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Dolby cinema equipment

364 Cinema Noise Reduction Unit and E2 Cinema Equalizer

Optical sound tracks to meet the standards of today's audiences

A major advance in cinema sound

There have been many improvements in the optical technology of motion pictures in recent years. New anamorphic lenses, new projection formats, and improved colour films have contributed greatly to the visual impact of today's screen presentations. No other medium of entertainment or communication is as clear, as informative, or as pleasurable to see. Only the film sound track has lagged behind, during a time in which high quality sound recording has grown to an enormous industry in its own right.

Now, the optical sound track can become an appropriate match in realism and entertainment value to the screen image of the new cinema. The Dolby system transforms the optical sound track into a medium of excellent fidelity. Film audiences can therefore enjoy sound reproduction quality which is fully professional, by use of the same system that has played an important part in setting contemporary standards in the music recording industry.

Forty years of obsolescence

The significance of the introduction of the Dolby system to the cinema can be appreciated by considering briefly the history of the optical sound track.

Early methods of recording and playing such tracks resulted in a high level of background noise and distortion. The noise became even worse as a film was repeatedly shown; dust, abrasion and scratches added their noise to that of the grain already present in a new print. Only the limited fidelity of early theatre sound equipment concealed these defects from audiences, but few listeners would have noticed the problems. Electrical sound reproduction was new, and its embodiment in motion pictures was an outstanding technical achievement, bringing to many millions of filmgoers sound quality better than they had ever before heard.

The 'Academy' characteristic

As sound reproduction technology improved generally, so did the sound equipment used in film theatres. The main effect of this was to enable audiences to hear the comparatively poor sound track on films more clearly. Moreover, studios had adopted a variety of practices during sound recording and post-production aimed at compensating for the characteristics of early sound tracks and loudspeaker systems. Playing of these tracks through high-quality

sound systems of the type which were being developed resulted in a harsh, unnatural sound. On the other hand, if the compensating practices were dropped, dialogue would become unintelligible in the many older theatres with older sound systems. The industry's solution was to sacrifice the high-frequency response which scientists had worked for years to make possible. The Standard Electrical Reproducing Characteristic of the Academy of Motion Picture Arts and Sciences, which was agreed upon in 1938, prescribes a severe reduction in high frequency output to be incorporated in cinema sound systems (see Figure 2). In 1948, additional curves were published showing the cut in high frequencies to be applied to various loudspeaker systems developed since the introduction of film sound, so that if these loudspeakers were installed in a theatre their higher quality would not disclose the limitations of the optical sound tracks then being produced.

It is a remarkable fact that now, more than forty years after the introduction of sound to motion pictures, the same 'Academy' curves are used to fix the quality of theatre sound systems—in an age when millions of film viewers have excellent high-fidelity sound equipment in their own homes.

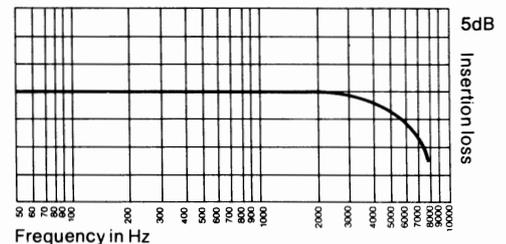
The Dolby system breaks the vicious circle

The Dolby system resolves the dilemma of optical sound track recording by suppressing noise while extending fidelity. The Dolby system has already transformed professional music recording—more than 20,000 channels in studios are Dolby equipped.

The Dolby system makes wide-range, high-fidelity optical sound tracks possible for the first time, in a practical sense, because it is able to reduce background noise effectively without reducing high-frequency response. Filters can be removed from the theatre sound system, and the limited response of the Academy characteristic exchanged for the sound which today's audiences are accustomed to hearing from records and FM broadcasts. An important advantage of the use of the Dolby system is that the resulting release prints are fully compatible, and can be shown in any theatre, whether or not equipped with Dolby equipment. Properly played with this equipment, the same tracks can have a quality comparable to, and often even better than that of typical magnetic stripe sound tracks—until now the highest quality obtainable from motion picture film. Voices, music and sound



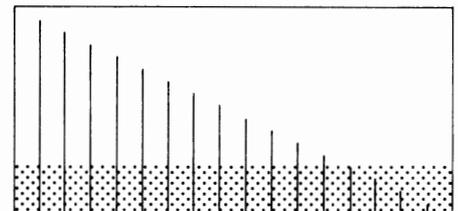
1. A section of optical sound track magnified about 250 times. The granular structure of the track is clearly visible.



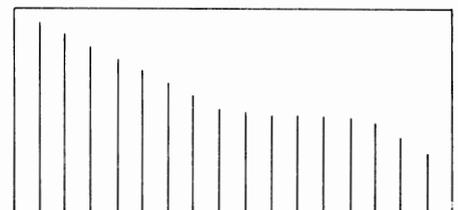
2. A typical 'Academy' curve. Although rather drastic in its effect, this curve applies only to the section of the system which precedes the loudspeaker. Because the loudspeaker often removes much of the remaining high frequency content, the actual result is far more severe than the curve indicates.



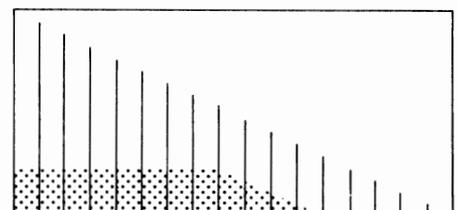
A. Any recording medium has background noise



B. Noise is only a problem when the sound is quiet.



C. Before recording, the Dolby system raises the levels of the quietest sound



D. When the recording is played, the system restores the correct levels, reducing the noise in these places at the same time

3. The diagrams show, in simplified form, the principle of operation of the Dolby system. The audible spectrum is divided into four frequency bands, and the noise reduction technique shown above is applied independently in each band. As a result, signals in one band do not affect operation of the system in the other three bands.

effects have new realism and dramatic impact. The full capability of modern optical recording and theatre projection equipment can be exploited for the first time.

The Dolby system in film production

To make a Dolby system recording, the program is passed through a Dolby noise reduction unit just before it is fed to the recorder. Later, when the recording is played back through another Dolby unit, all low-level noise introduced between recording and playback—such as that produced by the recording medium itself—will be suppressed by at least 10 dB (see Figure 3).

In the production of a film, the music, effects and dialogue recordings pass through various stages of transfer and mixing. Noise is inevitably added each time a recording is copied. If the Dolby system is used at each stage, the noise introduced by the tape, magnetic film, and electronic equipment used in pre-mixing, mixing and post-sync recording is suppressed. The resulting film sounds cleaner and quieter not only in the studio, but in the theatre when it is shown, even if the Dolby system is not used for the release print. Many film sound tracks have already been made in this way, using the Dolby equipment which film studios already own.

The most important step, however, is taken by transfer of a Dolby-encoded magnetic master directly to optical so that it can be played with a Dolby unit in the projection room. Because such prints are compatible, they can be shown in theatres equipped with Academy sound systems without difficulty; although there will

naturally be no general improvement in quality, the distortion heard will be less than usual.

The Dolby system in the cinema

Dolby 364 Cinema Noise Reduction Unit and E2 equalizer form the Dolby theatre package. Used together, the two units permit cinemas to reproduce Dolby-encoded optical sound tracks with the high accuracy required to meet modern sound reproduction standards.

As soon as they are installed, the 364/E2 combination offers immediate and important improvements in film sound. There is no longer a need for external filters, as the Model 364 contains accurate electrical reproducing characteristics for all optical and magnetic sound tracks, selected instantly by push-buttons.

The E2 provides four independent types of adjustment: (1) gain adjustment to match projector output to the 364, and to match input requirements of the theatre power amplifier (2) high-frequency adjustment to correct sound head aperture loss (3) separate high-frequency and low-frequency adjustments for the overall theatre sound system (4) twenty-seven independently adjustable level controls for narrow-band filters at ISO centre frequencies, 40 Hz to 16 kHz. Adjustments (1) and (2) operate on the "A" portion of the cinema sound reproduction chain, and affect only the reproduction of film sound tracks; (3) and (4) correct for both electrical and acoustical characteristics of the 'B' part of the chain, ie, the overall sound system in the theatre, and therefore improve the reproduction of non-sync signals as well as film sound. Proper adjustment of the E2

requires the availability of equipment to measure the performance of the sound system from the seating area of the theatre, and a trained person to make the measurements. Dolby Laboratories can advise on local availability of this service.

Restoring accurate frequency response to the cinema

When optical sound tracks are made and reproduced with the Dolby noise reduction system, the disturbing effects of background noise are suppressed, and the full capability of optical sound recording can be used. Audiences gain maximum benefit from the process when the frequency range available from the sound system in the cinema is as extended and as uniform as possible. Fortunately, the sound in most cinemas can be greatly improved in this respect without replacement of existing equipment, or with only minor additions to the loudspeaker complement, through use of the Dolby E2 Cinema equalizer. Used in conjunction with the Dolby 364 noise reduction unit, the E2 can offer audiences fidelity comparable to professional tape recordings and FM broadcasts, from simple, economical, optical sound tracks. Used with films which are not Dolby-encoded, or which are old or worn, the Dolby 364 provides exact 'Academy' response with optional dynamic noise reduction, by push-button selection.

Dolby system release prints are compatible, and can be shown without difficulty in theatres equipped only with standard Academy characteristic sound systems; although there will then be no noise reduction, distortion will be lower than is usual.



In operation, either the optical or magnetic push-button on the 364 is depressed, and then one of the following three:

Button	Use	Characteristics
Dolby film	For use only with release prints which have been made with the Dolby System.	Dolby A-Type noise reduction (10 dB up to 5 kHz, 15 dB at 15 kHz); no filter in circuit.
New print Non-Dolby	For all other prints except those which are noisy or worn.	No noise reduction, but standard 'Academy' filter in circuit.
Clean-up	For old films or noisy prints.	6 dB clean-up noise reduction, plus standard 'Academy' filter in circuit.

In the event of equipment failure or if faulty operation is suspected the system can be bypassed by pressing the 'service' button on the E2. This bypasses both the E2 and the 364.

364 Specifications

Operating controls

Illuminated push button controls located on front panel (see figure).

Panel meter

Dolby films and magnetic tracks have recorded on them a length of characteristic Dolby tone signal. Proper calibration of a unit is achieved when the tone indicates Dolby Level on the front panel meter. To assist in setting levels at other points subsequent to the unit a Dolby tone oscillator is built in.

Signal connections

Standard screw-type terminal blocks; solder tag fanning strip supplied.

Input circuit

Unbalanced input, 10k ohms impedance. Level adjusted by multi-turn potentiometer accessible from front of unit. Minimum input 350mV for Dolby Level.

Output circuit

Unbalanced output at low impedance. Level adjusted by multi-turn potentiometer accessible from front of unit. Maximum output level +16dB into 150 ohms, +14dB into 50 ohms. Rear panel attenuator switch to match unit into systems with low level projector outputs.

Balanced signal option

Input and output signal transformers available only on special order. Write for prices, delivery and further information.

Overall total harmonic distortion

At +8 dBm, less than 0.1% at 1 kHz; less than 0.2% from 40 Hz to 20 kHz.

Noise reduction

Dolby A-Type professional characteristics, providing 10 dB of noise reduction from 30 Hz to 5 kHz rising to 15 dB at 15 kHz in 'Dolby film' position; 6 dB rising to 10 dB in 'clean up' position. On 'new print' setting, unit becomes unity gain line amplifier with Academy filter characteristics.

Overall noise level

Playback, 80 dB (unweighted, 30 Hz to 20 kHz bandwidth) below Dolby Level.

Stability

System is highly stable—does not require routine alignment.

Operating temperature

Up to 45°C.

Construction

Plug-in Noise Reduction Module accessible through front panel. Glass fibre circuit boards, solid state devices throughout.

Finish

Steel case, grey stoved plastic textured finish; front panel clear anodized with black characters.

Size

44 x 483 mm rack mounting (1 $\frac{3}{4}$ in x 19in). Maximum projection behind mounting surface—228mm (8 $\frac{15}{16}$ in). Maximum projection in front of mounting surface—22mm ($\frac{7}{8}$ in).

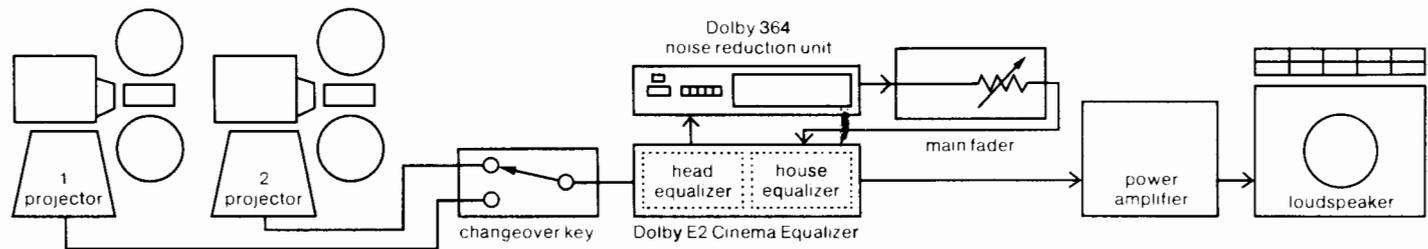
Weight

5 kgs (11 lbs).

Power requirements

Unit is designed for operation from centrally switched power source. Power cable provided. 100–130 V and 200–260 V, 50–60 Hz single phase, 14 VA.

Block diagram to show location of 364/E2 combination in cinema sound system



E2 Specifications

Head equalizer (for A chain)

For insertion between projector and Model 364 noise reduction unit. Input sensitivity, 5mV or 50 mV switched.

Input impedance, 20k ohms.
Output level, 350 mV for 50% film modulation.
Output impedance, 100 ohms.
Controls: gain, hf (high frequency aperture loss correction up to 12 dB at 8 kHz).

House equalizer (for B chain)

Input sensitivity, 5 mV or 50 mV switched.
Input impedance, 20k ohms.
Output level, adjustable up to 1.55V (± 6 dB) for 50% modulation.
Output clipping point, 9 V r.m.s. (± 21 dB) at nominal power line voltage.
Output impedance, 200 ohms.
Controls: bass ± 10 dB at 63 Hz, treble ± 11 dB at 8 kHz, input gain, output gain, one-third octave controls giving ± 8 dB at 27 ISO centre frequencies (40 Hz–16 kHz).

Front panel layout

Service switch removes equalizer and associated Model 364 from circuit. Meter for level setting.

Electronic module

Two-part plug-in module; one section for all electronics, other containing potentiometers which allow pre-set and repeatable equalizing even when electronics board is removed for servicing or for replacement by a new board.

Connectors

Standard screw-type terminal blocks at rear.

Harmonic distortion

Less than 0.1% at Dolby Level.

Signal to noise ratio

Better than 65 dB relative to 0 dBm output for Dolby Level.

Finish

Steel case, grey stoved plastic textured finish, front panel clear anodized with black characters.

Size

44 x 483 mm rack mounting (1 $\frac{3}{4}$ in x 19in).
Maximum projection behind mounting surface—228 mm (8 $\frac{15}{16}$ in).
Maximum projection in front of mounting surface—22 mm ($\frac{7}{8}$ in).

Weight

4.5 kg (10 lbs).

Power requirements

80–130V and 160–260V, 10VA.
50–60 Hz single phase.

Typical house curves, as shown on screen of a real-time analyzer, illustrating the degree of control over theatre sound which the E2 permits. Response before installation of the E2 is shown at top; centre curve demonstrates that equalizer range allows essentially flat response to be achieved. The desired curve, which rolls off smoothly at 3 dB/octave at high frequencies, is shown at bottom. Response can be made as uniform as is necessary, and is mainly limited by the power-handling abilities of the speakers used.

