Dolby® SR

Cat. No. 280
Spectral Recording Module
User Information

USER INFORMATION
FOR
SPECTRAL RECORDING MODULE

CAT. NO. 280

Dolby Laboratories Incorporated

U.S.A. 100 Potrero Avenue, San Francisco, CA 94103
Tel: (415) 558-0200; Telex: 34409; Fax: (415) 863-1373

U.K. 346 Clapham Road, London SW9 9AP
Tel: 01 720-1111; Telex: 919109; Fax: 01 720-4118

WARRANTY INFORMATION: Equipment manufactured by Dolby Laboratories is warranted against defects in materials and workmanship for one year from the date of purchase. There are no other express or implied warranties and no warranty of merchantability or fitness for a particular purpose. During the warranty period Dolby Laboratories will repair or, at its option, replace components which prove to be defective, provided the unit is shipped, prepaid, to the manufacturer directly or via an authorized distributor. Defects caused by modifications, misuse or accidents, and any further damage caused by inadequate packing for service return, are not covered by this warranty.

Dolby Laboratories' obligation is restricted to the repair or replacement of defective parts and under no circumstances shall Dolby Laboratories be liable for any other damage, either direct or consequential.

All requests for repairs or information should include the unit serial number to ensure rapid service.

S87/7417/7493

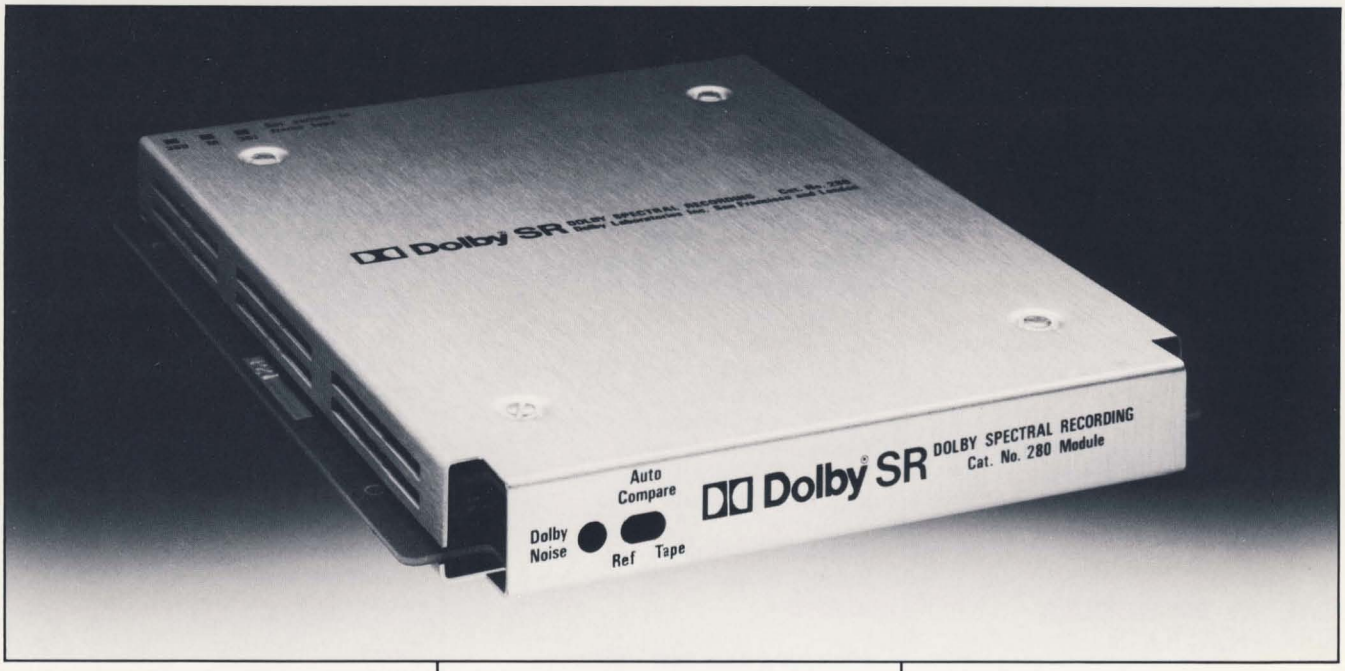
This information is intended to serve as an introductory user's guide for the Cat. No. 280 spectral recording module. It assumes previous knowledge of the basic principles of audio recording, complementary signal processing, and some familiarity with Dolby A-type noise reduction and interface frames.

Important Note

The Cat. No. 280 spectral recording module is both pin and level compatible with the Cat. No. 22 A-type module. In most cases, the Dolby A-type user can simply replace the Cat. No. 22 module with the Cat. No. 280 module and continue recording using established studio procedures. (A switch on the rear of the Cat. No. 280 must be set to the appropriate frame type.)

Dolby® Cat. No. 280 Spectral Recording Module

Dolby SR



The Cat. No. 280 module is the first commercially available embodiment of the new spectral recording process developed by Dolby Laboratories. The module has been designed for ease of installation in existing 360-Series and M-Series frames from Dolby Laboratories.

Dolby spectral recording is a new audio recording technique which provides audible signal integrity superior to that of any other recording method in use. The performance of Dolby SR with contemporary analog professional tape recorders stands up to extensive scrutiny. The Cat. No. 280 module has been designed to allow easy operational use of the Dolby SR process, using existing frames, with no major studio equipment changes or capital expenditure.

The Cat. No. 280 spectral recording module utilizes function logic similar to that of the Dolby Cat. No. 22 A-type noise reduction module; consequently the control facilities of 360, 361 and M-Series units operate normally, such as IN/OUT, RECORD/PLAY and input/output gain controls.

Dolby SR modules incorporate a new recorder alignment and verification tool called Auto Compare. A built-in pink noise generator in the module applies bursts of noise (Dolby Noise) at a calibrated level to the recorder. The signal is used at the head of a tape to identify the use of Dolby SR, and to assist in recorder calibration (however, the spectral recording process is more tolerant of input/output gain errors than Dolby A-type noise reduction). During playback, the Auto Compare circuitry automatically alternates the monitor output between the Dolby Noise off-tape and the internal noise generator. LED indicators on the module front indicate the current monitor condition. Auto Compare assists in recorder set-up alignment, but additionally provides a rapid method of checking a recorder track by ear during a session.

Dolby Laboratories has delivered over 80,000 Cat. No. 22 noise reduction modules throughout the world, and this widespread availability of interfaces accepting the Cat. No. 280 modules will facilitate adoption of the new Dolby SR process.

Other Dolby SR configurations are available, including the Cat. No. 431, a module for Dolby SP- and XP-Series units. In addition, two testers are available to assist process evaluation and module performance verification.

Full descriptive information about the Dolby spectral recording process, and product leaflets describing other Dolby SR modules and testers are available on request from Dolby Laboratories.

Dolby® Cat. No. 280 Specifications

INTERFACES:

The Cat. No. 280 module can be installed in the following frames:

Models 360 and 365

All module functions available, including simultaneous record/play Auto Compare if two Model 360s are used in dedicated Record and Play modes.

Model 361

Auto Compare functional during tape-playback following recording, but not during simultaneous recording.

M-Series Units

Simultaneous record/play Auto Compare. The Cat. 280 requires a special top cover (Cat. No. 359) to fit in Channels 2, 10, and 18 of M-Series interface.

CAT. NO. 280 MODULE SPECIFICATIONS:

Layout:

A pair of printed circuit cards mounted together form the module. Signal input/output and control functions compatible with Cat. No. 22 noise reduction module.

Input Circuit:

680 k ohms unbalanced, 300 mV rms for reference level.

Peak Encode Input Level:

3.0 V rms (20 dB above reference level).

Peak Decode Output Level:

3.0 V rms from Output 1,
5.0 V rms from Output 2.

Line Amplifier:

When mounted in interface, maximum output +22 dB into bridging load, +21 dB into 600 ohms
(0 dB = 0.775 V rms).
(A 6 dB higher level is possible using +36 V line-amplifier supply voltage.)

Overall Frequency Response:

±1 dB, 20 Hz-20 kHz (encode/decode).

Bandwidth Limitation:

Internal filters: 10 Hz-50 kHz.

Overall Harmonic Distortion:

2nd & 3rd harmonic each 0.3% at 3 dB below peak level, 20 Hz-20 kHz.
Negligible higher order distortion components at any level.

Overall Dynamic Range of SR System (typical):[1]

105 dB — clipping level to CCIR/ARM noise level.
93 dB — clipping level to CCIR Rec. 468-2 weighted noise level.
105 dB — clipping level to NAB A-weighted noise level.[2]
95 dB — clipping level to unweighted noise level, 20 Hz-20 kHz.[3]

Typical Obtainable Dynamic Range, 15 ips:

90-95 dB.

Matching Between Units:

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

Signal Delay:

Approximately 7.0 μs per channel, 14 μs overall, encode/decode, plus delay of interfaces used.

Calibration Facilities:

Dolby Noise generator for establishing correct levels and frequency response, via built-in meter amplifier and interface meter. Output signal can also be fed to external analysis facilities. Automatic audible Auto Compare function, allowing comparison of Dolby Noise from tape with internally generated reference pink noise.

Status Indicators:

Yellow LED on front of module indicates Dolby Noise mode.
Auto Compare Reference/Tape function status indicated by red and green LEDs on front of module.
(LED control signal available for remotely situated LEDs or lamps.)

1. Processor alone; in interfaces, may depend on line levels used.
2. Weighting filter supplemented by 25 kHz 4-pole low-pass filter to ensure that only audible noise is measured.
3. Rms or average responding meter, 4-pole filters.

Control Inputs:

External +18 to +30 V to actuate record mode (provided in interface).
External single pole switch for process in/out (provided in interface).
External single pole switch for Dolby Noise mode (provided in interface).
Internal three position switch to adjust operating logic to Models 360 and 365, Model 361, or M-Series interfaces.

Stability:

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

Operating Temperature:

Up to 45 degrees C.

Construction:

Fiberglass printed circuits, solid state devices throughout; clear anodized aluminum covers, black characters.

Size:

192 x 155 x 20 mm (7.6 x 6.1 x 0.8 inches).

Weight:

500 gm (18 oz.).

Power Requirements:

SR circuit: +20 V to +28 V, 100-140 mA.
Line amplifier: +18 V to +36 V, 13-17 mA.

Dolby Laboratories Inc., 100 Potrero Avenue,
San Francisco, CA 94103-4813,
Telephone (415) 558-0200, Telex 34409.

346 Clapham Road, London SW9 9AP,
Telephone (01) 720-1111, Telex 919109.

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SECTION 1
INTRODUCTION

1.1 Dolby Spectral Recording

Dolby spectral recording, or Dolby SR, has been developed to answer the needs of modern professional recording. The Cat. No. 280 SR module is the first implementation of this new recording process. It can be used in existing interface frames manufactured by Dolby Laboratories and will, therefore, allow a widespread introduction of this new high-quality recording format.

1.2 Dolby SR Packaging

To facilitate easy interchange, the Dolby SR circuit has been packaged in the same card profile and pin out as the familiar Cat. No. 22 noise reduction module. This will allow the process to be conveniently used in commonly available 360-Series and M-Series interface frames. The Cat. No. 280 cannot be used in the SP unit due to incompatibilities with the Cat. No. 230 carrier card. A specific Dolby SR module, the Cat. No. 431, will be available for the existing SP- and XP-Series multi-track frames.

While the Cat. No. 280 is generally compatible with the Cat. No. 22 module, there is one major difference: the standard Cat. No. 280 module is physically thicker (about .15 inch, 3 mm) than the Cat. No. 22, and therefore will not fit in some existing Cat. No. 22 applications. To address situations where the Cat. No. 22 cards have been mounted close together, such as in the Model 362, a special packaging adaptation of the Cat. No. 280 has been developed, the Cat. No. 280-L. This long but thin adaptation extends the Dolby SR circuits forward of the front panel by about 7 1/2 inches, or 190 mm, thereby allowing Dolby SR modules to be used in close-pitch situations.

The increased thickness of the Cat. No. 280 will not allow standard modules to fit in a few channels of the M-Series frame. To accommodate M-series channels 1,10 and 18, special module covers (Cat. No. 359) must be installed on the Cat. No. 280 modules used in these channels only.

1.3 Dolby SR Compatibility

Electrically, the Dolby SR process is very different from A-type noise reduction. Both Dolby A-type NR and Dolby SR are complementary processes that, when decoded properly, give excellent results. Dolby SR, however, goes far beyond noise reduction systems in its ability to improve the overall quality of a recording or transmission channel. Dolby A-type and Dolby SR are not considered cross-compatible--Dolby SR encoded tapes should not be decoded with Dolby A-type cards and vice versa.

1.4 Dolby SR Calibration

As with A-type noise reduction, Dolby SR requires the decode module to be correctly set in level with respect to the encode module. With A-type, this is accomplished using Dolby Tone; with the Dolby SR process, it is achieved using a new, easily identifiable alignment signal: Dolby Noise. Dolby Noise, abbreviated DN, is always used to establish correct decode level.

In addition to the Dolby spectral recording circuits and the Dolby Noise generator, the Cat. No. 280 contains an important new feature--Auto Compare. The Auto Compare circuit, using Dolby Noise as a signal, gives the user valuable gain and frequency response information about the recording channel. The Auto Compare mode allows an automatic aural comparison of the recorded Dolby Noise signal and the internally generated pink noise. The user can quickly, by ear, verify the performance of the recording system by comparing the reference pink noise with the Dolby Noise from the tape. The Auto Compare feature is discussed fully in Section 3 -- Calibration.

1.5 Cat. No. 280 Applications

The following is a summary of how the Cat. No. 280 can be used in specific Dolby interface frames. A full discussion of Cat. No. 280 operation in these units is covered in Section 5 -- Practical Operation.

360 Series

Model 360

The Model 360 is intended for single-channel, dedicated encode or decode operation. Two interface frames and two Cat. No. 280 modules are required for one channel of simultaneous record and playback operation. The Auto Compare feature can be fully operational during both record and playback.

Model 361

The Model 361 is designed for changeover operation of a single module for both record and playback. The Cat. No. 280 module is switched into the record and playback signal paths just as with the Cat. No. 22. The Auto Compare sequence is available only when playing back previously recorded Dolby Noise.

Model 362

The Model 362 is designed to hold two Cat. No. 22 A-type modules, and functions as a dual-channel Model 360. Due to height restrictions, two standard Cat. No. 280 modules cannot be installed. To incorporate Dolby SR in the Model 362, a special adaptation, the Cat. No. 280-L, must be used. The Cat. No. 280-L contains the two circuit cards that make up the standard Cat. No. 280 module, with one mounted behind the other. This results in a module that is of single thickness but double length, therefore extending forward of the front panel by $7\frac{1}{2}$ inches (190 mm).

M-Series

The M-Series chassis was designed to hold 16 Cat. No. 22 A-type modules. Two chassis can be linked to accommodate 24 or 32 channels. It is possible to use Dolby SR in all channels, provided that special covers

are installed on the Cat. No. 280 modules used in channels 1, 10 and, in the M-24 unit, channel 18. Cat. No. 280 modules with standard covers can be used in all other M-series channels. The special cover, referred to as the Cat. No. 359, will be available through Dolby product distributors.

SP/XP Series

The greater thickness of the Cat. No. 280 prohibits its use in the SP Series. Additionally, there are some electrical incompatibilities with the Cat. No. 230 carrier card. The Cat. No. 431, due in late 1986, will fit both the SP and XP multi-track units. This module will be a plug-in replacement for the entire Cat. No. 230/22 combination in existing SP units and for the Cat. No. 331 A-type module in the newer XP frames.

Cinema Products (CP50, CP100, CP200)

The Cat. No. 280 requires minor modification for use within cinema units. In a few special situations, however, it may be necessary to use a Cat. No. 280 in a CP50, CP100 or a CP200. In this case, contact Dolby Laboratories for more information.

SECTION 2
CAT. NO. 280 INSTALLATION

2.1 General Installation

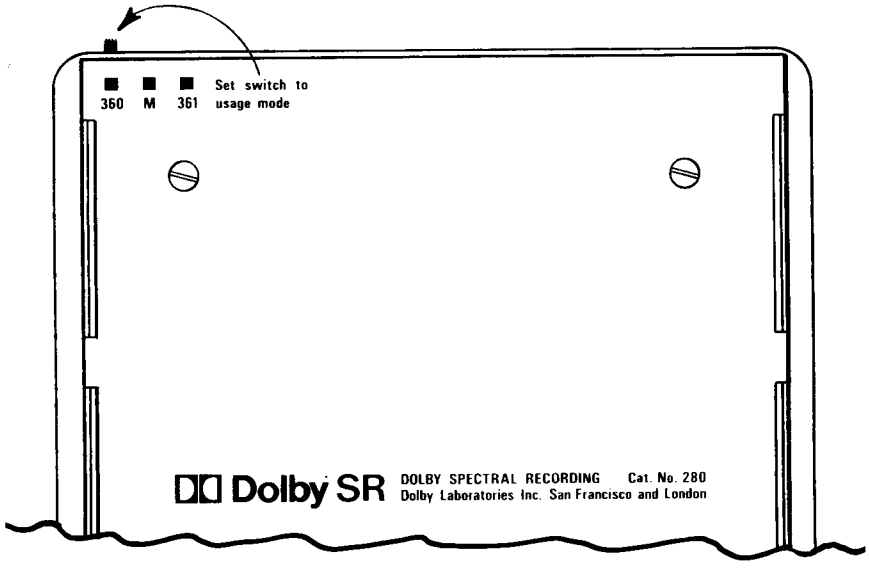
If the Dolby interface frame has been previously aligned for use with the Cat. No. 22 A-type module, the system is basically ready for use. Installation is, therefore, simply a matter of removing the existing Cat. No. 22 from the Dolby interface frame, setting the configuration switch on the Cat. No. 280, and plugging in the module.

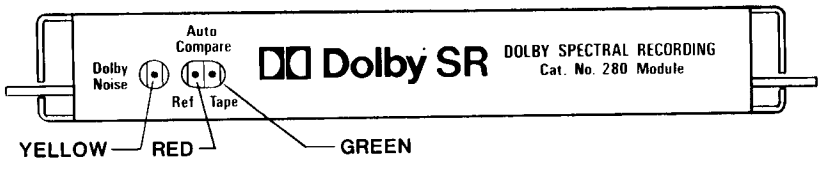
For optimum performance of the Dolby SR circuits, however, calibration of the recording system and interface frame input and output levels is recommended and is covered in Section 4. If the interface frame (360 Series or M Series) is being installed at the same time, refer to the appropriate interface frame manual for information regarding connections, etc.

The Cat. No. 280 module consumes roughly the same amount of power as the Cat. No. 22 A-type module and, therefore, has the same cooling requirements. It is important that adequate free air be provided around the Dolby interface frame, particularly the M-Series unit, which should always have a blank panel above and below the chassis.

2.2 Configuration Switch and Indicators

Before installing the Cat. No. 280, the user should be familiar with the basic function of the switches and indicators mounted on the module. There are three indicators and one switch on the Cat. No. 280. The configuration switch should be set for the appropriate usage condition.





Cat. No. 280 Configuration Switch

Selects usage mode. (360, 361, M Series)

This switch is found on the rear of the Cat. No. 280 module. It selects the appropriate internal logic for correct operation of the Auto Compare circuits. In general, it should be set to match the type of interface frame containing the Cat. No. 280 module. An exception exists, however, when Model 361 frames (or channels of an M-Series unit) are used for dedicated encode or decode operation, as if they were Model 360 units. In this case, the configuration switch should be set to the "360" position.

Since the Model 362 functions as a dual-channel Model 360, the configuration swith on the Cat. No. 280-L should be set to the "360" position.

If the Cat. No. 280 module is plugged into a frame with this switch incorrectly set, the Auto Compare circuit may not operate correctly. No damage will occur, and the Dolby SR circuits will continue to operate correctly. The tape will always be properly encoded or decoded regardless of the position of the configuration switch.

Cat. No. 280 Indicators

YELLOW indicator. **Dolby Noise ON**

The yellow indicator is ON whenever the Dolby Tone/Cal button on the interface frame is pressed. The Dolby Tone/CAL button is used to control the generation of Dolby Noise and to enable the Auto Compare mode.

RED and GREEN Indicators. **Reference (RED) / Tape (GREEN)**

These two LEDs indicate the source of Auto Compare audio. RED ON indicates the internal reference pink noise. GREEN ON indicates the Dolby Noise being played off the recorder. Neither LED is ON if Auto Compare is inactive.

2.3 Interface Frame Switch and Meter Labeling

The Cat. No. 280 card has been designed to be installed in interface frames originally designed for the Cat. No. 22 A-type NR module; therefore, several switches are labeled inappropriately. For example, with the Cat. No. 280 installed, the switch labeled Dolby Tone/CAL is used to select Dolby Noise, and the switch labeled NR ON/OFF is used to switch ON or OFF the Dolby SR process.

2.4 Optional External Connections

The main edge connector on the Cat. No. 280 has terminals which can be used for remote display of the Auto Compare status indicators. The reference pink noise is available at the edge connector for other uses. Additionally, a terminal has been provided that will allow Auto Compare circuits to be synchronized. The user is encouraged to use these optional connections to make the use of Dolby SR and Auto Compare more convenient. Appendix B gives specific information on using these options.

SECTION 3
CAT. NO. 280 CALIBRATION -- DOLBY NOISE

This section describes Dolby Noise, Auto Compare and their use during calibration. Alignment and operation of the Cat. No. 280 in specific Dolby interface frames is covered in Section 5 -- Practical Operation.

3.1 Dolby Noise

Dolby Noise is an alignment signal derived from internally generated pink noise. The pink noise is generated at an accurate level with respect to the Cat. No. 280's internal signal levels and then interrupted every two seconds by a 20 ms gap of silence. These periodic interruptions (sometimes called "nicks") serve to positively distinguish Dolby Noise from other pink noise. These interruptions also provide the synchronization signal for the Auto Compare circuit used during playback.

The Cat. No. 280 is switched into the Dolby Noise mode whenever the "Dolby Tone" or "Cal" button on the interface frame is pressed. The YELLOW LED on the front of the Dolby SR module will be ON.

When making a recording using the Dolby SR process, the user should always record a short section of Dolby Noise at the beginning of each reel (just as is done with Dolby tone for A-type recordings). This Dolby Noise positively identifies the recording as being Dolby SR encoded, and provides an accurate alignment reference for the decoder. When Dolby Noise is recorded (the "Dolby Tone" or "Cal" button on the interface frame is pressed), the Dolby Noise is sent to the recorder at 15 dB below Dolby Level. This lower level is compensated by gain in the calibration meter amplifier so that Dolby Noise will read on the Dolby Level dot in the center of the calibration meter. In other words, the level of the Dolby Noise on the calibration meter will read very low during normal playback, but will read Dolby Level--the center dot--when the Dolby Tone/Cal button is pressed.

3.2 Auto Compare

The Auto Compare feature provides a simple and convenient way of quickly verifying the recording channel. During the Auto Compare mode, the internal reference pink noise and the recorded Dolby Noise are alternately switched to the monitor output on four-second intervals. This provides, in effect, a continuous A/B comparison between the reference pink noise generator and the Dolby Noise off the tape.

The Auto Compare feature in the Cat. No. 280 module allows the easy identification of errors in level, high and low frequency response (including wrong equalization settings), azimuth, or any other audible conditions.

The Dolby Noise recorded on the tape has interruptions every two seconds. The internal reference noise, on the other hand, is continuous and does not have the interruptions. This leads to an easily identifiable pattern of four seconds of continuous reference noise and four seconds of the interrupted or "nicked" Dolby Noise. After several initial alignment sessions, the "nicked/continuous" pattern is easily identified as a tape/reference pattern, even though the two noises may sound identical -- which they will, if the recorder and Dolby SR levels are aligned properly. Two LEDs on the front of the Cat. No. 280 indicate whether the monitor

is receiving the internal reference noise (RED) or the Dolby Noise from the recorder (GREEN).

3.3 Auto Compare Control

Auto Compare is controlled by the Dolby Tone/Cal button on the interface frame and the status of the tape recorder. An Auto Compare sequence will automatically begin IF the recorder is playing Dolby Noise AND the Dolby Tone/Cal button on the interface frame is pressed. In other words, when the Dolby Tone/Cal button is pressed, the Cat. No. 280 automatically recognizes Dolby Noise at its input; the four- second alternating reference/tape sequence will automatically begin.

When a Cat. No. 280 is installed, the Dolby Tone/Cal button is used only in association with Dolby Noise and has no application with other tones or program material. If the button is inadvertently left pressed while playing program material, the tape will not be decoded and the Auto Compare circuit may occasionally be triggered by transient program material, resulting in bursts of reference noise being sent to the monitor. If the Dolby Tone/Cal button is released, the situation returns to normal and the tape will be correctly decoded.

The exact operation of the Auto Compare feature depends on which Dolby interface frame the Cat. No. 280 has been installed in and whether the interface frames are used for dedicated encode/decode or changeover operation. The mode of operation is selected by the rear switch on the module. These specific differences are discussed in Section 5 -- Practical Operation.

3.4 Auto Compare Metering

The calibration meters in the interface frames (360 Series and M Series) were designed to read correctly on sine waves at a single level--specifically Dolby Level. In order for Dolby Noise to produce an accurate and reliable meter reading, the Dolby Noise is band limited to reduce meter bounce and reduce the effects of recorder frequency response errors at extreme frequencies. The meter signal is then amplified so that Dolby Noise reads Dolby Level--the dot--on the calibration meter. When the Dolby Tone/Cal button is not pressed, the meter functions normally, as with a Cat. No. 22 installed.

An important point to remember:

Although the Dolby Noise is always recorded at −15 dB with respect to the established Dolby Level, it is metered at Dolby Level on the calibration meter whenever the Dolby Tone/Cal button is pressed.

3.5 Auto Compare Synchronization

In currently available Dolby interface frames, the Auto Compare switching circuits are not synchronized between channels, unless the user has modified the interface frame as suggested in Appendix 1. In the Dolby SR module for the SP and XP Series, the Cat. No. 431, Ref/Tape switching will be synchronized between channels. Regardless of whether synchronization is provided, it is important to remember to listen to only one channel at a time for valid Auto Compare information.

3.6 Dolby Tone and the Cat. No. 280

Dolby Tone is used to establish the decode level for Dolby A-type NR and has no application in setting the decode level for Dolby SR. When the Dolby Tone/Cal button is pressed with the Cat. No. 280 installed, the calibration meter on the Dolby frame cannot be used for reading external tones because of the band limiting and gain used. When the Dolby Tone/Cal is not pressed, the calibration meter functions normally as if a Cat. No. 22 were installed, without the extra gain and band limiting.

If the Dolby interface frame and the tape recorder have been properly aligned using external tones, Dolby Noise will be correctly set for the proper decode level during playback. (Dolby Noise will read Dolby Level on the calibration meter when the Dolby Tone/Cal button is pressed.) If tapes are played that have been recorded with the tape recorder set up for a different reference flux level, the "Play Cal" on the recorder (or, sometimes more conveniently, the input potentiometer on the interface frame) will have to be adjusted to obtain the Dolby Level reading while the Dolby Noise is being played AND the Dolby Tone/Cal button is depressed.

Note:

As a safeguard, Dolby SR levels should always be established using Dolby Noise, even though the recorder and overall system may have been carefully aligned using tones. System levels are set using tones and test tapes in the conventional manner with the Dolby SR processing switched off (NR OFF on the associated interface frame). Following that, the Dolby SR level alignment is checked using Dolby Noise with the Dolby Tone/Cal button pressed. As Auto Compare provides the user with an accurate reference for setting playback frequency response and decode level, the user should always attempt to get the Dolby Noise that has been recording on the tape to audibly match the reference noise.

SECTION 4
SYSTEM ALIGNMENT

4.1 General System Alignment

This section covers general recording levels for optimum performance of Dolby SR. As covered in Section 3, the signal levels through the Dolby interface frame should be set using external tones and test tapes with the Dolby SR switched OFF (NR OFF on the interface frame).

4.2 Recording Levels for Dolby SR

Dolby Level can be established anywhere in the 100 nWb/m through 500 nWb/m region, and the Dolby SR system will give good results in all practical recording situations. Because of the overload characteristics associated with modern recording tapes, however, it is recommended that Dolby Level be established in the 185 nWb/m or 200 nWb/m region in order to achieve the very highest measured signal-to-noise ratio performance.

The Dolby SR process is capable of giving magnetic recording the capacity for extraordinarily high dynamic range, in some cases as high as 100 dB for 15 IPS 1/4-inch tape. In order to measure such a high signal-to-noise ratio (under test bench conditions), the noise and overload points of the tape and that of the associated electronic circuits in the recording system (including the Dolby interface frame and the Cat. No. 280 module) must be reasonably matched. In most real recording situations with Dolby SR, the overall performance of the recording system is limited by the microphone pre-amplifiers or the ambient noise level found at the recording location, so such attention to precise matching is unwarranted.

The basic Cat. No. 280 based Dolby SR system (encode-decode) has a clip-to-noise window of approximately 107 dB. The internal reference level of the Dolby SR electronics, or Dolby Level, is set to be about 20 dB below the internal clip point and about 85 dB above the electronic noise floor of the system. Modern recording tape has a saturation point around 15 dB above 185 nWb/m; therefore, if 185 nWb/m or 200 nWb/m is the chosen reference, tape saturation will occur just before the Cat. No. 280 clips, and the noise floor measured will be essentially that of the tape -- the desired effect. Recording studios that use 185 nWb/m or 200 nWb/m as a reference can continue to record using already established procedures, and obtain maximum benefits of Dolby SR.

Note:

While the clip point of the SR circuits themselves is about 21 dB above Dolby level, the actual headroom through the system may be limited by the line amplifier, the interface frame, and how the output level has been adjusted. For example, when the Cat. No. 280 is installed in the Model 360 Series, the maximum output level is +21 dBm into 600 ohms -- that is, 17 dB above Dolby Level. If the output potentiometer has been set so that Dolby Level is equal to +8 dBm, (a common 0 VU output level for U.S. broadcast applications), the headroom will be limited to 13 dB above Dolby Level.

Listed below are the maximum output levels of Dolby interface frames with the Cat. No. 280 module installed:

360 Series	+20 dBm	into 200 ohms
	+21 dBm	into 600 ohms
	+22 dBm	into 10 K ohms (bridging)
M Series	+21 dBm	into 200 ohms
	+22 dBm	into 600 ohms
	+23 dBm	into 10 K ohms (bridging)

4.3 General Alignment Using VU Meters

The following is a general alignment procedure for use with external VU meters and reference tapes with a 185 nWb/m or 200 nWb/m test tape:

1. Switch the Dolby SR process OFF (NR OFF on the associated Dolby interface frame).

2. Play the reference level tape on the recorder.

3. Adjust the Dolby frame "input" potentiometer so the calibration meter on the interface frame reads the dot in the center -- Dolby Level.

4. Adjust the "output" potentiometer to restore reference level at the Dolby interface frame's output.

5. Send a tone at reference level from the console to align the record aspects of the Dolby interface frame. (With the Model 361, this has been already accomplished with the steps above.)

6. Adjust the record sensitivity of the recorder to give a Dolby Level reading on the Dolby frame calibration meter.

7. With the Dolby Tone/CAL button depressed, record a short section of Dolby Noise. Play this section back and verify that it reads Dolby Level on the calibration meter.

Note:

The Dolby SR circuits in the Cat. No. 280 have been set to have unity gain at Dolby Level within the 700 - 1 kHz region. If the external tone is in this frequency band, it will make no difference if the alignment is done with or without the Dolby SR process switched in. Tape recorder frequency response measurements and equalization adjustments should always be done with Dolby SR switched off, as there will be noticeable deviations outside the 700 - 1 kHz region. As Dolby A-type must be switched off for alignment, it is probably a good practice to be consistent, and turn Dolby SR off as well.

4.4 Using VU Meters with High Level Reference Tapes

It has become common practice for many U.S. studios to use a reference flux level of 250 nWb/m, 261 nWb/m or 320 nWb/m, any of which can be established as a reference level for Dolby SR with good results. Some European studios, however, have established an alignment tone that is closely related to "peak recording level" and can be as high as 1000 nWb/m, a few dB below tape saturation. If such a high flux level is set to equal Dolby Level in the interface frame, much of the headroom of Cat. No. 280 will go unused and the noise floor will be influenced by that of the Dolby SR processing electronics; the full effect of the Dolby SR process will not be obtained. In order to get the maximum measured performance from Dolby SR when using such a high flux level reference tape, it is necessary to alter the suggested alignment procedure. The following are two possible solutions, either of which will give acceptable results:

a. Establish a secondary tone, lower than the reference flux level by a fixed amount, that will serve as the Dolby calibration tone. The secondary tone will read lower on the recorder and console meters but at Dolby Level--the center dot--on the interface frame. The reference alignment tone will read high, or even off scale, on the Dolby calibration meter.

b. Always align the Dolby interface frame with the high flux level reference tone to the "DIN" dot on the upper part of the Dolby calibration meter. The "DIN" indication is placed approximately 5 dB above Dolby Level on the Dolby calibration meter. (Some older meters may be labeled "32" or not have any upper mark at all.) Dolby Noise will still be generated and metered at Dolby Level--the center dot.

Regardless of the specific procedure used to set reference level through the Dolby interface frame, Dolby Noise must be set to read Dolby Level--the center dot--on the Dolby calibration meter. It is important to remember that the level of Dolby Noise is pre-set to 15 dB below the established Dolby Level at the tape recorder. The Dolby Noise is automatically restored to read Dolby Level when the Dolby Tone/CAL button is pressed. When playing back previously recorded Dolby Noise, the Dolby Tone/CAL button should be pressed and, if necessary, the "Play Cal" on the recorder adjusted so the Dolby calibration meter reads Dolby level.

4.5 Aligning with Peak Program Meters

Like VU meters, peak program meters can be used to set signal levels through the Dolby interface frame. Peak program meters are widely used, especially in Europe, because their faster rise times more accurately indicate the peak level of complex program material, while VU meters read the average program level. Studios using peak reading meters, therefore, need less headroom between their 100% reference level and the clipping or overload point on the tape. It is typical when aligning Cat. No. 22 Dolby A-type modules to set Dolby Level about 5 dB below the 100%, or "peak reference" alignment tone, normally used by some studios. In the case of Dolby SR, much of the available headroom in the Cat. No. 280 will go unused and the measured noise floor will be influenced by the Dolby SR processing electronics. In order to obtain the full benefits of the Dolby SR process when aligning with peak reading meters, Dolby Level should be established at roughly 10 - 15 dB below the peak indications on the meters. This should, in most cases, result in a flux level of around 200 nWb/m being chosen for Dolby Level.

The following is a general alignment procedure that should be followed when aligning Dolby SR using external peak program meters:

1. Switch the Dolby SR process OFF (NR OFF on the associated Dolby interface frame).

2. Send a tone from the console at the chosen Dolby Level (10 to 15 dB below 100%) or if adjusting the playback side, play a tape recorded at this level.

3. Adjust the Dolby interface frame "input" potentiometer so the calibration meter reads the dot in the center -- Dolby Level.

4. Adjust the "output" potentiometer to restore unity gain through the Dolby interface frame.

5. Send a tone at reference level from the console to align the record aspects of the Dolby interface frame. (With the Model 361, this has been already accomplished with the steps above.)

6. Adjust the record sensitivity of the recorder to give a Dolby Level reading on the Dolby frame calibration meter.

7. With the Dolby Tone/CAL button depressed, record a short section of Dolby Noise. When it is replayed, verify that it reads Dolby Level on the calibration meter.

Note:

Various peak reading meters use different dynamic characteristics and scales to indicate peak level. When aligning a Dolby interface frame with external peak reading meters, remember that reference level actually corresponds to a numerical indication on the scale that indicates the studio's standard operating level. For optimum performance of the Dolby SR circuit, the level which corresponds to the center dot on the Dolby calibration meter should be about 10-15 dB below the maximum program level indicated on the peak reading meter.

SECTION 5
PRACTICAL OPERATION

There are differences in the detailed alignment procedure and the operation of the Auto Compare circuit between the Model 360, Model 361 and M-Series units; therefore, a separate procedure is provided for each. Please refer to the appropriate section on the following pages.

5.1 Model 360 Operation

Two Model 360 units and two Cat. No. 280 modules are required per channel for record and playback operation without repatching. One Model 360 is dedicated to record (REC button pressed), while the other is dedicated to playback (PLAY button pressed). The configuration switch on both Cat. No. 280 cards should be set to the "360" position.

The Dolby Tone/Cal buttons on the two units should be linked together by connecting the frames with a 1/4-inch phone plug on the rear of the chassis. This allows the user to engage the Dolby Noise mode in both units by pressing either Dolby Tone/Cal button.

The units are initially aligned with external tones with the Dolby SR and DN switched off (Dolby NR and Dolby Tone OFF on the interface frames). The alignment is done in the conventional manner as if Cat. No. 22 modules were installed; that is, a reference tape is played and the "input" potentiometer on the playback unit is adjusted to obtain Dolby Level--the dot in the center of the calibration meter. The "output" potentiometer on the playback unit is adjusted to restore reference level to the console. Following playback unit alignment, the record unit is adjusted by sending a reference tone from the console and adjusting the "input" potentiometer on the record unit to obtain Dolby Level on the calibration meter. The "output" potentiometer on the record unit is then adjusted to obtain reference level at the recorder.

5.2 Auto Compare in the Model 360

When the Dolby Tone/Cal button is pressed on either unit (assuming they have been linked; otherwise both buttons will have to be pressed), the Cat. No. 280 in the record unit will send Dolby Noise to the recorder. The calibration meter will read the "Line In" signal (see note on calibration meters reading on early Cat. No. 280 modules). The YELLOW LED on the record or encode Cat. No. 280 will be ON. Neither the RED nor GREEN LED will be ON, as the record Cat. No. 280 is not in the Auto Compare mode. The playback or decode Cat. No. 280 will automatically begin the Auto Compare sequence in any of the following cases:

1. The recorder is recording and playing back the Dolby Noise generated by the encode Cat. No. 280.

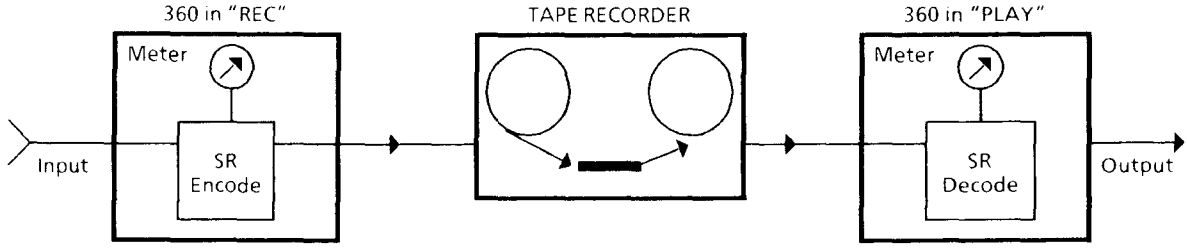
2. The recorder is stopped but switched to "INPUT," thereby feeding the record unit's Dolby Noise to its output.

3. The recorder is playing back previously recorded Dolby Noise.

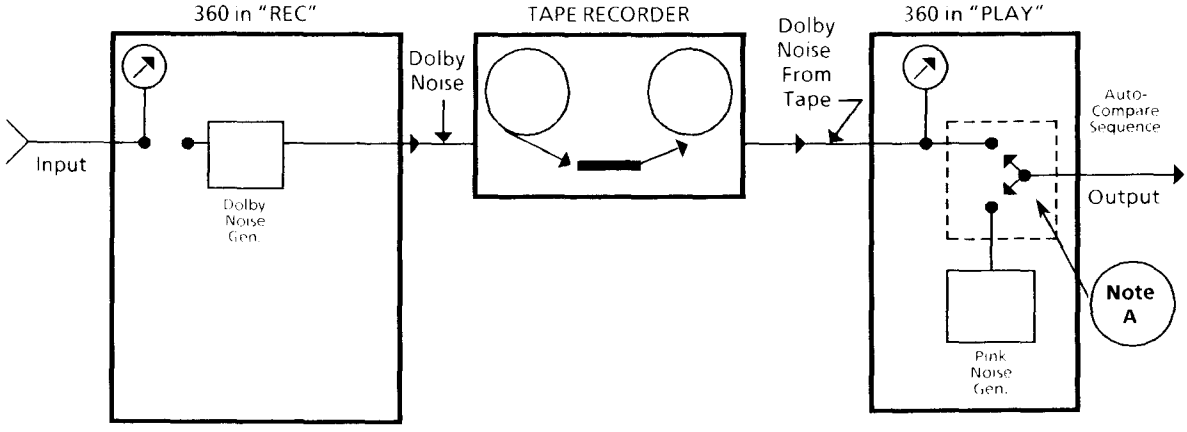
The YELLOW indicator on the playback Cat. No. 280 will be ON and the RED or GREEN LEDs will indicate the source of the noise being fed to the monitor. The RED LED will indicate the reference noise being generated inside the playback Cat. No. 280 and the GREEN LED indicates the Dolby Noise from the recorder. The calibration meter on the playback unit will indicate the replay signal from the tape.

360

RECORD/PLAY:



DOLBY NOISE/CAL, RECORD/PLAY:



Note A: Cat. No. 280 modules before serial number 456 have the playback meter signal connected to the output of the Auto Compare switch. Boards stamped 456 and above have the calibration meter connected as drawn. The result is that when an early generation Cat. No. 280 is used, the calibration meter will read the reference noise/Dolby Noise sequence, while with later generation boards, the calibration meter will always read the Dolby Noise from the recorder.

5.3 Model 361 Operation

The Model 361 is designed for changeover operation of one module. Relays inside the interface frame place the Cat. No. 280 module either in the input (RECORD) signal paths of a recorder or the output (PLAY) signal paths. A selector switch on the front of the Model 361 allows the module to be manually switched between the RECORD and PLAY modes. Typically, the Model 361 is automatically switched under control from the recorder.

Initial alignment of the Model 361 is done with Dolby SR and DN switched OFF, as when a Cat. No. 22 module is installed. A reference tape is played and the "input" potentiometer on the Model 361 is adjusted so the calibration meter reads Dolby Level. The "output" potentiometer is then adjusted to restore reference level to the rest of the system.

Unlike the M-Series, SP- and XP-Series units, the Model 361 has only one "input" and one "output" potentiometer (and, therefore, only one output line amplifier). This generally simplifies alignment, in that the record side adjustments will automatically be correct if the playback alignment has been done. This is true provided that the recorder is set for unity gain, that the "Line In" and "To Monitor" levels are expected to be identical, and there are no unusual loading or impedance matching conditions.

Note that it is possible to use two Model 361 units for simultaneous encode/decode operation as if they were Model 360 units. In this case, the configuration switch on the rear of the Cat. No. 280 should be put in the "360" position and the general alignment procedure for the 360 Series followed. The console should be connected through to the recorder using the "Line In" and "To Recorder" connections on the record unit and the REC and NORMAL buttons should be pressed. On the playback unit, the recorder is connected through the "From Recorder" and "To Monitor" connections and the PLAY and NORMAL buttons pressed.

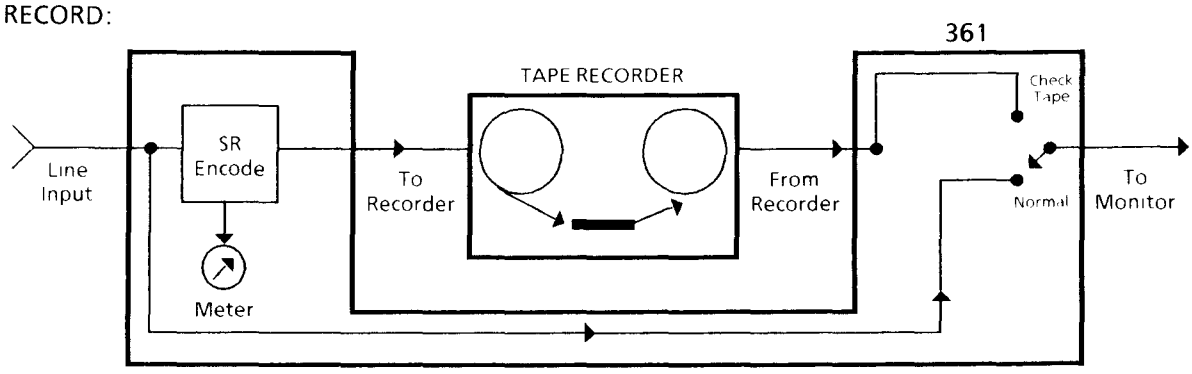
5.4 Auto Compare in the Model 361

The "automatic" Auto Compare sequence is available only when playing back previously recorded Dolby Noise. In playback, the line amplifier drives the "To Monitor" output while the Auto Compare circuit alternately switches between the Dolby Noise from the recorder and the internal reference noise. The RED (reference) and GREEN (tape) LEDs will indicate the source of the signal being sent to the monitor.

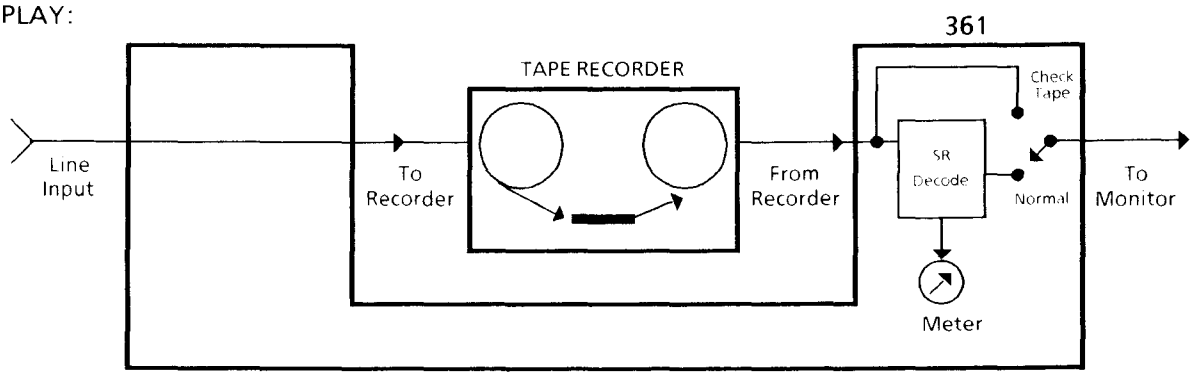
With the Model 361, the "automatic" Auto Compare sequence is not available while recording Dolby Noise because the output line amplifier is being used to drive the recorder (the "To Recorder" send). While Dolby Noise is being recorded, the monitor will receive the Dolby Noise direct from the generator in the NORMAL mode and will receive the Dolby Noise being returned from the recorder in the CHECK TAPE mode. By switching back and forth between NORMAL and CHECK TAPE, a useful "manual" Auto Compare function can be achieved. The reference signal heard in the NORMAL switch position, however, will not be pink noise but the interrupted or "nicked" Dolby Noise and, of course, the switching will not be synchronized. The calibration meter on the Model 361 will indicate the Dolby Noise being returned from the recorder regardless of whether the interface frame switch is in the NORMAL or CHECK TAPE position.

361

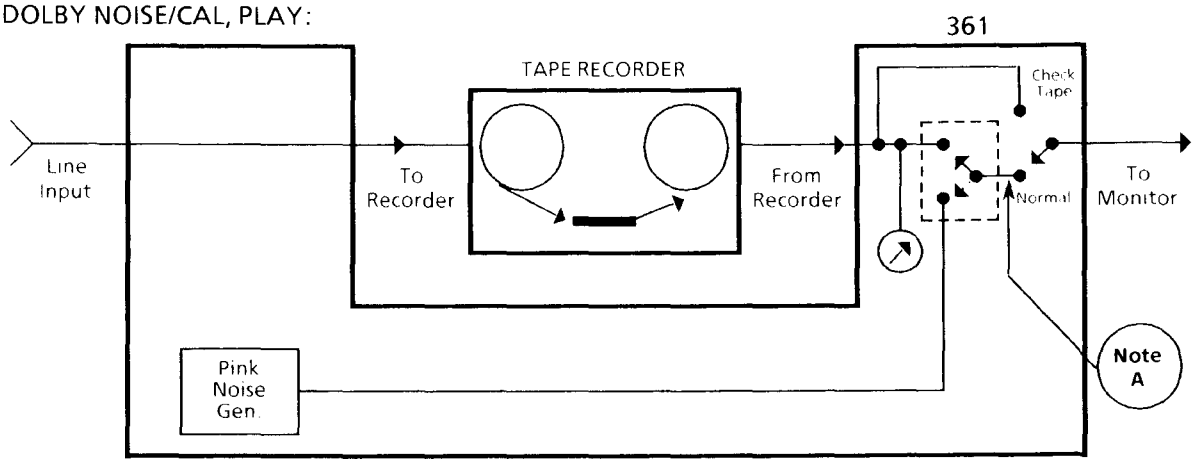
RECORD:



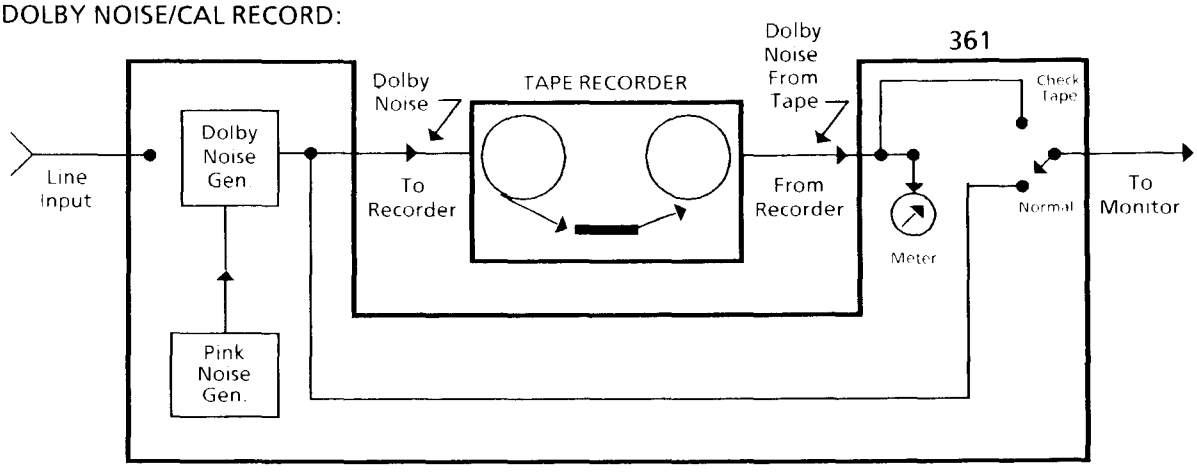
PLAY:



DOLBY NOISE/CAL, PLAY:



DOLBY NOISE/CAL RECORD:



Note A: Cat. No. 280 modules before serial number 456 have the meter connected to the output of the Auto Compare switch. Boards stamped 456 and above have the calibration meter connected as drawn. The result is that when an early generation Cat. No. 280 is used, the calibration meter will read the reference noise/Dolby Noise sequence, while with later generation boards, the calibration meter will always read the Dolby Noise from the recorder.

5.5 M-Series Operation

Like the Model 361, the M Series has been designed for changeover operation of one module. Solid-state switches in the Cat. No. 44 interface module place the Cat. No. 280 module either in the input (RECORD) signal paths or the output (PLAY) signal paths. The M Series is typically switched between the record and playback modes under control from the recorder. Additionally, the Cat. No. 44 interface module contains a dedicated input buffer and line amplifier and individual level trims for the "From Recorder" and "To Recorder" signal lines. (The older Cat. No. 44 modules have a fixed level of +4 dBm or 1.23 volts at the "To Recorder" outputs, while the Cat. No. 44H cards have an adjustable output.)

Alignment of the M Series is done by playing a reference tape on the recorder and adjusting the "From Recorder" input potentiometer to obtain Dolby Level on the Cat. No. 44 calibration meter. The "To Monitor" potentiometer is adjusted to restore reference level to the output of the M-Series. The record side is adjusted by sending a reference level signal in to the "Line In" inputs with the M-Series in the record mode. (The "meter reads Line In" LED on the Cat. No. 44 interface module will be ON.) The "Line In" potentiometer is adjusted to obtain Dolby Level on the calibration meter and the "To Recorder" output potentiometer is adjusted to restore reference level at the recorder.

Note that it is possible to use two M-Series channels for simultaneous encode/decode operation as if they were Model 360 units. It this case, the configuration switch on the rear of the Cat. No. 280 should be put in the "360" position and the general alignment procedure for the 360 Series followed. The console should be connected through to the recorder using the "Line In" and "To Recorder" connections on the record channels and "Rec Rem" triggers linked so that the channel is locked into encode or record operation. The "Line In" and the "To Rec" (on the Cat. No. 44H version only) potentiometers are used to set record path input and output levels.

On the channels used for playback, the recorder is connected through the "From Recorder" and "To Monitor" connections and "Rec Rem" triggers linked for play, or decode, operation. The "From Rec" and "To Mon" potentiometers are used to set playback path input and output levels. (Refer to the M-Series manual for specific information regarding the remote record/play connections.)

5.6 Auto Compare in the M Series

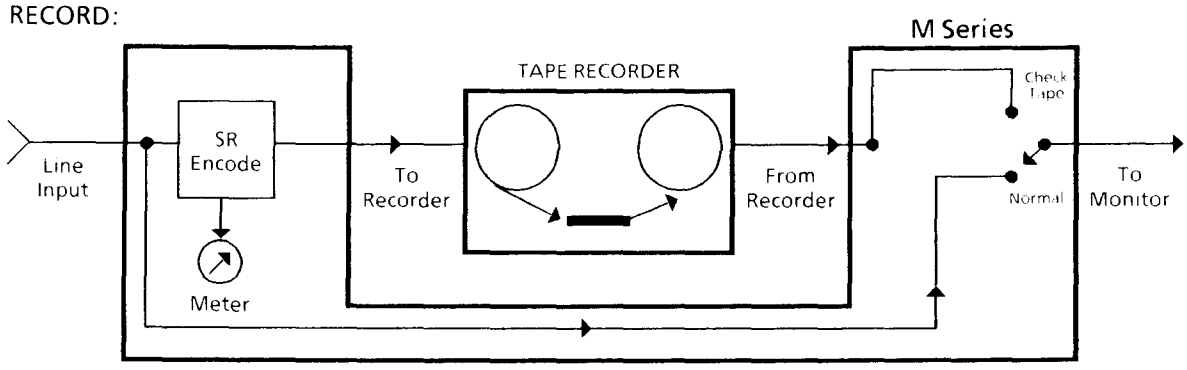
The Auto Compare sequence is available in both record and playback when the Cat. No. 280 is used in the M Series. The monitor-select switches on the common facilities module, Cat. No. 45, are left in the NORMAL position. As with all other units, the button labeled "Dolby Tone" on the Cat. No. 45 must be switched ON for Auto Compare to operate.

In record, Dolby Noise generated on the Cat. No. 280 is sent to the recorder via the "To Recorder" line amplifier on the Cat. No. 44 interface module. The recorder returns the Dolby Noise to the M-Series (recorder is in "INPUT," "SYNC," or "PLAY") via the "From Recorder" input buffer. The Auto Compare circuit alternately switches between the Dolby Noise from the recorder and the internal reference noise. The RED (reference) and GREEN (tape) LEDs will indicate the source of the signal being sent to the monitor. If the recorder is in PLAY, the function of the Auto Compare is identical, except that Dolby Noise is not sent to the recorder.

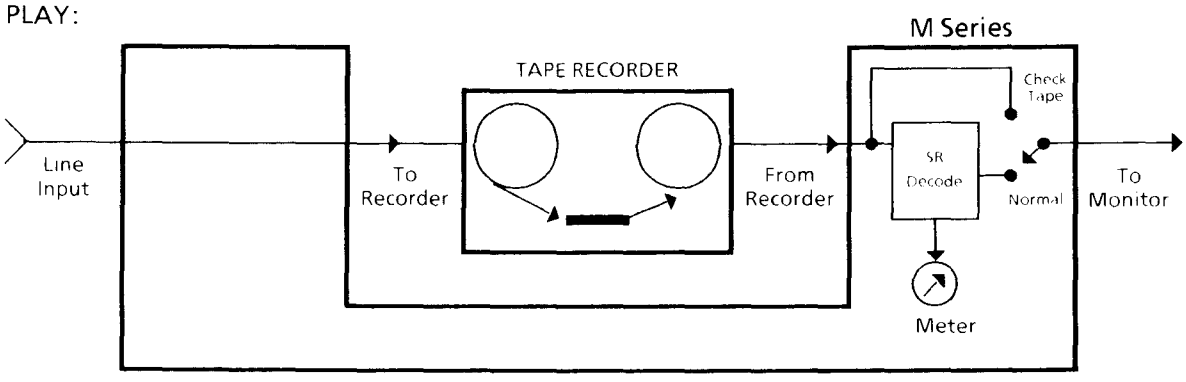
When the monitor-select switch on the Cat. No. 45 is in the LINE IN position, the calibration meter and the monitor will always receive the "Line In" signal. If the monitor-select switch is in the CHECK position, the monitor will always receive the signal from the recorder. This will be true regardless of the status of the Auto Compare circuit.

M SERIES

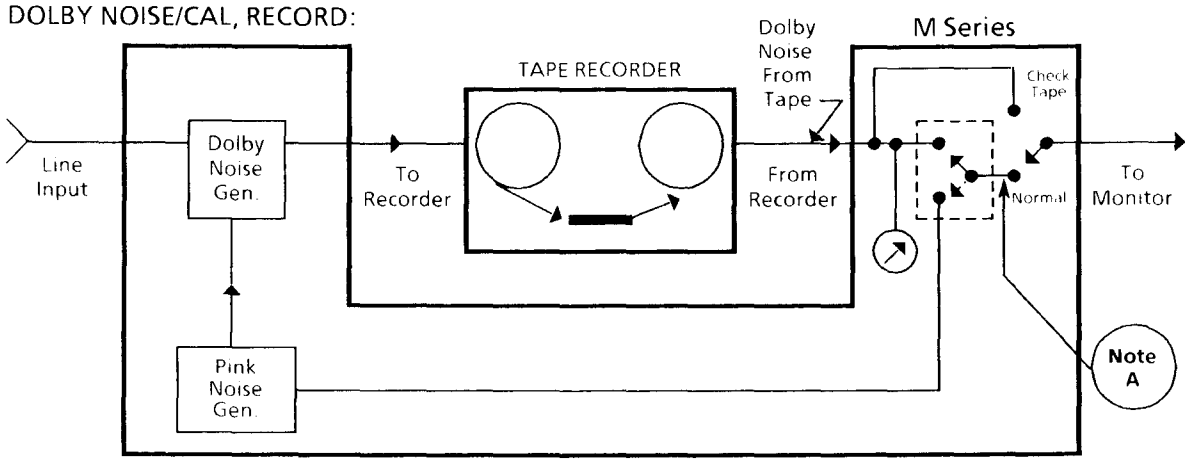
RECORD:



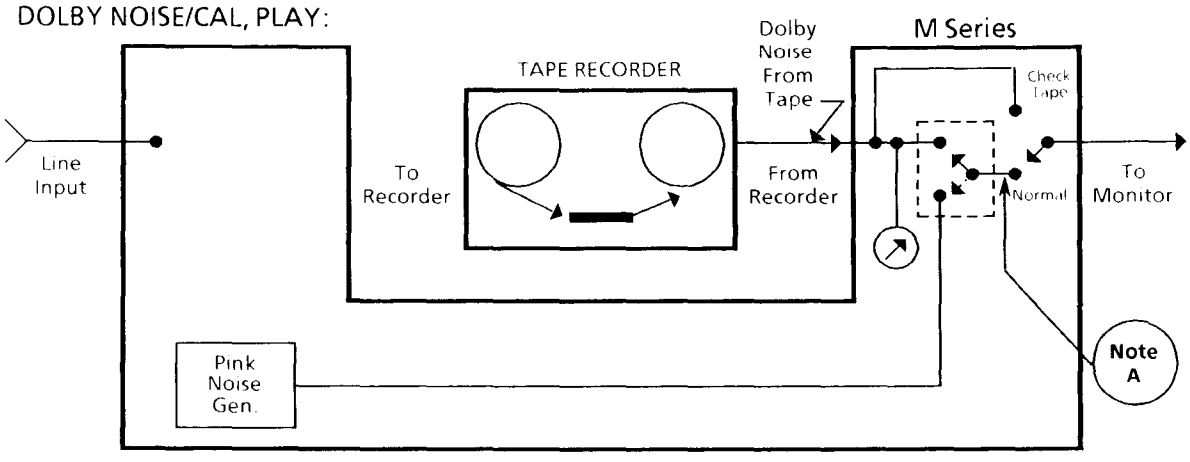
PLAY:



DOLBY NOISE/CAL, RECORD:



DOLBY NOISE/CAL, PLAY:



Note A: Cat. No. 280 modules before serial number 456 have the meter connected to the output of the Auto Compare switch. Boards stamped 456 and above have the calibration meter connected as drawn. The result is that when an early generation Cat. No. 280 is used, the calibration meter will read the reference noise/Dolby Noise sequence, while with later generation boards, the calibration meter will always read the Dolby Noise from the recorder.

Spectral Recording Process

Technical Aspects

Dolby Laboratories Inc.
San Francisco and London
S86/6825

RMD
February 24, 1986

Spectral Recording Process

Brief Outline

The spectral recording process includes some layout and operating characteristics in common with those of the A-type, B-type, and C-type noise reduction systems. Regarding general principles, reference should be made to the technical papers on these systems; the C-type paper is particularly relevant.

Referring to the figure called "Basic Block Diagram - Spectral Recording Encoder and Decoder", a main signal path is primarily responsible for conveying high level signals. The side chain signals are additively combined with the main signal in the encoding mode and subtractively in the decoding mode, whereby an overall complementary action is obtained. In this diagram a dedicated encoder and decoder are shown laid out in a symmetrical fashion; other decoder configurations are possible in switchable circuits.

The SR stage layout resembles that of the C-type system, except that three levels of action staggering are used: high-level, mid-level, and low-level. There are various advantages arising from the use of multi-level stages, including action compounding for good spectral discrimination, accuracy and reproducibility, low distortion, and low overshoot. The thresholds used are about -30 dB, -48 dB, and -62 dB below reference level (20 dB below SR peak signal level). For the high-level and mid-level stages both high frequency and low frequency circuits are used, with a crossover frequency of 800 Hz. The low-level stage is high frequency only, with an 800 Hz high pass characteristic. There is a significant overlap region between the high and low frequency stages, the high frequency stages extending their effects down to about 200 Hz, and the low frequency stages extending their effects up to about 3 kHz. This overlap contributes to the spectral tracking abilities of the system.

Each stage above has a low-level gain of 8 dB, whereby a total dynamic effect of 16 dB is obtained at low frequencies and 24 dB is obtained at high frequencies. A further dynamic action of about 1-2 dB takes place above the reference level.

The spectral skewing network has the same purpose and function as in the C-type system, except that a spectral skewing action is provided at low

frequencies as well. The high frequency network is a low pass filter with an attenuation characteristic similar to that of a 12 kHz two-pole Butterworth filter. The low frequency network is a 40 Hz high pass filter, connected in series with the high frequency network, also with a two-pole Butterworth-like characteristic. The spectral skewing networks de-sensitize the stage circuits to the influence of signal components at the extreme ends of the audio frequency band. This effect is particularly helpful if the tape recorder has an uncertain frequency response in these regions. The filters are of course also important in attenuating subsonic and supersonic interferences of all kinds. The spectral skewing action is compensated in the decoder, resulting in an overall flat response.

Both high frequency and low frequency antisaturation networks are provided in the main signal path. The networks are operative above about 4 kHz and below about 100 Hz. There is an effective compounding of the antisaturation effects produced by the antisaturation networks and the spectral skewing networks. The overall result is an antisaturation effect of 2-3 dB at 5 kHz, 6 dB at 10 kHz and 10 dB at 25 Hz and 15 kHz.

Least Treatment Principle

A design philosophy used in the development of the new system is that the best treatment of the signal is the least treatment. The design goal for the encoder is to provide a predetermined, fixed gain for all sub-threshold signal components. If a large signal component appears at a particular frequency or frequencies, then the gain should be reduced at those frequencies only, in accordance with a predetermined compression law so that it is possible to restore the signal during decoding. In other words, the compressor tries to keep all low level signal components fully boosted at all times; when the boosting must be cut back at a particular frequency the effect should not be extended to low-level signal components at other frequencies.

The audible effect of this type of compression is that the signal appears to be enhanced and brighter but without any apparent dynamic compression effects (the ear detects dynamic action primarily by the effect of a gain change due to a signal component at one frequency on a signal component at some other frequency). If the ear cannot detect dynamic effects in the compressed signal then a) it is unlikely that noise modulation effects will be evident in the decoded signal, and b) it is unlikely that signal modulation effects will be evident in the decoded signal if there should be a gain or frequency response error in the recording or transmission channel.

In the spectral recording process two new methods are used that greatly reduce the circuitry required to achieve the design goal of a full spectrally responsive system. In particular, both fixed and sliding bands are used in a unique combination, called action substitution, that draws on the best features of both types of circuits. A further technique, called modulation control, greatly improves the performance of both the fixed and sliding bands in resisting any modulation of signal components unless necessary.

The use of the new methods reduces the basic encoder to two frequency bands only (high frequency and low frequency), each with a fixed band and a sliding band. When the three-level action staggering layout is taken into account, five fixed bands and five sliding bands are employed.

Action Substitution

Both fixed band and sliding band dynamic actions are used in each of the five stages. In any particular stage, fixed band operation is used whenever it provides best performance; sliding band operation is substituted whenever it has an advantage. In this way the best features of both methods are obtained, without the attendant disadvantages of each.

The substitution is effective on a continuous and frequency by frequency basis. For example, the output from a given high frequency stage will typically be from the fixed band for frequencies up to the dominant signal component and from the sliding band above that frequency. Conversely, the output from a low frequency stage will be from the fixed band for frequencies down to a low frequency dominant component and from the sliding band below that frequency.

The advantages of fixed band circuits arise from the fact that all signal frequencies within the band are treated equally, in contrast with sliding band action. Thus the appearance of a signal component actuating the compressor results in a loss of noise reduction effect that manifests itself in a uniform manner throughout the band; the loss is not concentrated in any particular frequency region, as in sliding band circuits.

In contrast, the advantages of sliding band compression and expansion circuits derive from the fact that all signal frequencies are not treated equally. In particular, compression, expansion, and noise reduction action are well maintained above the frequency of the dominant signal component in high frequency circuits, and below the frequency of the dominant signal component in low frequency circuits; this action maintenance effect, except on a one to one basis, is absent in fixed band circuits.

The action substitution technique provides the advantages of fixed and sliding band circuits while avoiding their disadvantages. In other words, there is a significantly improved adherence to the ideal of least signal treatment; the signal more closely approaches fully boosted conditions in the encoding mode, with a consequently improved noise reduction effect in the decoding mode.

Modulation Control

In the A-type, B-type, and C-type systems the signal from the side chain is highly limited under high-level signal conditions. This high degree of limiting, beginning at a low-level threshold, is responsible for the low distortion, low overshoot, and low modulation distortion which characterize these systems.

A closer examination shows that it is unnecessary to utilize such a low threshold and such a strong limiting characteristic under certain signal conditions. In particular, whenever the side chain signal departs from an in-phase condition with respect to the main path signal, then the threshold can be raised. Furthermore, after an appropriate degree of limiting has taken place at a given frequency (in order to create the desired overall compression law), then it is unnecessary to continue the limiting as the signal level rises. Rather, the level of the side chain signal can be allowed to rise as the input signal rises, stabilizing at some significant fraction of the main path signal level.

In the fixed band portions of the circuit the above arrangement results in conventional performance in the pass-band (in-phase) frequency region. However, in the stop-band region the modulation control arrangement causes the limiting threshold to rise and the degree of limiting to be reduced. In this way large signals in the stop-band do not cause signal modulation in the pass-band and consequently an impairment of the noise reduction effect achieved during decoding.

Similar considerations apply in the SR sliding band circuits. Above the threshold at a particular frequency the variable filter slides to the turnover frequency needed to create the overall (main path plus side chain signal) compression law. As the input level rises, and once an overall gain of unity is obtained, there is no reason for further sliding of the variable filter. At this point the modulation control arrangement counteracts further sliding of the variable filter; as with the fixed band circuits, this prevents unnecessary modulation of the signal with consequent impairment of the noise reduction effect.

The modulation control aspects of the SR process result in a compression action which is remarkably free of noticeable signal related modulation effects. Working together with action substitution, modulation control contributes to the goal of least treatment, in providing a highly boosted, audibly stable signal.

Overshoot Suppression

A highly flexible overshoot suppression system is used; a multiplicity of overshoot suppression circuits operate directly upon the control signals of the various stages. The SR process employs overshoot suppression thresholds that are significantly higher than the steady state thresholds; the low level overshoot suppression levels are set at about 10 dB above the relevant steady state thresholds. The overshoot suppression effects are then phased in gradually as a function of increasing impulse level. The net result is that for most musical signals the overshoot suppressors rarely operate; the compressors are controlled by well smoothed, double integrated dc control signals. When the the suppressors do operate, the effect is so controlled that modulation distortion is minimal. Under relatively steady state, but nonetheless changing, signal conditions the overshoot suppression effects are gradually phased out with increasing signal levels; this action further ensures low overall modulation distortion from the system. The thresholds are controlled by the same modulation control circuits used to control the steady state characteristics; thus there is a tracking action between the transient and steady state behavior.

In the low frequency circuits special overshoot suppressors are used for relatively slowly changing low frequency signals; these are very gentle, slow acting circuits which reduce low frequency transient distortion.

Operating Characteristics

Quiescent (sub-threshold) noise reduction effect:

The spectral recording process has been designed in a way that takes advantage of the characteristics of hearing and of existing recording processes. There is less of a problem in the generation and perception of noises at moderately low frequencies (e.g. 200 Hz) than at moderately high frequencies (e.g. 3 kHz); therefore two low frequency stages are employed, but three high frequency stages are used. A noise reduction effect of about 16 dB is obtained at low frequencies; at high frequencies the effect is about 24 dB.

At very low and very high frequencies less noise reduction is needed (below 50 Hz and above 10 kHz). Strong spectral skewing actions can therefore be used in these regions, resulting in high and low frequency sliding band actions which are more accurate in the event that the tape recorder has response irregularities in these regions. Additionally, the spectral skewing networks provide for good immunity to high and low frequency interference (supersonic audio components, tape recorder bias; subsonic noise components, particularly room rumble from traffic and air conditioning).

The overall shape of the low-level noise reduction characteristic resembles the inverse of the low level Fletcher-Munson and Robinson-Dadson curves, as well as the consequently derived CCIR noise weighting curve.

The amount of noise reduction provided by the spectral recording process is enough to yield an overall usable dynamic range with 15 ips tape that comfortably equals or exceeds that of 16 bit PCM. For example, if signal gains are adjusted such that the audible noise levels of the two recording processes are similar, at high levels SR will typically have several dB of further soft clipping headroom available. At very low signal levels, with increased monitor gain, the audible signal quality of SR will be superior because of its inherently linear analogue transfer characteristic.

Dynamic action for steady-state dominant signals:

Low frequencies: dynamic action occurs in the range -48 dB to - 5 dB (with respect to reference level); i.e. there is no action in the lower 35 - 40 dB of the total dynamic range (starting from the system noise level) but full boosting or attenuation, or the top 25 dB of the total dynamic range (ending with the clipping level): there is a linear dynamic characteristic in these two regions.

High frequencies: dynamic action occurs in the range -62 dB to -5 dB (with respect to reference level); i.e. there is no action in the lower 20 - 25 dB of the total dynamic range (starting from the system noise level) but full boosting or attenuation, or the top 25 dB of the total dynamic range (ending with the clipping level): there is a linear dynamic characteristic in these two regions.

In the dynamic action ranges the effects of the multi-level stages are joined together to create a compression ratio of about 2:1.

Dynamic action for steady-state non-dominant signal components:

Non-dominant signals are boosted or attenuated over and above that of the dominant signal towards the two spectrum ends by high and low frequency sliding band actions. If there are two dominant signals, a fixed band compression or expansion effect prevails for the non-dominant signal components between the frequencies of the dominant signal components (therefore no mid-band modulation effect).

Thus, non-dominant signal components are boosted or attenuated by an amount at least equal to that of the dominant signal. The boosting or attenuation of the non-dominant signals is maintained towards the spectrum ends even though the level of the dominant signal is relatively high (e.g. in the range -10 dB to +20 dB, with respect to reference level). This boosting or attenuation action spectrally tracks the dominant signal frequency or frequencies.

To provide a steep boosting or attenuation effect away from the frequency of the dominant signal component, the SR circuit employs the steepness enhancing effect that arises from the use of cascaded stages. The low frequencies have two stages of steepness compounding. At high frequencies the use of three stages improves the effect even further.

The overall result is that the encoder circuit tends towards keeping all low level signal components boosted at all times. Only those components above the threshold are subject to a reduction of boosting. The advantages of this type of characteristic are:

a) A powerful noise reduction effect in the presence of signals, much more so than with any previous system. This property is responsible for the high purity of signals from the SR system.

b) Freedom from the mid-band modulation effect. The system is essentially immune to exaggerated frequency response errors due to frequency response problems in the recorder, including 30 ips head-bump signal-pumping effects.

The audible encoding effect of the system is to create a dense, bright sounding signal, but with little or no apparent dynamic action. Harmonics, overtones, and small scale components of the sound, including noise, are all enhanced.

The decoding effect of the system, in response to an encoded signal, is to provide a wholly restored signal with respect to frequency and phase response, including all transient effects. Regarding noises introduced into the encoded signal, the decoding property of the system is to create a very clean sounding replica of the input. The decoder reduces the tape bias noise and modulation noise, spectrally and temporally, in a way that previous systems have not been able to do. Moreover, the low frequency noise reduction effect of the system is quite useful in dealing with high frequency intermodulation components. For example, if two or more simultaneous high frequency tones are applied, at a level high enough to create audible intermodulation distortion, the system will significantly reduce the lower frequency distortion components produced.

The decoder is also useful in reducing harmonic distortion produced by the recording medium. Steady-state third harmonic distortion is typically reduced to less than one-half; fifth harmonic distortion is reduced to less than one-quarter. Higher order harmonics are even further reduced. Thus, especially if the medium has a hard clipping characteristic, the audible cleanliness of the signal at high recording levels is significantly improved.

Antisaturation aspects:

The antisaturation effects of SR are maintained down to fairly low levels (about 15 dB below reference level). The result is to produce recordings that are notably freer of intermodulation distortion than would otherwise be the case. This is particularly true in live recording situations, in which significant supersonic signal components may exist.

At low frequencies the LF antisaturation characteristic counteracts tape overload in NAB recordings. With the CCIR recording characteristic, low frequency antisaturation reduces low frequency distortion and intermodulation of high frequency signal components when present with high level low frequency components.

In optical recording the LF antisaturation characteristic has a double significance. First, low frequency signal components are reduced in amplitude on the recording, thereby permitting higher signal levels at higher frequencies (in optical recording, the spaces used on the sound track add directly, in contrast with magnetic recording, which, to some extent, allows the high frequencies to be superimposed on the low frequency components). Second, the antisaturation characteristic carries on strongly down to very low frequencies (40 Hz, 20 Hz). This allows the recording and reproduction of low frequency special effects with ease (10 dB of antisaturation at 25 Hz).

The existence of the new system will no doubt prompt a re-evaluation of recording and transmission formats which have been thought to be inadequate or marginal for professional use. In radio broadcasting, for example, the new system might result in greater use of 7 1/5 ips and various cassette and cartridge formats. Conventional landlines will also be worthy of investigation; the new system is substantially more effective than previous ones in dealing with landline types of noises (whistles, hums, buzzes, crosstalk).

Calibration Arrangements

The spectral recording calibration procedures and circuits are conceptually similar to those of the A-type noise reduction system. That is, signal levels in the decoder circuit ideally should match those in the encoder circuit (however, the SR system is more tolerant of gain and frequency response errors than A-type). For tape interchange standardization it is also preferable if, at least within a given organization, the "Dolby Level" of the encoder and decoder corresponds to a known and fixed flux level. Whether or not a standardized flux is used for Dolby Level, the matching of the decoder to the encoder is accomplished by a calibration signal generated in the encoder and recorded on the tape; this allows the tape replay gain to be set correctly, using the meter in the decoder unit.

Most problems in the studio use of A-type noise reduction, and indeed analogue recording in general, can be traced to incorrect level settings and/or frequency response errors in the recorder. This may be because checking these factors is a time consuming and boring process. A faster and more interesting method of accomplishing these checks would be more likely to produce reliable and consistent results.

Commercial embodiments of the SR process include a pink noise generator which is used for both level and frequency response calibration, instead of a single-tone sine wave oscillator. For identification, the pink noise is interrupted with 20 ms "nicks" every 2 seconds; the resulting signal is called "Dolby Noise". During recording this signal is fed to the tape at a level of 15 dB below reference level (Dolby Level), a level low enough not to cause saturation problems with low speed tape recording or highly equalized transmission channels.

During playback the tape signal is automatically alternated with internally generated reference pink noise (uninterrupted) in 4 second segments (8 second total cycle time) and passed to the monitor output. An audible comparison can thus be made between the reference pink noise and the Dolby Noise coming from the tape. This mode of operation is called "Auto Compare". Any discrepancies in

level and/or spectral balance are immediately noticeable and can be corrected or at least taken note of. If desired, the signal can also be fed to a real time analyzer. The 20 ms nicks in the signal do not affect the analyzer display because of the peak hold circuits employed in the analyzer.

In using the new calibration method it is important to be able to tell when the 4 second tape segments are being passed to the monitor and when the signal heard is from the reference pink noise generator. Differentiation of the tape segements from the reference segments is accomplished in two ways. First, the reference segments are 4 seconds of continuous pink noise, and the tape segments begin with a nick, have a nick in the middle, and end with a nick; this time sequence is easily identified with a little practice. Second, lights on the SR module identify the signals. A green light marks the tape signal, a red light the reference signal. An output is available for actuating externally mounted lights, such as near the loudspeakers.

A further yellow light on the module shows that the module is in the Dolby Noise mode, which is actuated by pressing the "Dolby Tone" button on the frame.

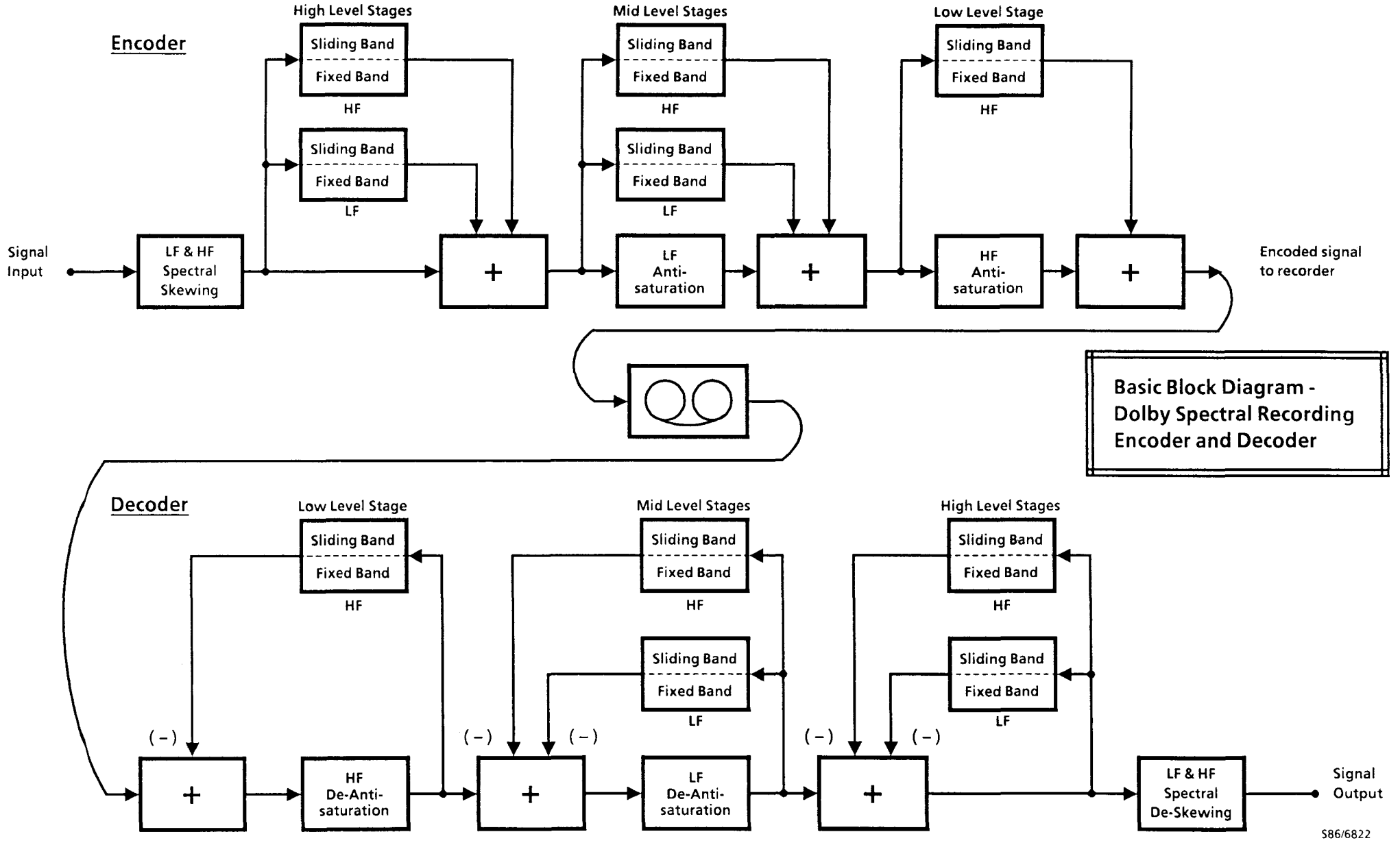
During calibration the meter circuit in the frame is fed by a band limited (200Hz - 4 kHz) Auto Compare signal from the module. Band limiting reduces the effect on the meter reading of frequency response errors in the tape recorder and also improves the stability of the reading (less bouncing).

The calibration facility built into the new system will give the recording engineer and producer a control and monitoring of the recording process that was previously unavailable. At any time an Auto Compare check of the recorder. can be made. The result can be heard immediately and conclusions drawn about whether any recorder adjustments might be necessary.

With tape and signal interchanges it will be possible to tell quickly whether there is any error or misunderstanding about levels, equalization, azimuth and the like. If the original recording of Dolby Noise stays with the tape, the quality of the ultimate playback, even after copying, will be retained. Thus the Auto Compare function serves to ensure that the recorder and spectral recording process will provide on a routine basis the high signal quality and reliability of which they are capable.

Conclusion

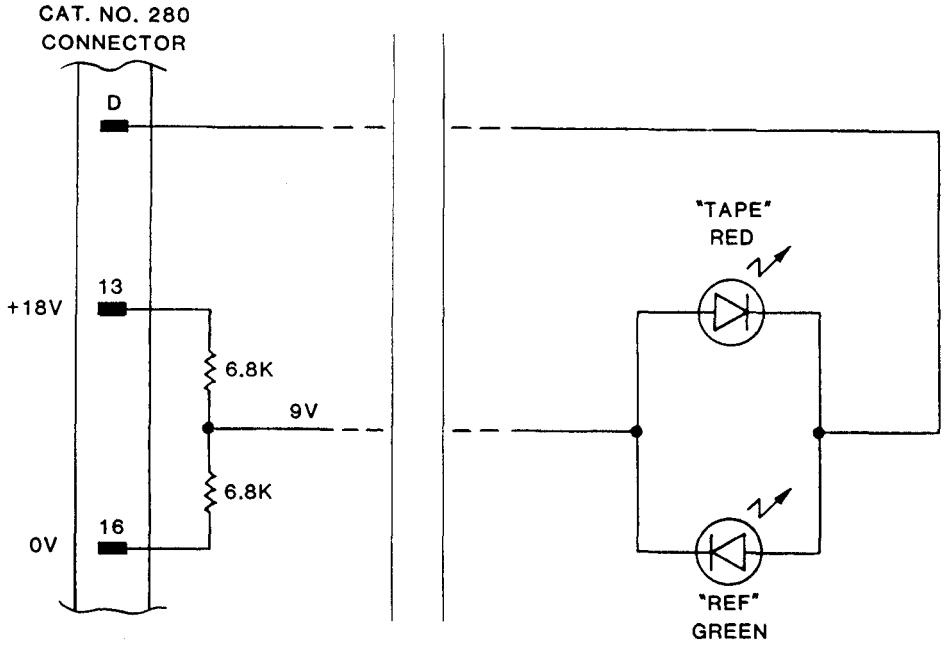
Brief details of the new spectral recording process have been given. A full technical account of the system will be presented at the forthcoming Fall 1986 AES Convention in Los Angeles.


Encoder
High Level Stages
Mid Level Stages
Low Level Stage
Sliding Band
Fixed Band
HF
LF
Signal Input
LF & HF Spectral Skewing
+
LF Anti-saturation
HF Anti-saturation
Encoded signal to recorder
Basic Block Diagram - Dolby Spectral Recording Encoder and Decoder
Decoder
Low Level Stage
Mid Level Stages
High Level Stages
(-)
HF De-Anti-saturation
LF De-Anti-saturation
LF & HF Spectral De-Skewing
Signal Output
S86/6822

APPENDIX B
OPTIONAL CAT. NO. 280 CONNECTIONS

Pin D--Remote Auto Compare Status Display

Pin D can be used to remotely display the Auto Compare status. Pin D will be at about +18 volts in the "REF" mode, 0 volts in the "TAPE" mode, and at +9 volts in the OFF (Auto Compare inactive) mode. A maximum of 3 ma. current can be passed into or out of pin D. The user can install a remote status display, conveniently located near the loudspeakers, by using Pin D to control LEDs as shown. Higher current remote lamps could be controlled by using external relays and additional circuitry.



Pin A--Pink Noise for external use.

The reference pink noise is available on Pin A. The pink noise is referenced to +9 volts DC; therefore, an external coupling capacitor will be necessary.

Pin C--External Auto Compare Synchronization

In the record mode, the Dolby Noise mark ("nick") generator on the Cat. No. 280 module normally free runs. In stereo and multi-track recording situations, it is convenient if the Dolby SR modules switch between the reference pink noise and Dolby Noise simultaneously. This can be accomplished by linking pin C on the Cat. No. 280 modules.

In the Model 360 Series, the two-wire phone connector normally used to link Dolby Tone between units can be substituted with a three-wire stereo phone connector that will serve to link both Dolby Noise control (or Dolby Tone, if a Cat. No. 22 is installed) and Auto Compare synchronization information between units.For standardization between interface frames, the tip should be used for linking Dolby Noise (or Dolby Tone with Cat. No. 22 modules installed) and the ring used for Auto Compare synchronization.