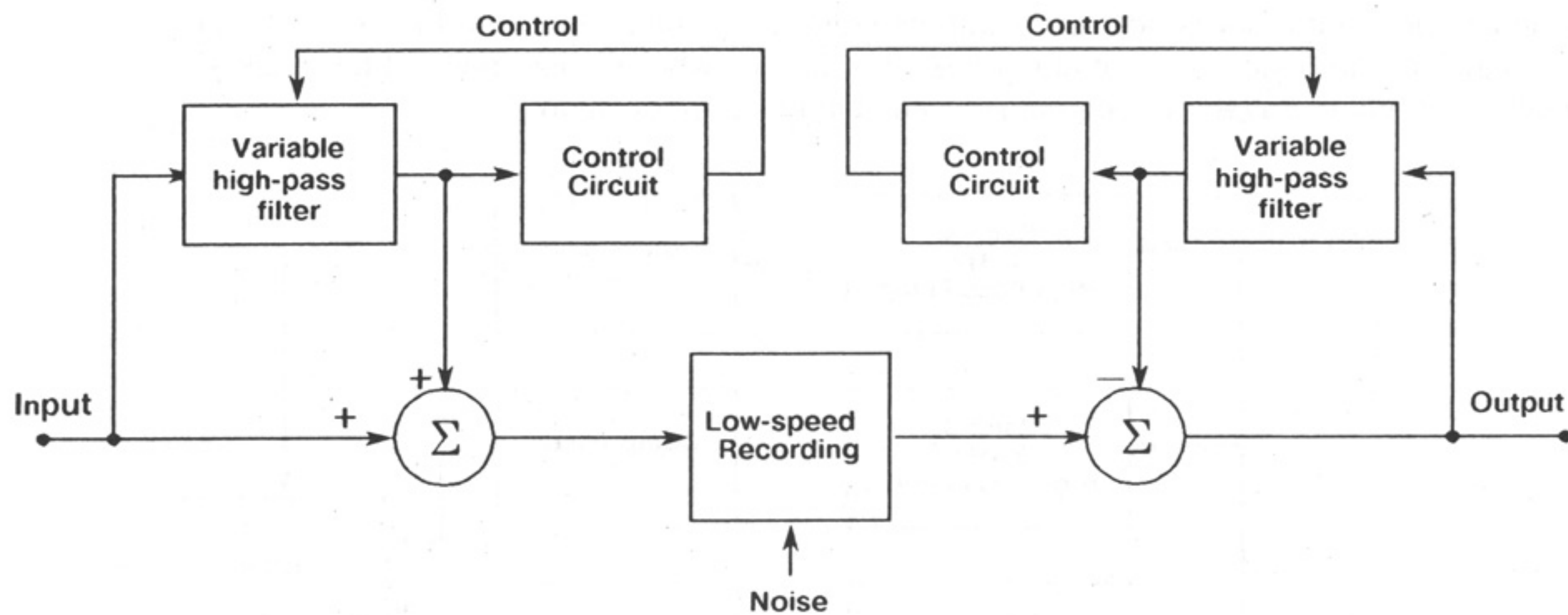


Figure 5.6 Block diagram of B-type noise reduction

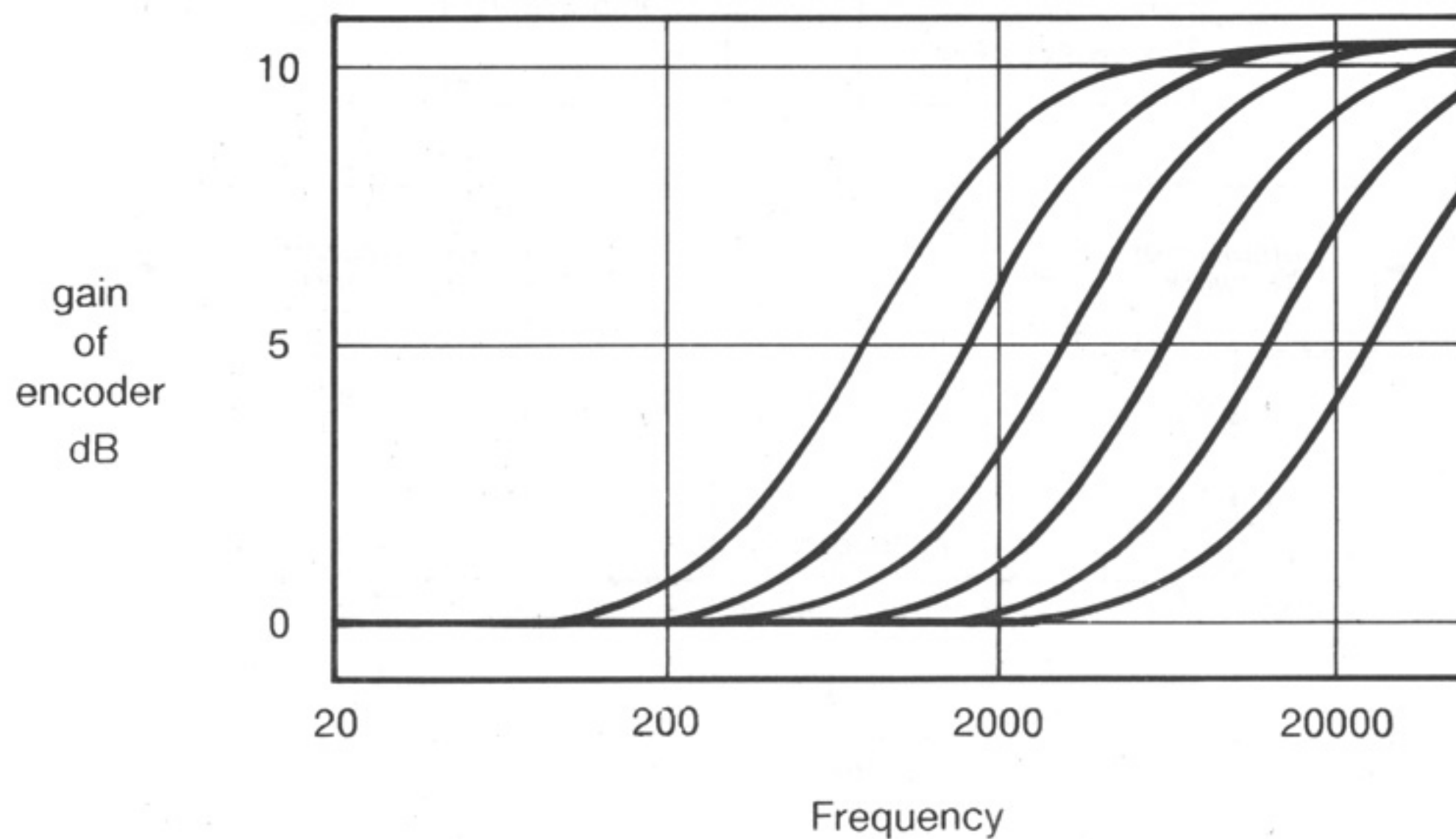


Figure 5.7 Family of response curves for B-type noise reduction

5.5 Dolby C-type noise reduction

C-type nr was introduced in 1980 and is used in consumer audio cassette recorders and in the audio channels of professional Betacam*, MII*, and U-matic SP* video recorders. It operates in a manner similar to B-type, but offers 20 dB of nr. It achieves the steeper filter slopes required to give adequate nr at high frequencies in the presence of lower frequency dominant signals by employing two overlapping processor stages in tandem, operating with offset ("staggered") thresholds and with an action extending two octaves lower than B-type (see Figures 5.8 and 5.9).

Frequency shaping ("spectral skewing") at the input of the encoder desensitizes the processor to the effects of high frequency response errors. Additional shaping in the main path ("anti-saturation") lowers the amplitude of high frequency high level signals before they are applied to the tape, reducing high frequency distortion and self-erasure.

The decoder contains complementary circuits to restore the frequency response: the amount of nr at the highest frequencies is decreased, but this is where the ear is least sensitive to noise.

Virtually all C-type circuits are built under license.

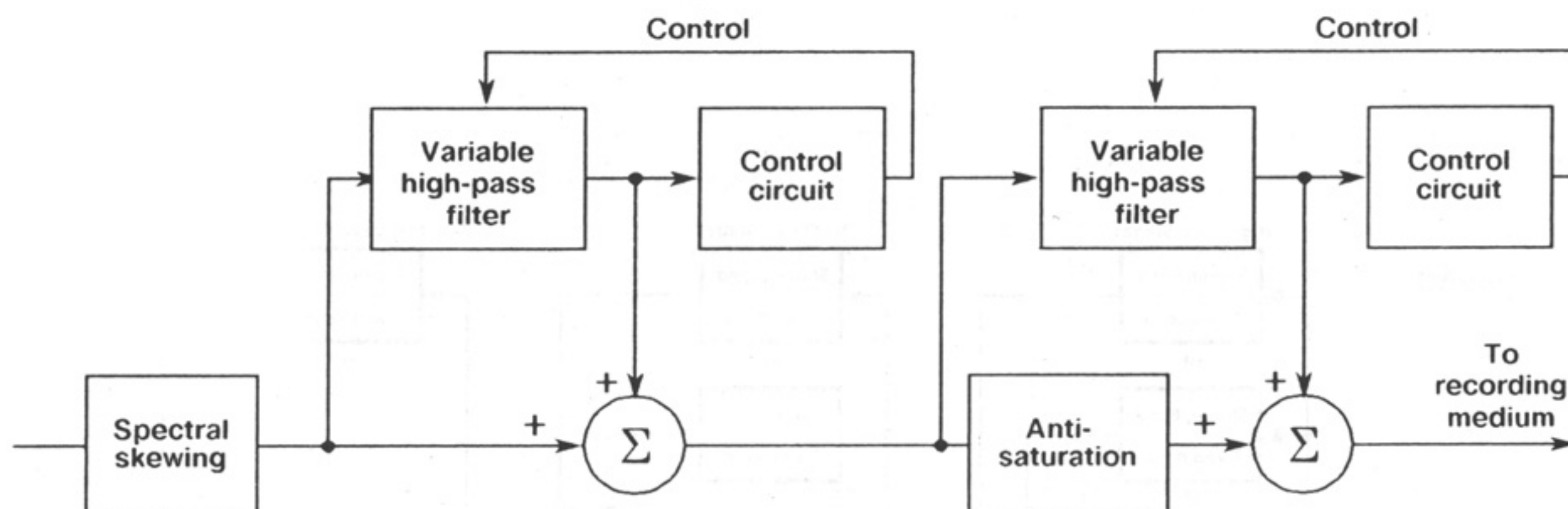


Figure 5.8 Block diagram of C-type encoder

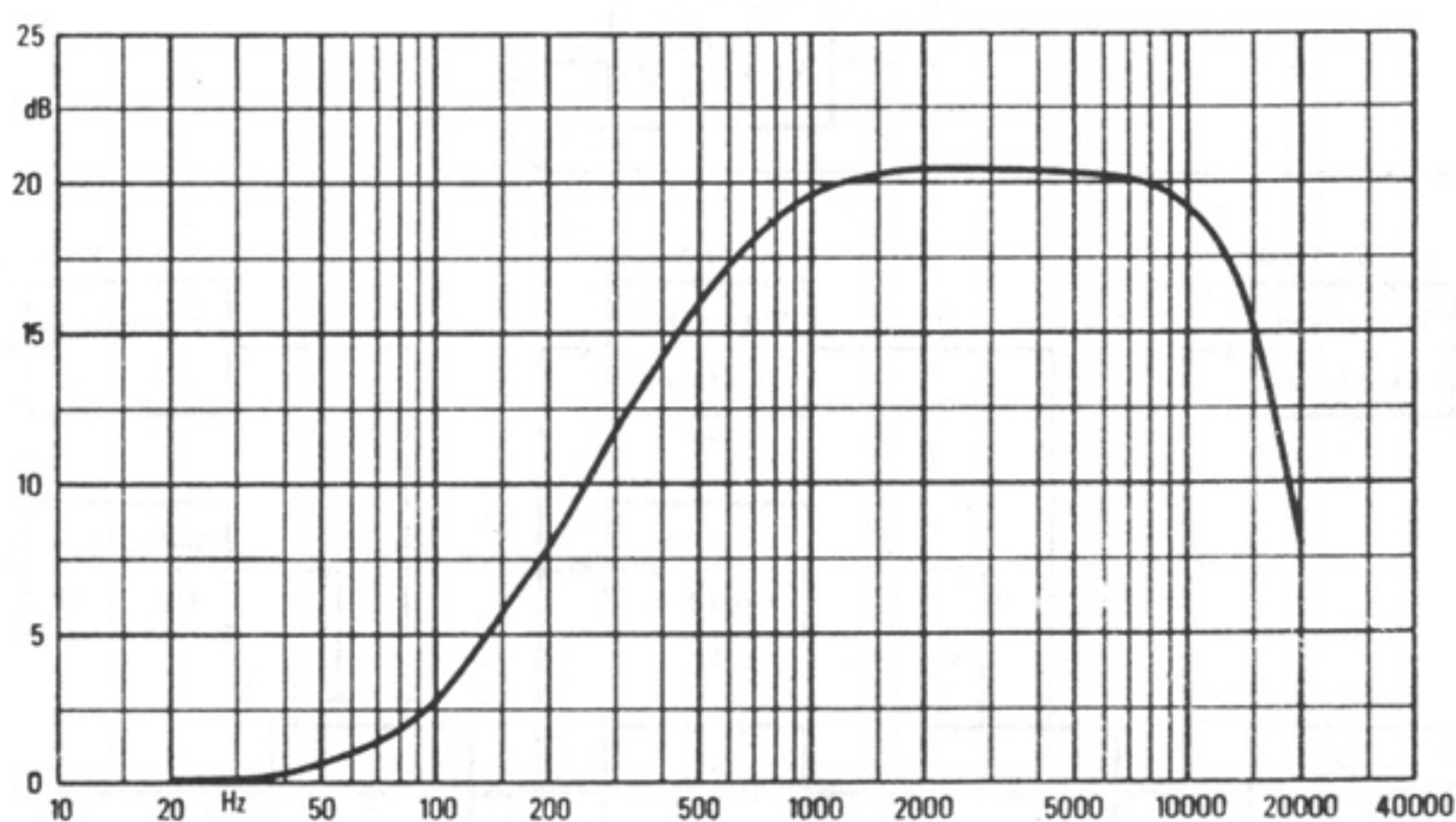


Figure 5.9 Low-level C-type encoder response

* Betacam and U-matic are trademarks of Sony Corporation, and MII is a trademark of Matsushita Electric Industrial Co. Ltd.

5.6 Dolby Spectral Recording

Introduced in 1986, Dolby Spectral Recording (SR) is a professional system which combines all the advantages of fixed bands (as in A-type) with the spectral adaptation of sliding bands (as in B-type and C-type). It also employs spectral skewing and anti-saturation, but applied at low frequencies as well as high.

SR uses three high frequency and two low frequency stages in tandem, with a crossover at 800 Hz (see Figure 5.10). Together they result in a reduction in audible noise of 24 dB (see Figure 5.11), taking into account the frequency dependent sensitivity of the ear.

The SR processor response adapts to the input spectrum to obtain full unchanged boost except in the immediate neighborhood of dominant frequencies. In this way, the system reduces not only noise but other unwanted signals such as tape modulation noise and distortion products introduced between the encoder and decoder.

The spectral skewing and multi-stage processing give greater tolerance to level and frequency response errors compared with A-type nr.

Dolby SR circuits are built exclusively by Dolby Laboratories.

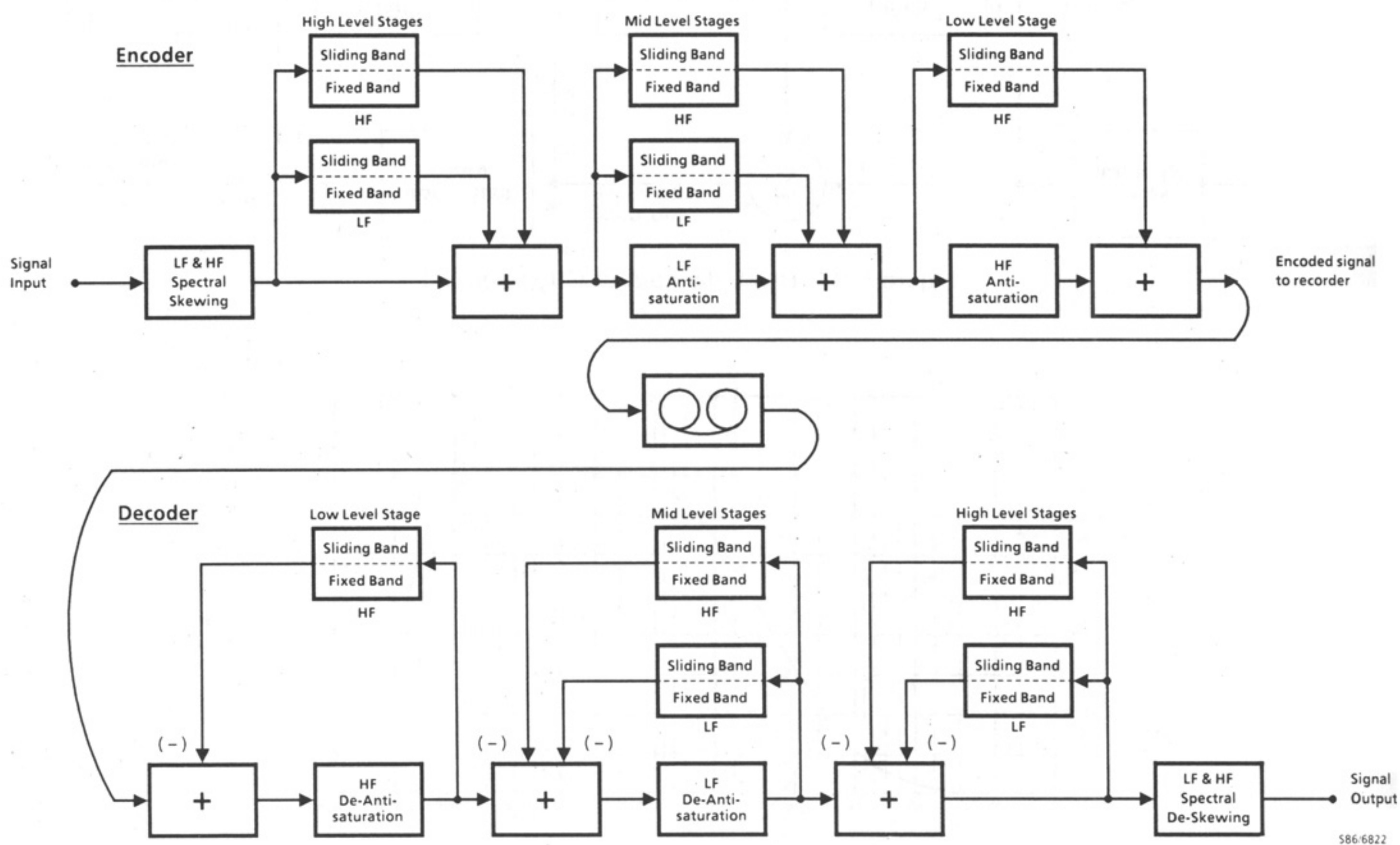


Figure 5.10 Block Diagram of Dolby SR