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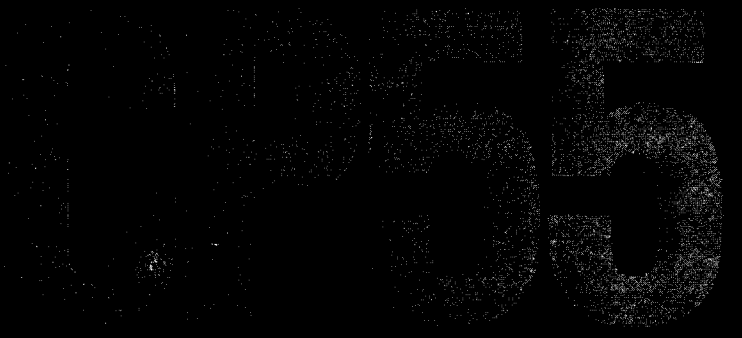
OPERATOR'S GUIDE

DOLBY STEREO®



Cinema Sound Processor

TABLE OF CONTENTS

Thank you for purchasing the Dolby Model CP55 Cinema Processor. It combines the high performance for which all processors manufactured by Dolby Laboratories are well known with new features, flexibility, and ease of interface and operation with theatre automation systems.

About This Manual

This Operator's Manual has been prepared specifically to help projectionists and theatre managers get the most from the Model CP55 and the theatre sound system after proper installation has been accomplished (installation and alignment instructions are provided in a separate manual). We suggest that you keep this manual readily available and that you also attach the supplied "Operating Instructions for the Projectionist" card to the projection booth wall for quick reference.

The manual is organized as follows:

- Section 1, **Operating Instructions**, covers the basic control functions and operation of the CP55, and is all you need to get the show started.
- Section 2, **Maintenance and Adjustments**, contains tips for maintaining not only the CP55 but rest of the theatre sound system as well.
- Section 3, **Trouble Shooting**, will help you track down problems in the sound system without test equipment. It consists of a trouble-shooting chart and procedures to follow during a show, between shows, and after closing.
- The **Appendices** contain valuable background information which will help you to get the most out of the Model CP55 and your theatre sound system.
- The **Index** guides you to the appropriate page of the manual when you have specific questions.

For the sake of clarity, boldface type is used for all specific references to the CP55 controls and their labels, such as **bypass**, **mute**, and front-panel **fader**. In addition, indicator lights on the CP55 are referred to in the text as LEDs (light-emitting diodes).

About The Dolby CP55

The Dolby Model CP55 is the heart of your theatre sound system, as shown in the block diagram. All sound sources are connected to the CP55 which processes their signals appropriately and feeds them to the power amplifiers.

The CP55 precisely complements the techniques used in the preparation of Dolby Stereo optical releases. By providing a stereo optical preamp with precise slit-loss correction, professional Dolby A-type noise reduction, an advanced 2:4-channel decoder, and third-octave screen speaker equalization, the CP55 ensures the most exact reproduction possible of all Dolby Stereo releases. It has also been designed for particularly convenient interface with theatre automation systems.

Among the features of the CP55 are a built-in fader with remote and mute facilities; simple push-button sound-track format selection; third-octave equalization for the playback of all sound sources, including non-sync; comprehensive fail-safe features that include a built-in standby power supply; optional surround speaker equalization; and optional optical bass extension for use with subwoofers.

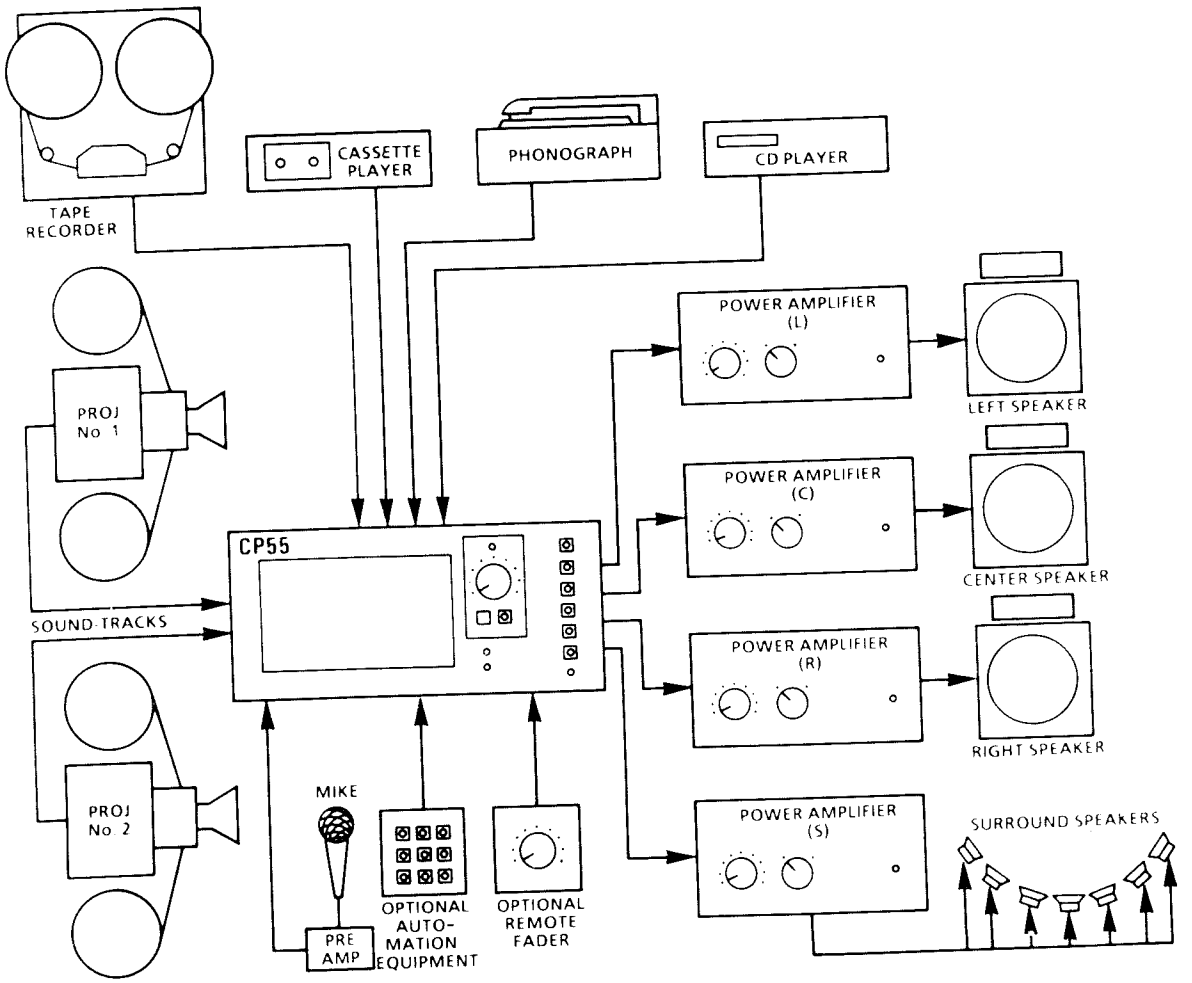


Figure 1. Block Diagram, Theatre System Incorporating a CP55.

A. NORMAL OPERATION

1. Initial Power-Up

Each time the CP55 is connected to power, it automatically sets itself as follows (what is called the wake-up state), regardless of the format and control settings last used:

- Format **04, Dolby stereo with surround**
- **Mute** off
- **Local** (front-panel) **fader** activated
- **Proj 1** or **Proj 2** LED illuminated, indicating the externally-selected projector that is active (Proj 1 is selected automatically if no external selection has been made).

NOTE

The above conditions are the wake-up state as shipped from the factory. Some changes can be programmed by the installation or service engineer.

The CP55 also reverts to this condition when it is restored to **normal** operation after having been operated in the **bypass** mode.

2. Format Selection

Select the desired film sound-track format or your non-sync source by pressing the appropriate button. The LED in the button illuminates to confirm that the format was selected. The formats are as follows:

01 mono optical: for all prints of any vintage with conventional mono optical ("Academy") sound-tracks.

03 Dolby stereo optical no surround: for the few early Dolby Stereo optical releases recorded without surround information (virtually all later and current Dolby Stereo releases are recorded with surround).

04 Dolby stereo optical with surround: for the vast majority of Dolby Stereo releases, including all current releases.

22 magnetic: if your theatre is so equipped, for 4-track magnetic prints with conventional (not Dolby encoded) sound-tracks.

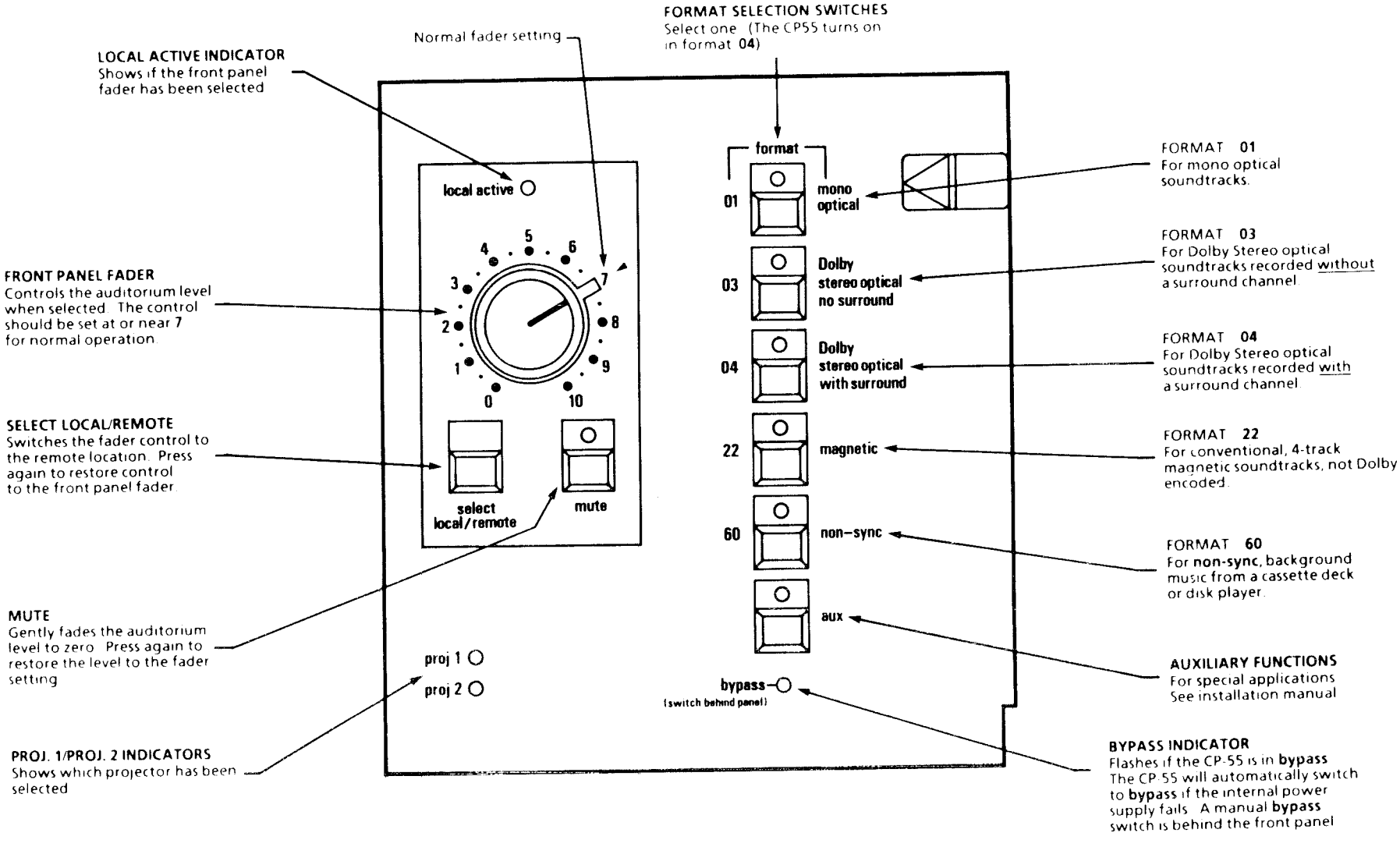


Figure 2. CP55, Front Panel

60 non-sync: for your intermission music tape or disc player with preamp.

Aux: for an extra sound source or format, such as a PA microphone and its preamp or a "stereo" synthesizer. (Genuine stereo sound in the theatre can be realized only from stereo optical or multi-track magnetic prints.)

The film sound-track format numbers on the CP55 (and also the model CP200) often appear on the film can and leader. If these numbers are not supplied and you are not sure if a print is mono or stereo optical, see Appendix A for a means to distinguish mono from stereo optical sound-tracks.

If you are playing an early Dolby Stereo release and do not know if it was recorded with surround information, we suggest you first determine if format **04 Dolby stereo optical with surround** gives good results. However, if too much of the dialogue "spills" into the surround speakers, use format **03 Dolby stereo optical no surround** for best results.

3. Local (Front-Panel) Fader

The local **fader** on the front panel of the CP55 controls the volume level in the theatre in both the **normal** and **bypass** operating modes. When the CP55 has been correctly installed, setting the **fader** to **7** provides the proper level in your theatre for any Dolby Stereo release (that is, the level at which the film was mixed).

A detent on the silver-colored outer ring around the **fader** knob enables you to turn the **fader** knob to a preset level (such as the standard setting of 7) by feel. The ring can be rotated to align the detent with the desired **fader** setting.

Although a minor adjustment in playback level might be required under unusual circumstances, you should avoid significant deviations from the correct level (**7**) established by the installer. If the playback level is set too low, dialogue will be hard to understand; too high a level risks damage to the speaker systems and complaints from the audience.

4. Remote Faders

If remote faders have been installed, they are activated by pressing the **select local/remote** button located directly below the **fader** (the button will have no effect if there are no remote faders). The **local active** LED will go out to indicate that the remote faders have been activated. If Dolby Cat. Nos. 122 and 123 remote faders have been installed, the remote fader associated with the operating projector will be activated automatically when the **remote** mode is selected.

To re-activate the **local** fader, press the **select local/remote** button again. The remote faders will be de-activated, and the **local active** LED will light to indicate that the front panel **fader** is now active.

5. Mute Function

When you press the **mute** button, the volume will automatically fade all the way down and the LED on the button will flash. When you press the button again, the volume will automatically rise to the level set by the **fader** and the LED will go out.

If the **mute** function has been activated, it is automatically cancelled when you select a film format. This feature is particularly useful when a show is started, for which we recommend the following procedure:

- Fade out the intermission music by pressing the **mute** button.
- If necessary, re-adjust the CP55 **fader** or a remote fader (if selected) to the correct playback level for the film.
- Start the projector.
- After the leader has passed through the gate, press the appropriate film format button on the CP55. The volume will automatically rise to the proper playback level, as though you had pressed the **mute** button once again.

If the CP55 is not conveniently close to the projector and there is a remote fader at the projector, use the following alternative:

- Fade out the intermission music by pressing the **mute** button.
- Select the **remote** fader mode on the CP55, and be sure the remote fader is all the way down.
- Select the film format (which automatically cancels the **mute** function).
- Start the projector.
- After the leader has passed through the gate, manually turn up the volume with the remote fader to the correct playback level.

Follow either of the above procedures to prevent the audience from hearing annoying thumps and leader crackle at the beginning of the show.

B. OPERATION WITH AUTOMATION SYSTEMS

If the CP55 in your theatre is connected to automation equipment, the format buttons and their associated LEDs may be duplicated elsewhere. The front panel controls of the CP55 can be used to override commands from the automation system. As automation equipment differs from installation to installation, check with the installer of your system if you have any questions about its operation.

C. BYPASS OPERATION

The CP55 has an independent power supply for emergency operation if the processor fails. Should the main power supply fail, the unit will automatically switch to bypass operation, allowing the show to continue with limited sound-processing functions. Bypass operation is signalled by the flashing of the bypass LED on the front panel.

In the case of other problems, such as distortion or the loss of a channel, the bypass mode may be selected manually by means of a switch located behind the front panel. However, should a problem arise, do not automatically assume that the CP55 is at fault because there are other components in the theatre sound system that could also fail. Be sure to refer to Section 3, **Trouble Shooting**, any time there is a problem.

The following occurs when the CP55 is in the **bypass** mode:

- The front-panel **fader** remains operational but remote faders will not work.

- You cannot select among formats. The optical preamp outputs and the inputs from a four-channel magnetic preamp remain operational simultaneously. If you are playing a magnetic print, be sure that the projector exciter lamps are turned off. If you are playing an optical print, be sure that there is no signal present from the magnetic preamp.

- Even when a stereo print is playing, a **mono** signal is fed to the screen speakers. Thus you can switch to the **bypass** mode to keep the show going if one of the power amplifiers fails.

- The Dolby noise reduction circuitry, 2:4-channel decoder, screen speaker equalizers, optional surround equalizer, and optional optical bass extension are not powered and thus do not operate.

Be sure to follow the trouble-shooting procedures and call your trained service engineer , if necessary, as soon as possible if **bypass** operation is required to keep the sound system going.

NOTE

*The CP55 may not operate even in the **bypass** mode if there is a fault in either the Cat. No. 240 optical preamp card or the bypass circuitry section of the Cat. No. 249 power supply card. It is strongly recommended that a spare of both of these cards be kept on hand for substitution in emergencies. "Parking" slots for these spares are provided in the CP55 (see Appendix C).*

The installation of the Dolby CP55 in your theatre indicates a commitment to providing a high-quality presentation to your audiences. However, the presence of even the very best equipment does not in itself guarantee the best results. A number of routine maintenance and adjustment procedures -- requiring no special test equipment or technical knowledge -- are necessary to realize the full potential of the sound system on a day-in, day-out basis. These procedures can also prevent costly show cancellations and service calls.

A Dolby Cat. No. 69 test film is required for proper maintenance of your sound system. We also recommend that you keep on hand the Dolby Cat. No. 251 Jiffy Test Film and run it regularly to check the theatre sound system thoroughly (see Appendix B).

A. SOUNDHEAD MAINTENANCE

No single maintenance procedure is more vital to good sound in the theatre than regular cleaning of the projector soundhead optics. Use cotton swabs and isopropyl alchohol to clean the optical barrel lens surfaces, but do not clean the solar cell. The solar cell and its adjustment are very delicate; avoid touching the cell. We strongly recommend that you use compressed air, readily available in convenient pressure cans, to blow dirt and debris away from the cell. Be sure that the nozzle does not touch the cell.

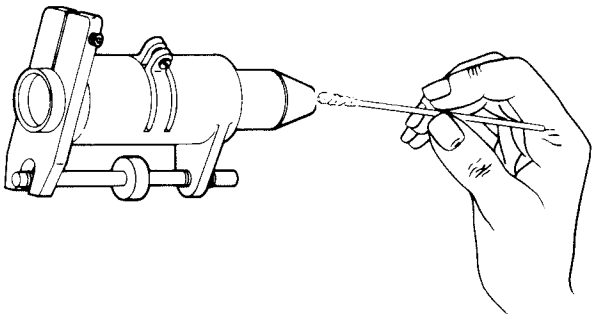


Figure 3. Cleaning the Soundhead Optics

B. PRINT CLEANLINESS

A high fidelity Dolby Stereo theatre system is like a high-quality home stereo system: it can sound only as good as the program material played through it. Just as a good home stereo clearly reproduces the annoying pops and clicks on poorly-maintained phonograph records, so a good theatre system reproduces pops, crackles, and other extraneous noise from worn and dirty prints.

If you receive a poor print from your distributor, there is little you can do except, if possible, arrange for its replacement. But while a print is in your theatre, you should treat it with respect and care to be sure your audiences receive the best in both sound and picture. Of greatest importance, the print should be kept as clean as possible -- when the film is played, when the print is stored between shows, and when a platter reel is made up (if your theatre is so equipped). In particular, when individual reels are unwound to make up a platter reel, do not let the film touch the floor or come in contact with other sources of dust and dirt.

C. DOLBY LEVEL ADJUSTMENT

Proper decoding of sound-tracks encoded with Dolby noise reduction requires careful level matching between each channel of each soundhead and the CP55 (see Appendix D for a discussion of Dolby noise reduction and why Dolby Level is important). When the CP55 is first installed, the installer makes this adjustment for you. However, it is always necessary to adjust Dolby Level whenever an exciter lamp is replaced. We also recommend that you routinely check Dolby Level and adjust it, only if required, to compensate for the normal aging of the exciter lamp.

Checking and adjusting Dolby Level requires a loop of Dolby Cat. No. 69 test film that is available from your theatre equipment supplier. You will also need the alignment tool supplied with the CP55 or a small screwdriver.

1. Select format **01 mono optical**.

2. Thread the loop of Dolby Cat. No. 69 test film on the projector to play the Dolby Level tone (with its characteristic warble); be sure that the emulsion side faces away from the screen.

3. Open the front panel of the CP55 and locate the Cat. No. 240 optical preamp and Cat. No. 222 noise reduction modules. (Dolby Level adjustments are made on the Cat. No. 240 while the LEDs on the Cat. No. 222 are observed as the test loop plays.)

4. As the test loop is played, watch the LEDs on the Cat. No. 222. Correct Dolby Level is indicated when the two center green LEDs for each channel are equally bright. If necessary, adjust the Left and/or Right **gain** controls on the Cat. No. 240 for the projector in use so that the pair of green LEDs is equally lit. Be very careful not to adjust the adjacent, recessed **hf** control by mistake; if this control is inadvertently changed, a service engineer with special test equipment is required to readjust it.

5. Repeat the above procedure for the other projector.

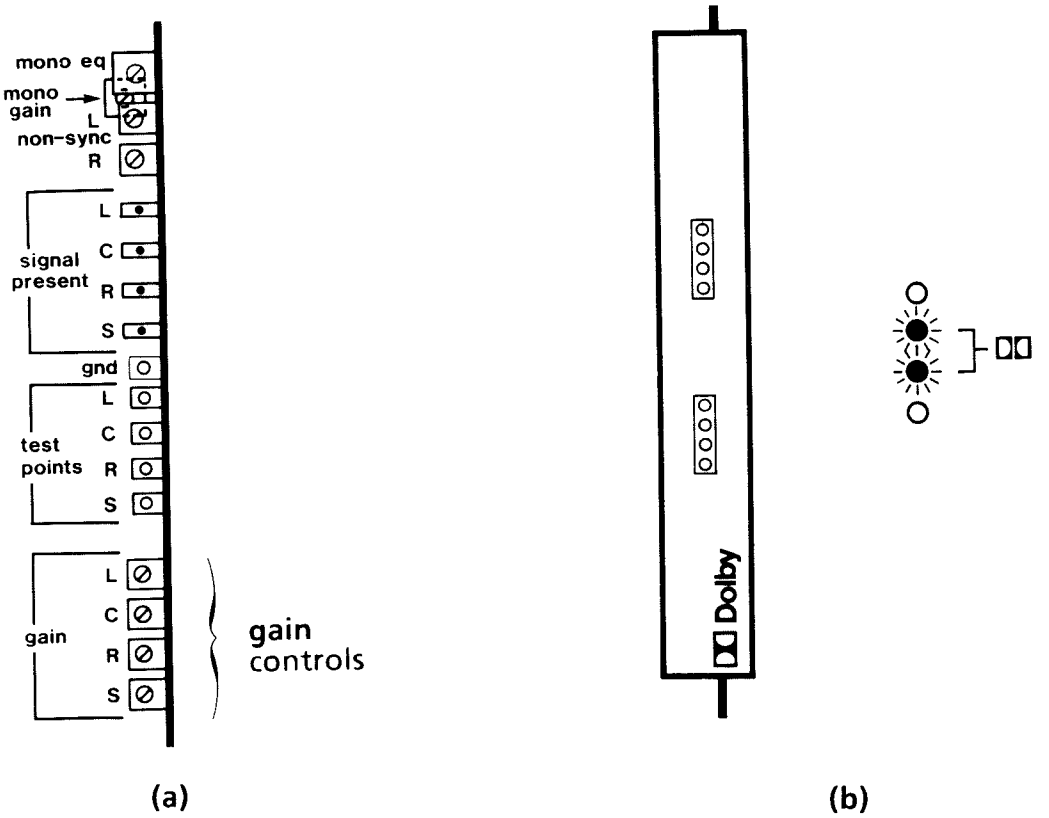
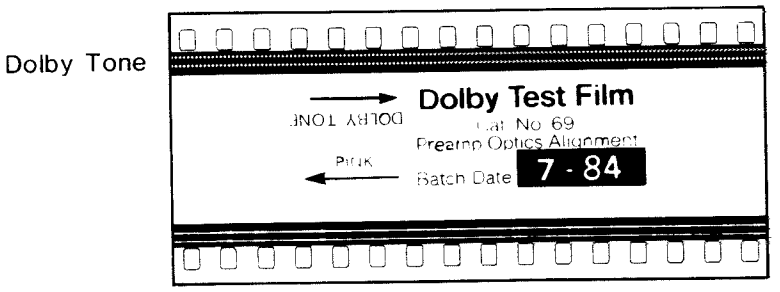


Figure 4. (a) Location of gain Controls on Cat. No. 242; (b) Dolby Level LEDs on Cat. No. 222.



Cat. No. 69

Figure 5. Identifying Dolby Tone on the Cat. No. 69 Film

NOTE

*If you happen to play the test film with a stereo optical format (**03** or **04**) selected after Dolby Level has been correctly adjusted, you may notice that the pairs of green LEDs are not equally lit or that one or both of the lower LEDs goes out completely. This is normal, and represents a very small (less than 0.5 dB) level difference when the Dolby noise reduction circuitry is switched on for the stereo formats.*

D. MONO ADJUSTMENTS

The sound-tracks on conventional mono optical releases, including current releases, are mixed differently than those on stereo releases. They are not encoded with Dolby noise reduction, and are recorded with a different high-frequency characteristic. The CP55 has **mono gain** and **mono eq** controls on the Cat. No. 242 circuit card to accomodate these differences.

These controls have been set by the installer and rarely require further adjustment. However, you may wish to adjust the **mono gain** control for a specific show if the difference in playback level between, say, a stereo release print and a mono trailer is substantial. Leave the front panel **fader** at its normal playback setting. Adjust the **mono gain** control while playing the mono trailer so that its dialogue plays at the same subjective level as the stereo print. Then you will not have to readjust the **fader** during the show.

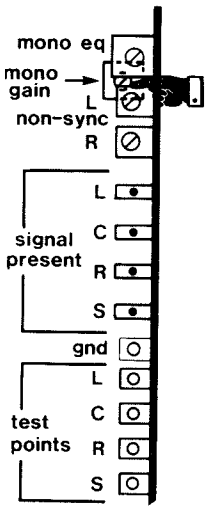


Figure 6. Location of mono gain Control on Cat. No. 242.

The **mono eq** control affects high frequencies, and should generally be left in its indicated center position. This setting provides the so-called "Academy" high-frequency playback standard, to which mono sound-tracks are usually recorded. Although a small adjustment might be appropriate to accomodate the occasional film with a different characteristic, do not turn up the **mono eq** control too high; exaggerated background noise and harsh, unsatisfactory overall sound will result.

WARNING

The CP55 was adjusted initially by a specially-trained engineer so that your theatre would have the same standard playback characteristics as the dubbing theatres in which all Dolby Stereo films are mixed. This results in the most accurate sound reproduction possible. Never attempt to adjust **any** controls within the CP55 except those specified above. All other controls are for use by a trained engineer when the CP55 is installed or repaired. Adjusting these controls requires the use of special test equipment. Misadjusting these controls can have an adverse effect on the sound in your theatre and will require a service call to restore proper operation. The first thing to do when you have a problem with the theatre sound is to consult Section 3, **Troubleshooting**, and not arbitrarily adjust the specialized controls.

In addition, do not adjust any controls on the other audio equipment in your theatre system, such as power amplifiers, which have been preset by the installer. For example, misadjusting the power amplifier gain controls can cause channel imbalance and/or too much amplifier noise. Those controls have been set by the installer for correct channel balance and so that the playback level is proper in the theatre with the **fader** set to 7. If a satisfactory level is achieved with the **fader** at a substantially lower setting, the gain controls on the power amps have been set too high and should be recalibrated by a service engineer.

Your theatre sound system consists of a number of critical audio components in addition to the Dolby CP55. Thus the first step when something goes wrong with the sound is to find the source of the problem. The block diagram of a CP55 system on page 16 can be helpful, as well as the trouble-shooting chart in this section, starting on page 20.

If the trouble-shooting chart is not sufficient for finding and solving the problem right away, the procedures in the following paragraphs should be helpful. Each paragraph is gauged to the time available for trouble shooting -- during a show, between shows, and after closing. In addition, Appendix C contains brief descriptions of each circuit module, which will further help you to track down any problems with the CP55.

If you are unable to solve the problem using the information which follows, call your local authorized service engineer. If he is unavailable, you may also call Dolby Laboratories' 24-hour emergency number in San Francisco for expert advice: (415)392-0308 (USA only). You will be asked to leave your name and number and a Dolby engineer will call you back promptly.

A. DURING THE SHOW

1. If All Sound Is Lost

- Immediately open the door of the CP55 and switch the CP55 to **bypass**. If sound comes back on, it will be mono but you can continue the show while you try to find the source of the trouble.

- If sound is not restored, check that power is connected to the CP55. If power was disconnected for some reason, switch the CP55 back to **normal**. Normal sound should be restored when power is restored.

- If you still have no sound, check that the exciter lamp is lit.

- Next, check all control settings. Be sure that the correct format and projector are selected, and that the CP55 is not in the **mute** mode (indicated by the flashing of the LED on the **mute** button).

- Check both the main and bypass fuses and replace if necessary (mute the CP55 and switch off the power amplifiers to prevent loud thumps out in the theatre as fuses are replaced).

- If these checks do not restore the sound, switch the CP55 to format **60 non-sync** and play your source of intermission music. If the system operates properly in this format, there is no problem with the equipment following the CP55 in the system (such as amplifiers and speakers) and the problem may well be in the projectors. Double-check both projectors and continue the show on a working projector if you find that one projector is at fault.

2. If One Channel Fails or is Distorted

Switch the CP55 to **bypass**; a mono signal is then fed to all three screen channels. If the distortion persists in one channel, the power amplifier or speaker for that channel is probably at fault and the amplifier for that channel should be switched off for the remainder of the show. If the left or right channel has failed, also switch off the power amp for the good channel so that only the center channel is in operation; this will provide the subjectively best mono sound.

If you are showing a mono film and the center channel fails or is distorted, switch the CP55 to **bypass** so that the mono signal is fed to the undistorted left and right channels. In this case, turn off the power amplifier for the center channel.

3. If Switching to bypass Does Not Restore Sound

- First, check the exciter lamps, the position of all faders and the mute button. Make certain that all components including power amps are receiving AC power.

- Turn the **fader** down:

  - Check the **bypass** LED on the CP55; it should be flashing, indicating that the CP55 switched to the **bypass** mode. If it is not flashing and you are sure that AC power is reaching the CP55, its bypass fuse may have blown. Open the front panel, and remove the bypass fuse on the Cat. No. 250 module by pushing in and turning the gray fuse cap. If the fuse is blown, replace it with the spare fuse stored in the adjacent fuse holder.

  - If the bypass fuse is good, and you have on hand, as recommended, a spare Cat. No. 240 optical preamp module, switch off the power amps and replace the Cat. No. 240 in the CP55 with the spare. Switch the power amps back on and check if sound is restored.

  - If replacing the Cat. No. 240 does not restore sound in the **bypass** mode, the bypass circuitry within the Cat. No. 249 circuit card may have failed. If you have a spare on hand as recommended, disconnect power from the CP55 and the power amplifers, and replace the Cat. No. 249 in the CP55 with the spare. Apply power to the CP55 and turn on the power amps to see if sound is restored.

4. Excessive or Inappropriate Sound from the Surround Speakers

As an emergency measure to continue the show, select format **03 Dolby stereo optical no surround** to switch off the surround channel. At your next opportunity, find out if the problem is related to the release print itself or the theatre sound system.

- A few early Dolby Stereo optical releases were mixed without surround information. While these will usually sound satisfactory with format **04 Dolby stereo optical with surround** selected, you may be showing one of the comparatively few films that do not sound good in this format. Check with the distributor to see how the film was originally mixed and continue to play it in format **03** for the rest of the run if it turns out to be a release without surround information.

- If the release was mixed to include surround information, as are the vast majority of Dolby Stereo films, the problem may be in (1) the sound system, (2) the alignment of the solar cell in the projector being used, (3) the Cat. No. 240 optical preamp or (4) the Cat. No. 150 2:4 decoder. Continue the show in format **03** and have the problem corrected later by your service engineer.

B. BETWEEN SHOWS

If bypass operation was required to complete a show and your preliminary checks suggest that the cause of a problem may be a fault within the CP55, you can take some further steps when you have more time between shows.

- First, listen to each channel individually over the booth monitor. If each channel sounds OK, the problem is in equipment following the CP55 in your system. To verify this conclusion, play a film and watch the signal-present LEDs on the Cat. No. 242. If they flicker as the film is playing, chances are that the CP55 is working properly and the fault probably is after the CP55.

- If the indications are that the fault is in the CP55, perform the checks below after you have turned off the power amps to prevent loud thumps in the theatre.

  - With the CP55 still in **bypass**, check the main fuse on the Cat. No. 250. If it is blown, replace it (a spare fuse is in the right-hand fuseholder).

  - Next, locate the three red LEDs at the top of the Cat. No. 249 (they indicate the status of the three power supply voltages). Switch the CP55 from bypass back to normal operation, and watch what happens to the LEDs:

    - If <u>all three</u> LEDs come back on and stay on, the Cat. No. 249 is working properly. If all three go out again after about three seconds, the Cat. No. 249 may be at fault, and you should try substituting your spare Cat. No. 249

    - If none of the LEDs light, the main fuse may have blown again. The Cat. No. 249 or 250 is probably at fault. Call your service engineer to correct the problem.

    - If <u>only one or two</u> of the LEDs come on and then go out in about three seconds, one or more of the power supplies are not working. Substitute your spare Cat. No. 249 for the one in use, and see if that restores proper operation.

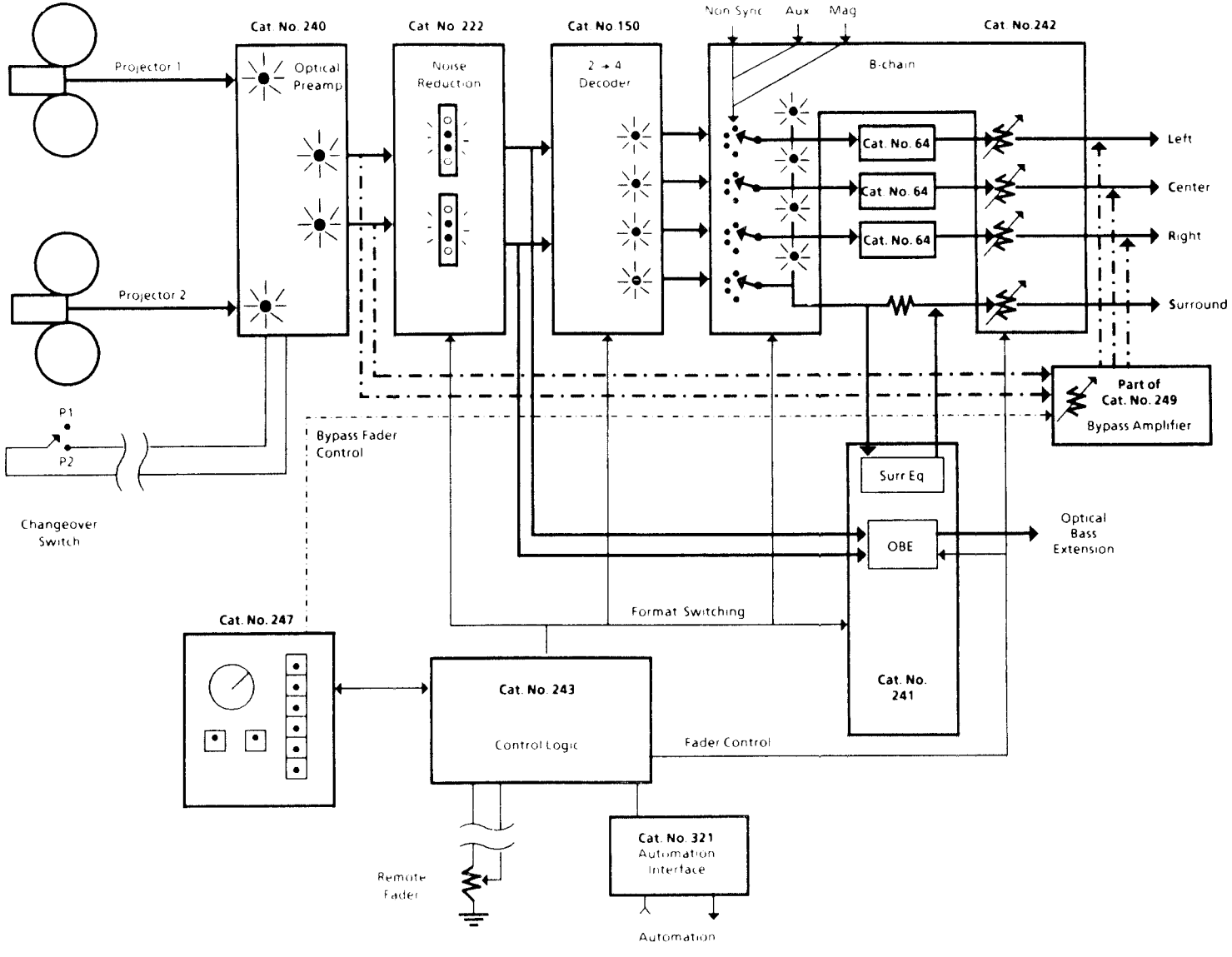


Figure 7. CP55, Block Diagram

If by now you have not been able to restore all sound system functions, switch the CP55 back to **bypass** and finish the day's shows. When the theatre is closed and you have more time, follow the instructions in the following paragraphs to track down the problem.

C. WHEN THE THEATRE IS CLOSED

If you can take the time, the following procedures may help you to track down which module or modules in the CP55 may be the cause of a trouble. If you have to telephone your service engineer, the information you obtain can reduce the time required for him to correct the malfunction. Remember that you can still operate the system in **bypass**.

If the CP55 is one of several in a multi-screen theatre, temporarily substituting a module from another CP55 can help confirm your diagnosis. However, if you borrow a module from another unit, be sure to replace it in the unit from which it came. Nearly every module in the CP55 has been adjusted and jumpers have been programmed for its particular auditorium. Interchanging modules can result in poor sound or control errors.

1. General Fault-Finding Procedures

To facilitate trouble shooting, including your helping a service engineer to diagnose a problem over the phone, several of the circuit cards within the CP55 feature signal-present LEDs which flicker at least occasionally as a film is playing. They are shown on the accompanying CP55 block diagram which also shows the signal path (from left to right) within the CP55 in both normal and bypass operation.

The LEDs generally monitor the output of a module; therefore the module with LEDs that do not flicker is probably at fault and the module ahead of it in the circuit (that is, to the left of it on the block diagram) is likely to be functioning properly. For example, if the LEDs on the Cat. No. 150 do not function but those on the Cat. No. 222 do function, the fault is probably within the Cat. No. 150.

No test equipment is required to track down the probable cause of a problem to a particular module, but the Dolby Cat. No. 251 Jiffy Test Film can be particularly helpful because it tests each channel individually (see Appendix B). If you do not have the Cat. No. 251, any stereo or mono print will do.

Note the following about trouble shooting with the signal-present LEDs:

- Generally, you should select format **04 Dolby stereo optical with surround**.
- When a mono film is played, both of the LEDs on the Cat. No. 240 and both meter pairs of LEDs on the Cat. No. 222 will light; usually, only the center channel LEDs on the Cat. Nos. 150 and 242 will light, even if a stereo format is selected. With a stereo format selected, the decoder in the Cat. No. 150 assumes that the signals from the identical two tracks of a mono film are

dialogue from a stereo film, which should be steered to the center. If the LEDs for the other two channels do flicker regularly on a mono film, the print may be very dirty. If the print is clean, there may be a problem with the Cat. No. 150 or the Cat. No. 240, or the solar cell may be misaligned, requiring the assistance of a service engineer.

- Depending on the format that was selected, some of the LEDs on modules that follow the Cat. No. 222 on the block diagram may not light, even if there are no faults within the CP55. For example, if you select format 01 mono optical, only the center-channel LEDs will light because the other channels are disabled.

2. Front Panel Control Errors

If the CP55 does not respond properly to its front-panel controls, the fault may be with the Cat. No. 247 front-panel control module or the Cat. No. 243 control logic module. If your theatre has an automation system, the fault could be in the Cat. No. 321 automation interface on the back of the CP55 or in the external automation circuitry. To track down the problem:

- Open the front panel and check that the end of the ribbon cable from the Cat. No. 247 front-panel control card is securely plugged into the backplane connector.

- If the connection is secure and your theatre is equipped with an automation system, switch the CP55 to bypass. Then, obtain access to the rear of the CP55. Remove the four screws that hold the Cat. No. 321 automation interface module on the backplane of the CP55 and unplug the card from automation connector **J5**. Switch the CP55 back to normal operation and check if its various functions operate manually.

  - If so, the fault lies either with the Cat. No. 321 or the external automation circuitry and you can continue to use the CP55 manually until the fault is repaired.

  - If not, the problem may be with the Cat. No. 243 control logic module. If possible, substitute a Cat. No. 243 from another cinema processor.

  - If substituting the Cat. No. 243 does not help, the problem is most likely in the Cat. No. 247 front-panel control module which will require replacement by your service engineer.

3. Projector Change-Over Failure

If the problem is a failure to change over, first verify that your external change-over switch is functioning properly. If so, the problem may lie in the Cat. No. 240. Substitute your spare Cat. No. 240 or one from another processor. If that solves the problem and it is necessary to leave the alternate Cat. No. 240 in the CP55 to keep the system going, check and adjust Dolby Level as instructed on page 9. The high frequency response of the system may not be correct, however, unless the **hf** adjustments on the spare Cat. No. 240 were performed at an earlier time by a service engineer.

D. TROUBLE SHOOTING CHART

The following pages contain a brief trouble shooting chart that covers typical problems that can arise with the CP55 system. The chart is organized into three columns -- **Trouble** -- **Probable Cause** -- and **Recommended Action**. In the case of the recommended action, you are directed to follow simple procedures that can be performed rapidly in order to help you determine if your actions solve the problem. In some cases, the only remedy available to you is to replace a module or card. If you have a spare module or card, install it in place of the apparently malfunctioning item. (If the replacement item is a Cat. No. 242, Cat. No. 64, or Cat. No. 241, call your service engineer to perform the appropriate alignment). If you do not have replacement modules or cards or if such replacement does not solve the problem, call your service engineer.

D. TROUBLESHOOTING PROCEDURES

Trouble	Probable Cause	Recommended Action
The CP55 is dead. (No LEDs on the front panel or on the modules are lighted; the **bypass** LED does not flash; the CP55 does not respond to commands; there is no sound output.)	No power to CP55 Blown fuse(s).	Check that the power cord is firmly plugged into a live outlet of the proper line voltage. Check both the normal and bypass fuses. Replace the fuse with one of the proper rating (0.6A for 100/120V; 0.3A for 220/240V).
The CP55 locks in the bypass mode (the **bypass** LED flashes) regardless of any format command you select.	Blown fuse(s).	See above.
There is hum in the output. (You can detect hum coming from the booth speaker at normal listening level.)	Improperly set link across terminals 3 and 4 on terminal strip TB3 on rear of the CP55. Malfunctioning exciter lamp or lamp power supply. Stray light striking the stereo solar cells.	If link is in place, remove it and check if hum disappears. If link is not in place, install one (if possible) or call service engineer. Cover the solar cells with a business card or other opaque object. **Do NOT touch the cells and do NOT disturb the position of the cell bracket!** • If the hum disappears, the problem is in the exciter lamp. • If hum still persists, turn out all lights in the booth to check if stray light is triking the cells. If the hum disappears, turn on booth lights that are usually on during projection, one at a time, until you detect hum again. Redirect the light from the last source or keep it off during a showing. If the hum still is present, the problem is either in the grounding or wiring or in the CP55. Call service engineer.

D. TROUBLESHOOTING (cont'd.)

Trouble	Probable Cause	Recommended Action
All channels fail.	Defective exciter lamp or lamp power supply.	Check that the exciter lamp is on and that the lamp power supply is operating. If not, call service engineer.
	No signals coming from stereo solar cells.	Check that the signal present LEDs on the Cat. No. 240 optical preamplifier are flashing while film is projected. If not, there is no signal from the solar cells or the Cat. No. 240 has failed. Call service engineer.
	Malfunction in the CP55.	If the signal present LEDs on the Cat. No. 240 optical preamplifier are flashing, the problem is caused by a malfunctioning card or module in the CP55. Call service engineer.
One channel fails.	Defective power amplifier or wiring for that channel.	Place the CP55 in bypass. There should be three mono channels. If not, there is a fault in the power amplifier or wiring for the missing channel. Check if amplifier is on and if the fuse(s) blew. Check that the wiring from the CP55 to the amplifier to the loudspeaker has not been broken or disconnected.
	Malfunctioning module in CP55.	If the power amplifier and the wiring are satisfactory, the problem is a malfunctioning module in the CP55. Check the signal present LEDs to identify the module or card in which the missing channel first appears. Then call service engineer.

D. TROUBLESHOOTING (cont'd.)

Trouble	Probable Cause	Recommended Action
The sound from one channel is distorted (you can detect the distortion at the booth monitor at normal listening level).	Defective power amplifier for that channel.	Check if amplifier is on and if its fuse(s) blew.
	Defective speaker for that channel.	Check speaker.
	Malfunctioning Cat. No. 242 B-chain facilities card or misaligned Cat. No. 64 equalizer modulefor that channel.	Not only can a malfunctioning Cat. No. 242 cause distortion in a single channel, but a misaligned Cat. No. 64 can also produce distorted output. Interchange Cat. No. 64 equalizers between channels to determine if problem persists. Call service engineer.
	Wiring from the stereo solar cell to the CP55.	Check that the wiring from the stereo solar cell to the CP55 has not become kinked and that the solder connections to the fanning strip are secure. Check that the fanning strip is firmly attached to the terminal strip on the CP55.
	Malfunctioning Cat. No. 240 optical preamplifier card or Cat. No. 222 Dolby noise reduction module.	Call service engineer.
The sound from two or more channels is distorted (you can detect the distortion at the booth monitor at normal listening level).	Malfunctioning dual-channel power amplifier.	If two distorted channels are served by the same dual-channel amplifier, the problem is probably caused by it. See the manufacturer's instructions.
	Malfunctioning Cat. No. 240 optical preamplifier card or Cat. No. 222 Dolby noise reduction module.	Call service engineer.

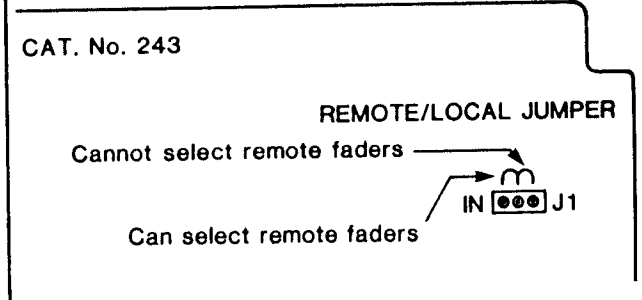
D. TROUBLESHOOTING (cont'd.)

Trouble	Probable Cause	Recommended Action
When a stereo film is projected, the sound appears to be coming from the wrong speakers.	The A-chain has become misaligned.	Call service engineer.
You can hear pops and thumps at projector changeover.	A diode should be soldered across the winding of the projector changeover relay to prevent noise from the changeover relay from leaking into the audio wiring. This diode may be missing or defective.	Check that the diode is installed across the relay winding, if possible. If you are familiar with such electronic components, check to see that it is not blown. If the diode is not present or if it appears to be blown, install a diode; 1N4004 for 100/120V (1 amp, 400 V diode) or a 1N4008 for 220/240V (1 amp, 800 V diode)
	Malfunctioning Cat. No. 240 optical preamplifier.	Call service engineer to correct the malfunction.
Sound from the front (screen) channels is leaking into the surround channel.	The A-chain has become misaligned.	Call service engineer.
	Surround sound delay set improperly.	Call service engineer.
	Surround sound level set too high.	Call service engineer.
You detect an echo in a small theatre.	Surround sound delay set improperly.	Call service engineer.
The sound level in bypass is higher or lower than the normal sound level.	**Bypass** gain improperly set.	Call service engineer.

D. TROUBLESHOOTING (cont'd.)

Trouble	Probable Cause	Recommended Action
There is distortion when you play non-sync sound, but sound from the film prints is not distorted.	The non-sync source is introducing distortion.	Change the non-sync selection. If the distortion persists, the device (tape player, gramophone, CD player, etc) may be the source of the trouble. Try a different device. If the distortion goes away, the selection is at fault. If changing both the device and the selection does not eliminate the distortion, the problem is in the CP55.
	Malfunctioning Cat. No. 242 B-chain facilities card.	Call service engineer.
Sound from a mono film appears to be distorted but stereo sound appears to be OK.	Incorrect setting of Dolby Tone.	Readjust Dolby Tone level (see page 9).
	Malfunctioning Cat. No. 150 2:4 channel decoder or Cat. No. 242 B-chain facilities card.	Call service engineer.
Sound from a mono film is distorted as is sound from the center channel of a stereo film.	Malfunctioning power amplifier.	Interchange power amplifiers to determine if distortion is still present.
	Malfunctioning loudspeaker.	Interchange speakers to determine if distortion is still present.
	Malfunctioning or poorly aligned center channel Cat. No. 64 equalizer.	Call service engineer.
Projector changeover command does not change to sound output of change-to projector.	Defective changeover relay or switch.	If possible, check that the relay or switch contacts actually open and close as the changeover command is issued several times.
	Defective wiring from relay or switch to terminals 1 and 2 of TB2 on rear of the CP55.	Check that the wiring has not been damaged and that connections are firmly made at both ends.
	Malfunctioning Cat. No. 240 optical preamplifier.	Call service engineer.

D. TROUBLESHOOTING (cont'd.)

Trouble	Probable Cause	Recommended Action
The sound output of the CP55 is at the highest level (full on), regardless of the setting of the fader control.	Short circuit in fader circuitry.	Call service engineer.
When you select the local fader, there is no output from the CP55; all LED indications are proper; remote fader operation is OK.	Malfunctioning Cat. No. 242 B-chain facilities card, Cat. No. 243 control logic card, or Cat. No. 247 front panel card.	Call service engineer.
When you select the remote fader, there is no output from the CP55; all LED indications are proper; local fader operation is OK.	Defective wiring from remote fader to CP55. Malfunctioning remote fader interface cards. Defective remote fader.	Check the wiring for damage or breaks. Check that all connections are firmly made. Call service engineer. Repair or replace remote fader.
You cannot change from local to remote fader operation.	Improperly installed jumper on Cat. No. 243 control logic card Malfunctioning Cat. No. 243 control logic card or Cat. No. 247 front panel card.	Place CP55 in bypass and remove Cat. No. 243 module. Check that the jumper is as shown below. Change if necessary.  Call service engineer.

D. TROUBLESHOOTING (cont'd.)

Trouble	Probable Cause	Recommended Action
The mute switch does not appear to be working; the sound output is always muted.	Malfunctioning Cat. No. 243 control logic card or Cat. No. 247 front panel card.	Flip the **normal bypass** switch from **normal** to **bypass** to **normal**. If the sound is restored, continue the film. Call service engineer, even if sound is restored.
The CP55 freezes into one format and does not respond to any format or other types of commands when you press the front panel switches. (Optional automation not connected.)	The ribbon cable from the Cat. No. 247 front panel module is not plugged into the backplane. Malfunctioning Cat. No. 242 B-chain facilities card, Cat. No. 243 control logic card, or Cat. No. 247 front panel card.	Open front door of the CP55 and check that cable is firmly plugged into the receptacle. Call service engineer.
The CP55 freezes into one format and does not respond to any format or other types of commands when you press the front panel switches. (Optional auto nation is connected to the CP55.)	Malfunctioning Cat. No. 321 automation interface or incorrect wiring to D-connector plugged directly into J5 on CP55 (depending on your installation). Malfunctioning Cat. No. 243 control logic module.	Either remove Cat. No. 321 from your CP55 (unscrew the four fasteners holding the board in place first) or unplug the D- connector from J5 on the back of the CP55. If you can exercise local control over the CP55, the problem is in either the Cat. No. 321 or the wiring to the automation equipment or the automation equipment. Call service3 engineer. If you cannot exercise local control over the CP55 even with the automation equipment disconnected from the CP55, call service engineer.

HOW TO TELL A STEREO OPTICAL PRINT FROM A MONO PRINT

A Dolby Stereo optical print should be identified as such on both the film can and leader. However, with handling the identification may be lost. If you are not sure if you have a stereo print, play a reel and find a section with music and/or effects only (on dialogue or narration, stereo sound-tracks look much the same as mono sound-tracks). Examine the sound-tracks closely; on music and effects, the two sound-tracks will appear to be different on a stereo print; on a mono print they are identical. Alternatively, while the film is playing, open the front panel and check the signal-present LEDs; the left, center, and right LEDs will flicker regularly if the print is stereo; the center LED will predominate if the print is mono. If you specified a stereo print and received a mono print in error, be sure to check with your local exchange or the film distributor.

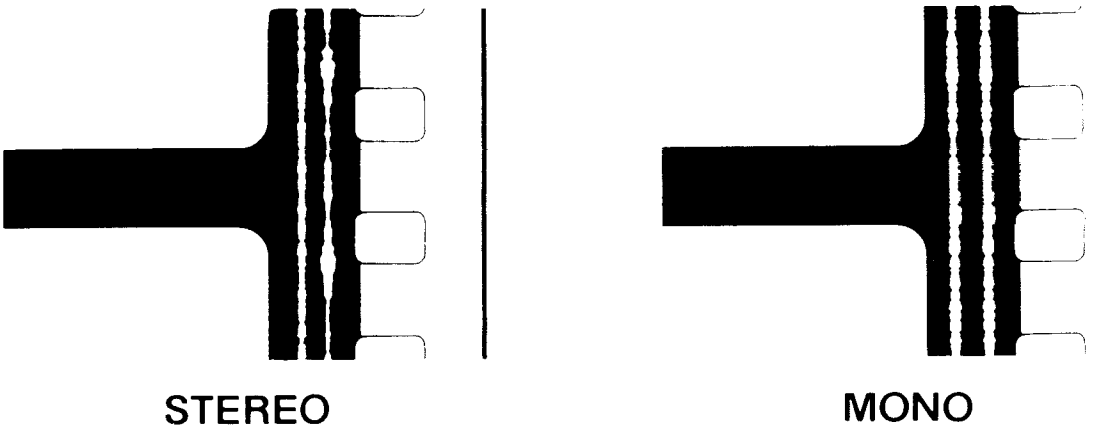


Figure A-1. Stereo vs. Mono Sound-tracks

There is no way to tell by visual inspection if a stereo print has been encoded with a surround channel. However, all but a few early Dolby Stereo releases do have a surround channel so, in general play any stereo print in format **04 Dolby stereo with surround**. (See "Format Selection", page 3, and "Excessive or Inappropriate Sound from the Surround Speakers", page 14.)

DOLBY TEST AND DEMONSTRATION FILMS

Several test and demonstration films produced by Dolby Laboratories are available from your equipment supplier. For proper system maintenance, the Cat. No. 69 test film is required and the Cat. No. 251 Jiffy Test Film is strongly recommended. Both films should be formed into endless loops for ease of use. The eight-minute color short ***"listen . . ."*** (Cat. No. 351) is an excellent way to demonstrate in an entertaining way your commitment to a quality presentation. Two additional test films, Cat. Nos. 97 and 151, are for use only by a trained engineer with special test equipment; they are mentioned here so you know what they are should you ever come across them.

1. Cat. No. 69: Dolby Tone and Pink Noise

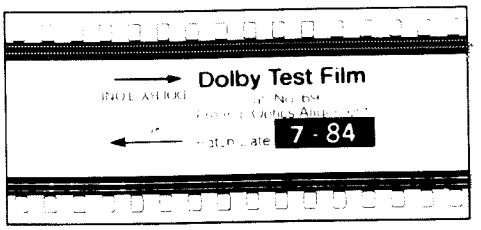
This film is required to maintain your theatre system. The Dolby Tone recorded on one side is for adjusting Dolby Level as instructed on page 9; this simple adjustment must be performed whenever an exciter lamp is replaced and should also be performed from time to time to compensate for the normal aging (and reduced light output) of exciter lamps. The other test signal, pink noise, is for use by a service engineer to optimize the high frequency response of each projector soundhead when the CP55 is first installed and when its Cat. No. 240 optical preamp is replaced.

2. Cat. No. 251: Jiffy Test Film

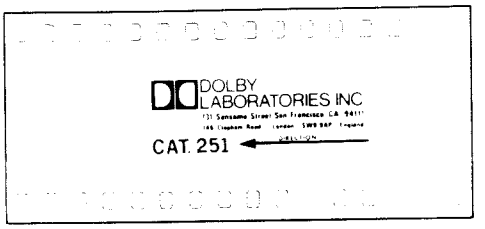
This eight-minute test film is strongly recommended to help keep your system sounding its best. No special equipment is required because the tests have been specifically designed to permit subjective judgement by ear. Each test is described by either a male or female voice and is supplemented by captions on the screen which help identify the causes of sound system problems. Visual checks are also included to assist in identifying some picture projection problems.

Tests provided on the Cat. No. 251 include: Level Set, Channel Identification, Channel Level and Loudspeaker Equalization, Loudspeaker and Amplifier Condition, Projector Wow and Flutter, Overall System Performance, Visual "Quick-checks", and a Noise and Interference Test.

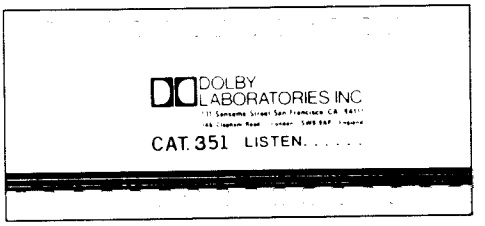
Duration:	8 minutes
Picture format:	35-mm color, can be screened either 1.85:1 wide-screen or 2.35:1 anamorphic
Sound format:	04 Dolby Stereo optical with surround



Cat. No. 69 Dolby Tone and Pink Noise Test Film



Cat. No. 251 Jiffy Test Film



Cat. No. 351 "*listen . . .*" Film

Figure B-1. Test and Demonstration Films and Identification

3. Cat. No. 351 Stereo Demonstration Film: *"listen . . ."*

"listen . . .", an eight-minute Dolby Stereo demonstration film for public exhibition, has been professionally produced to demonstrate the commitment of the theatre to providing its audiences with the best in both sound and picture. It is intended for screening prior to a feature and is a fast-paced, entertaining short which shows off a quality projection system to its best advantage. Thus, it serves to promote the experience which only the motion picture theatre can provide and which cannot be matched by home entertainment media.

"listen . . ." has no narration and no sales or technical message except that implied by the quality of its presentation in the theatre. It consists of a wide variety of short scenes, both live action and an animation sequence, integrated into a unique sight and sound exprience which bears repeated viewing. Because there were none of the plot constraints of a conventional feature, scenes were chosen specifically to demonstrate different aspects of stereo sound -- from a trickling brook to a cannon salute, from a string quartet to a church organ, from the sounds of children at play to the thundering lift-off of a Saturn 5 rocket.

To ensure quality at least equivalent to the feature likely to follow it in the theatre, Dolby Laboratories engaged professional film craftsmen, including several Academy Award winners, to produce *"listen . . ."*.

Running time:	8 minutes
Picture format:	35-mm color, 2.35:1 anamorphic
Sound format:	04 Dolby Stereo optical with surround

4. Cat. No. 97 and Cat. No. 151 Test Films

These two specialized test films are for use only by trained engineers with special test equipment and need not be kept on hand at the theatre. The Cat. No. 97 is used for aligning stereo solar cells in projector soundheads, while the Cat. No. 151 is used to set the level of the surround speakers relative to the screen speakers.

CP55 MODULE DESCRIPTIONS

1. **Spare Slot** (not wired) for storing an optional spare Cat. No. 240. The CP55 will not operate even in the **bypass** mode if the main Cat. No. 240 fails. This spare is strongly recommended (with a spare Cat. No. 249 power supply).

2. **Cat. No. 240 optical preamplifier** amplifies and optimizes the solar cell outputs of the selected projector. Electronic switches controlled by the external changeover contacts select projector 1 or 2.

3. **Cat. No. 222 dual noise reduction module** contains two channels of Dolby A-type noise reduction and metering for adjusting Dolby Level.

4. **Cat. No. 150 2:4 channel decoder** derives left, center, right, and surround information from the two tracks on stereo optical releases (includes the required time delay for the surround channel).

5. **Cat. No. 64B equalizers** contain 27-band third-octave equalization for optimum response from the left, center, and right screen speakers.

6. **Cat. No. 241 surround equalizer and bass extension module** provides equalization for the surround speakers and extracts low-frequency bass information from optical sound-tracks and sends the resulting signals to the subwoofer output through equalizer and fader circuits. (This module is not supplied as standard in some areas and may not be present in your CP55; see Appendix F for further information on optical bass extension.)

7. **Cat. No. 242 B-chain module** contains the signal processing circuitry for the B-chain other than the Cat. No. 64B equalizers. It has input buffers for non-sync and magnetic sources, electronic selector switches to determine formats, a 4-channel fader circuit, and output level potentiometers.

8. **Cat. No. 243 control logic module** sets the CP55 for the selected format. It also contains mute and fader local/remote status circuits, and generates control logic signals for the other modules in the CP55. It responds either to the front-panel controls or to signals from the automation system, if the theatre is so equipped.

9. **Cat. No. 249 power supply** is semi-regulated with nominal voltages of + 12V (for bypass operation), + 15V, − 15V, and + 24V. The bypass amplifier and gain trimmer are also located on this card.

10. **Cat. No. 250 transformer module** contains two power transformers which convert line-voltage AC to low-voltage AC. A line voltage selector switch, accessible through the backplane, allows operation of the CP55 with 100, 120, 140, 200, 220, or 240V AC power sources. The AC power cable connector is plugged into the Cat. No. 250 through the backplane. The Cat. No. 250 also contains main and spare fuses for both **normal** and **bypass** operation, and the **normal/bypass** switch.

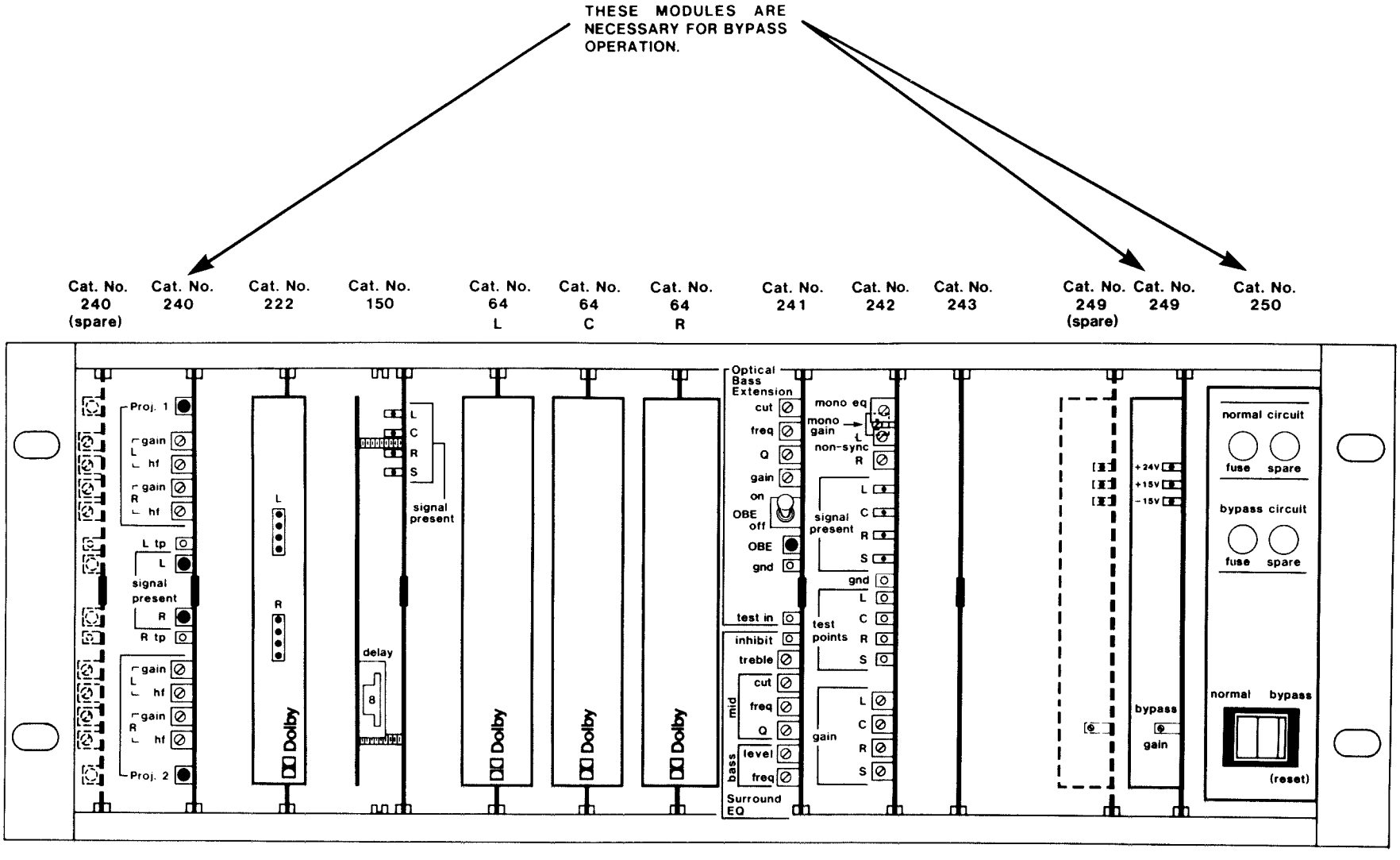


Figure C-1. Interior View of CP55, Showing Modules Installed in Place

11. **Spare slot** (not wired) for storing an optional spare Cat. No. 249 power supply. Because the CP55 will not operate in the bypass mode if the bypass circuitry on the main Cat. No. 249 fails, this spare is strongly recommended (with a spare Cat. No. 240 optical preamp).

12. **Cat. No. 247 front-panel control module** contains all front-panel switches, the main fader, and display decoder logic.

13. **Cat. No. 321 automation interface module** is mounted on the backplane of the CP55. It is an option for some theatres that use automation equipment for automatic selection and remote indication of format, mute, and fader functions and status. (This card is supplied as standard in some areas and may be present on your CP55 even if your theatre is not equipped with an automation system. Also, in some theatres an automation system may be wired directly to the CP55 without a Cat. No. 321 module.)

ABOUT DOLBY NOISE REDUCTION

The application of Dolby noise reduction to film sound-tracks, as explained in **Appendix G, Cinema Sound and the Evolution of Dolby Stereo**, has had a major impact on cinema sound recording and reproduction. An understanding of how it operates will help you understand both the CP55 and Dolby Stereo sound, including why the Dolby Level adjustment procedure is important in maintaining good sound in the theatre.

1. How Dolby Noise Reduction Works

Whenever a sound signal is recorded -- on magnetic tape, phonograph records, or film sound-tracks -- noise is added to the signal. Dolby noise reduction keeps that added noise down to a minimum in a way that has no adverse effect on the quality of the original signal, unlike simple filtering (e.g., turning down the treble).

Dolby noise reduction is a two-step process used both at the time a recording is made and when it is played back. Just before the signal is recorded, it is processed by the Dolby noise reduction circuitry. Loud sounds which inherently hide noise are passed through unchanged. But quiet sounds which would be marred by added noise are selectively boosted (that is, they are recorded louder than normal). The resulting recording or film sound-track is said to be "Dolby encoded". Both tracks on Dolby Stereo optical release prints are encoded in this way.

When the encoded recording or sound-track is played back, it is decoded by Dolby noise reduction circuitry which operates as an exact mirror image of the circuit used when the recording was made. Loud sounds again pass through unchanged. But the previously-boosted quiet sounds are reduced in volume to match their level exactly as before they were recorded -- a process which, at the same time, automatically reduces the noise added by the recording medium. The result is both noise reduction and the accurate reproduction of the original signal. The CP55 has two channels of Dolby noise reduction circuitry to decode the two sound-tracks on Dolby Stereo release prints (the four original channels are derived from the two sound-tracks after the Dolby noise reduction decoding).

2. Why the Dolby Level Adjustment Is Important

The accurate reproduction of Dolby encoded sound-tracks requires that the decoding noise reduction circuits act as precise mirror images of the circuits used when the tracks were encoded. This requirement is met in part by the very close tolerances to which all professional Dolby A-type noise reduction circuits are manufactured. Any two Dolby noise reduction circuits, regardless of when manufactured, can be connected to each other in an encode-decode configuration and provide flat response within 1 dB. Dolby noise reduction action in both recording and playback is level-dependent. Loud signals are untouched, while low-level signals are boosted during recording and attenuated during playback by an amount that depends on their level. How does the playback Dolby noise reduction decoder know when and by how much to attenuate the previously-boosted signals?

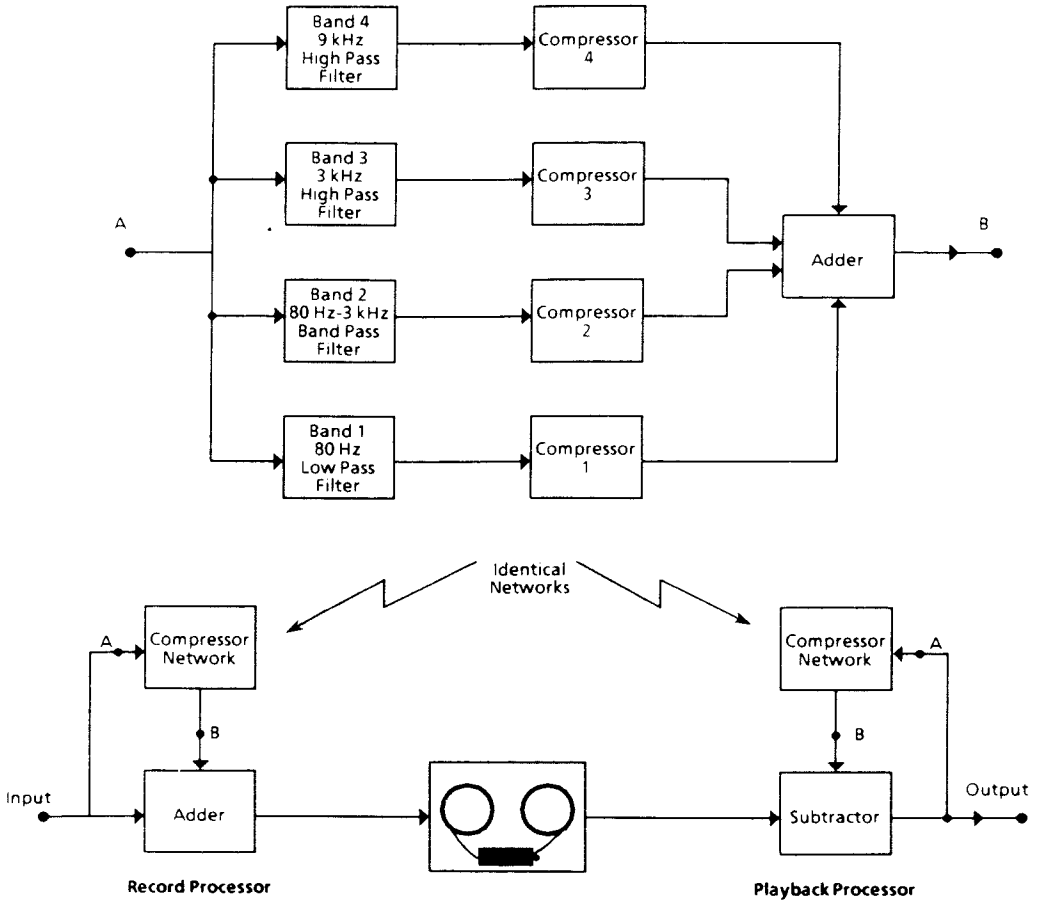


Figure D-1. Dolby Noise Reduction System, Basic Block Diagram

The answer is that it doesn't know; it is programmed to assume, when it sees any particular voltage, what happened when the recording was originally encoded. This is why it was necessary when Dolby noise reduction was first developed to establish a standard reference level to which all encoding circuits and all decoding circuits are calibrated.

The first step is to establish a reference level on the recording medium itself. This is where the Dolby Level Tone on the Cat. No. 69 film comes into play. The sound on that film is very carefully recorded at the standard reference level. The other step is the Dolby Level adjustment you make to the CP55. What you are doing is ensuring that the signal recorded at Dolby Level on the test film is converted to a standard reference voltage at the inputs to the decoders. The net result is not only essentially perfect mirror-imaging of the encoding used to prepare the sound-tracks, but complete compatibility as well. As long as the proper Dolby Level procedures are followed, any Dolby-encoded sound-track recorded anywhere in the world will be accurately decoded by any Dolby cinema processor anywhere in the world.

Although significant level-matching errors can cause audible decoding errors with respect to frequency response in particular, Dolby noise reduction is quite tolerant of errors smaller than about 2 dB. Thus, Dolby Level must be re-adjusted only if there is a significant change in the reproduction chain ahead of the Dolby NR decoding circuit. In the theatre, the one variable which can most affect Dolby Level calibration is the brightness of the exciter lamp. Because the voltage present at the inputs to the decoder circuitry is directly proportional to the amount of light that passes through the slit and sound-tracks to the solar cell, significant changes in the exciter lamp brightness -- likely as the lamp ages over time or when a new exciter lamp is installed -- should be compensated for by adjustment of the Dolby Level.

3. The Various Dolby Noise Reduction Systems

There are three Dolby noise reduction systems which share the basic operating principle described above. Dolby A-type noise reduction is used for professional purposes, including music recording, broadcasting, and preparing film sound-tracks (this is the system used in the CP55). Dolby B-type noise reduction was the first Dolby system developed for consumer use and is in use in many millions of home cassette recorders and other products (a modified version of B-type noise reduction is also used in the 2:4-channel decoder). Dolby C-type noise reduction is a newer system providing more noise reduction than Dolby B-type, and is provided along with Dolby B-type in many of today's high-performance consumer products.

The systems differ primarily in the type of noise reduction they achieve. Because it was developed for professional purposes, the Dolby A-type system reduces all types of noise at all frequencies (low frequency hum as well as high-frequency hiss). Dolby A-type noise reduction is particularly appropriate for the noise characteristics of film sound-tracks. The Dolby B and C systems were developed for consumer uses such as cassette recording where tape hiss is the main problem; the circuits are considerably simpler and operate primarily in the higher hiss-related frequencies.

HOW FOUR CHANNELS ARE DERIVED FROM DOLBY STEREO OPTICAL PRINTS

The 35-mm Dolby Stereo optical format calls for the recording in the studio and the reproduction in the theatre of four separate sound channels, -- left, center, right, and surround -- and yet a Dolby Stereo optical print has only two sound-tracks. How is it possible to derive four channels of sound from only two sound-tracks? The answer lies in the application of what are called phase matrix techniques for encoding four channels of sound onto two sound-tracks, much like the four-channel phonograph records of the early 1970's.

There are two characteristics of sound which cue the brain to its origin and thus its directionality. First is the amplitude or loudness of the sound. If the source of sound is directly in front of you, it arrives at both ears with equal loudness. But if the sound is located to the left, for example, the sound that arrives at your left ear is slightly louder then the sound that arrives at your right ear. This difference is processed by the brain so you recognize that the sound is coming from the left. Home stereo sound is is based in great part on this principle; two channels on a recording that is reproduced on two speakers are sufficient for home listening to convey directional information all across a listening "stage" in front of you.

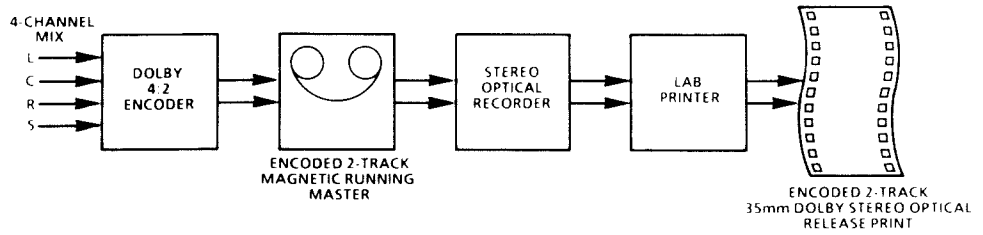
The other characteristic of sound which cues the brain to its directionality is phase. A sound coming from the left not only is louder when it arrives at your left ear but it arrives slightly earlier. That difference in timing results in what engineers call phase shift. The brain also processes that difference as a further directional cue.

The distinction between amplitude and phase as directional cues is not so important in conventional home stereo as in motion picture stereo. Movie theatres require more than two channels for good stereo sound. For example, in a theatre, left and right speakers are so widely spaced that sounds coming from the center (dialogue in particular) must be more firmly defined than in a home system. This requirement is met by the addition of a third, or center, channel and screen speaker. In addition, the use of a fourth channel toward the rear of the theatre is highly desireable to reproduce ambient sound for more life-like overall sound and to reproduce special directional effects. Thus, good theatre stereo requires a total of four channels.

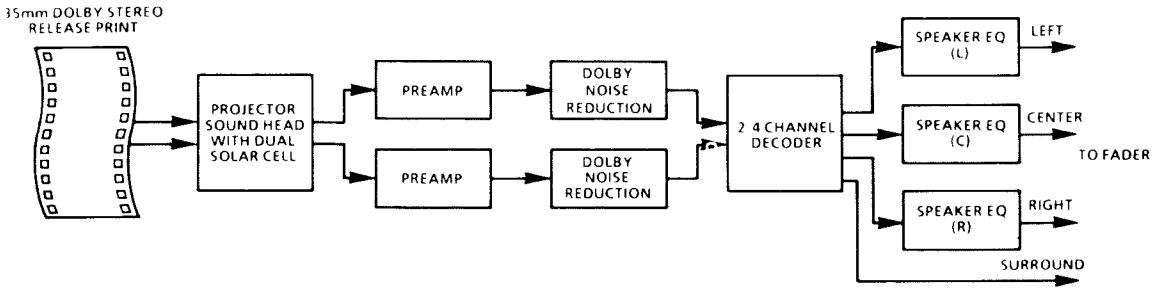
Dolby Laboratories developed a phase-matrix technique for encoding the four required channels of sound onto two tracks in exactly the same space as the conventional mono track. The final sound-track is mixed to four discrete channels (left, right, center, and surround). Those four channels are then encoded to the two tracks which ultimately wind up on the release print. Basic left and right information is recorded unchanged onto the left and right tracks. Information which is to be reproduced in the theatre as a center channel -- that is, sound which is identical in phase and amplitude -- is split between and recorded on both the left and the right tracks. And the surround information is also split between the two channels, but is recorded with a distinct phase shift to distinguish it from the left, center, and right information.

In the theatre, when the signals from the two tracks on a Dolby Stereo print reach the CP55 processor, its 2:4 decoder constantly compares the two signals. Those signal elements which differ primarily in amplitude are assigned to the left and right speakers. Those which are essentially identical in both phase and amplitude are assigned to the center speaker. And those parts of the signal which were recorded with the distinct phase shift are assigned to the surround speakers.

To accomplish the decoding process effectively requires very sophisticated circuitry. That is why the 2:4 decoder within your CP55 is one of the most complex circuit cards.



a. Encoding



b. Decoding

Figure E-1. Block Diagram, Dolby Cinema Stereo Encoding/Decoding

OPTICAL BASS EXTENSION

Dolby Laboratories developed the optical bass extension (**OBE**) circuitry that is provided on the Cat. No. 241 module (optional in some areas) for use with subwoofers -- special bass loudspeaker units designed to provide the very low-frequency bass performance lacking in most conventional theatre speaker systems. (If your theatre is not equipped with subwoofers, consult your theatre equipment supplier for further information on how to take full advantage of optical bass extension.)

At first glance, it would appear appropriate just to add extra amplifiers and subwoofers to reproduce the lowest bass frequencies recorded on a sound-track. Such an approach is insufficient and can even be detrimental to achieving realistic, natural sound. One problem is that at very low frequencies, there may not only be desirable music and effects information on the sound-track, but there may also be hum and low-frequency print noise. Furthermore, reproducing very low bass in the theatre can excite resonances which add an artificial, boomy quality.

The optical bass extension circuitry on the Cat. No. 241 is the vital link between the very low bass music and effects often recorded on wide-range Dolby Stereo prints and an installation that incorporates subwoofers and their associated amplifiers. The Cat. No. 241 is not merely a crossover network or a bass synthesizer; it extracts whatever low frequency music or effects information is already recorded on the release print and, at the same time, rejects low-level hum and low-frequency optical noise. In addition, a sophisticated filter system (adjusted by the trained installer) assures natural low bass response without the boomy quality which would otherwise result from the interaction between low-frequency bass speakers and the theatre acoustics. The result is smooth, deep bass response which complements the improved mid and upper range response already achieved in your theatre by means of the third-octave equalization in the CP55.

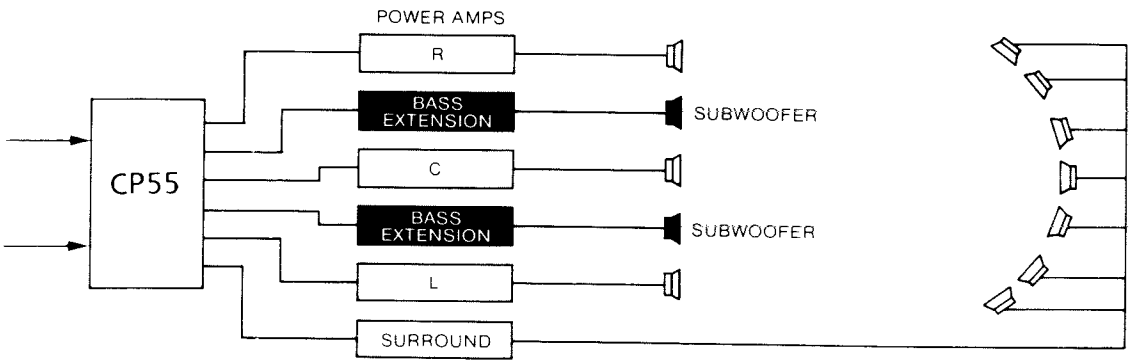


Figure F-1. OBE Installation.

CINEMA SOUND AND THE EVOLUTION OF DOLBY STEREO

1. Optical Sound

The photographic or "optical" sound-track was the first method of providing sound on motion picture film; today it is still the most popular way to do so. The sound-track is a visual image of the sound that is placed alongside the picture on the film. It is an opaque area containing a narrow, clear track that varies in width according to the variations and intensity of the sound being recorded. As the film is played in the projector, a narrow beam of light shines through the moving track. The amount of light that passes through the film varies in proportion to the width of the clear area of the track. This varying amount of light falls on a solar cell which converts the light to a similarly varying electrical signal. The signal is amplified and ultimately converted to sound by loudspeakers in the auditorium.

Several of the advantages of optical sound have contributed to its universal acceptance, the foremost being economy. For example, the sound-track is printed photographically on the film at the same time as the picture. In addition, the sound-track can last as long as the print which, with care, can last a very long time indeed. A further benefit is that the optical soundhead within the projector is itself economical and easily maintained.

Motion pictures with sound were first shown to significant numbers of moviegoers in the late 1920's. By the early 1930's, the "talkies" were no longer a novelty but an accepted necessity; many thousands of theatres were equipped in that short time to show films with optical sound-tracks. This phenomenally rapid acceptance of a sophisticated new technology was not implemented without some built-in drawbacks, however. Equipment was installed in theatres so rapidly that there was no time to take advantage of improvements in the technology, which occurred on an almost daily basis.

A good example is loudspeaker design. The first cinema loudspeakers had very poor high-frequency response. Then, within a few years, loudspeakers with vastly superior high-frequency capability became available. But there was no time to visit all the theatres that were already equipped for sound and retrofit them with new units because installation engineers were too busy equipping new theatres with their first sound installations. This situation caused a dilemma for the recordists preparing film sound-tracks: should the tracks be recorded to take advantage of the improved speakers, or should they sound best on the older speakers in the many existing installations? The only practical alternative -- given that it was impossible to release two versions of the sound-track -- was to tailor its response to the older speakers. The result was to ignore the improved high-frequency response of the newer, better speakers for best overall results (including relatively low noise) with tracks tailored to the older units.

As a result of the economics of the situation and to forestall compatibility problems, in the late 1930's a de facto standarization set in. The "Academy" characteristic (as it is usually called today) established a consistent theatre playback response to which sound-tracks could knowingly be prepared. As a

result, theatre owners knew what to expect from the films and what equipment to install. Directors and sound recordists knew what to expect from theatre sound systems and what kind of sound-tracks to prepare. The result was a system of sound recording and playback that even today makes it possible for just about any film to sound acceptable in any theatre in the world. However, it is a system without the flexibility to adjust to improvements in new equipment because it is matched to the equipment standards and limitations that existed in the 1930's.

Even given these limitations, the optical recording system for years possessed a sound quality superior to home phonographs and radios. But by the late 1960's and early 1970's, hi-fi stereo systems had been installed in many homes and a significant and influential proportion of the movie-going public was used to better sound at home than could be heard in the theatre.

2. Magnetic Sound

In the 1950's, a new method of providing sound on film was introduced as an alternative to the optical sound-track. After the picture is printed, narrow stripes of iron oxide material (similar to the coating on magnetic recording tape) are applied to the film. The print is run on a recorder while the sound is recorded on its magnetic tracks. The film has to be played back on projectors with magnetic heads (similar to those on a tape recorder) which are mounted in a special sound-head assembly called a "penthouse".

Magnetic sound was a significant step forward and provided potentially much improved fidelity compared to the conventional optical sound-track. Not only was magnetic sound technically improved but the multiple tracks made stereophonic sound possible in the theatre. The voice of an actor appearing to the left, center, or right of the new wide screens that were introduced at the time could be heard coming from speakers located at the left, center, or right of the screen. Music took on a new dimension of realism and special sound effects could emanate from the rear or sides of the theatre. The two main magnetic systems in use were Twentieth-Century Fox's four-track 35-mm Cinemascope system introduced for The Robe, and the six-track Todd-AO system for 70-mm films that was first used for Around The World in 80 Days.

Many theatres were equipped for magnetic sound in the 1950's even though the playback equipment was expensive. Large numbers of films were issued with magnetic sound-tracks although magnetic prints were, and are, much more expensive than optical sound prints (currently 35-mm magnetic prints cost at least double their optical sound equivalents, and 70-mm magnetic prints are about as much as fourteen times as expensive). By the 1970's, however, the film industry had declined, with fewer films and fewer theatres. The expense of magnetic release prints, their comparatively short life compared to that of optical prints, and the high cost of maintaining magnetic theatre equipment had led to a massive reduction in the number of magnetic releases and theatres capable of playing them. Magnetic sound came to be reserved for a only handful of first-run engagements of "big" releases each year. By the mid-1970's, moviegoers were for the most part only able to hear comparatively low fidelity, mono optical releases, with only an occasional multi-track magnetic release.

3. Dolby Stereo: Today's Film Sound

The situation that prevailed only a few years ago has almost completely changed. New, but affordable and practical, technology -- a vastly increased audience sensitivity to good sound -- and a turnaround in the financial decline of the industry have significantly increased the chances that one can hear a film with wide-range stereo sound, Dolby Stereo sound. (Today, more than 100 titles recorded in Dolby Stereo from many different countries are released each year.)

Technologically and economically, the most important development has been that of a practical 35-mm stereo optical release print format. In the space allotted to the conventional optical sound-track are two sound-tracks that carry not only left-right information as in home stereo sound, but also information for a third center-screen channel and a fourth surround channel for ambient sound and special effects.

Not only does this format make stereo possible from an optical sound-track but, in addition, various other techniques are applied to improve fidelity both when the sound-track is recorded and when it is played back in the theatre. Foremost among these techniques is the use of Dolby noise reduction (lowering hissing and popping associated with optical sound-tracks) and loudspeaker equalization (adjusting the characteristics of the output of the theatre sound system to a standard curve in order to compensate for the room acoustics in which the sound system is working). All this means that these prints can be reproduced in CP55-equipped theatres with far wider frequency response and much lower distortion than a conventional sound-track. In fact, today there is a new wordwide playback standard for wide-range stereo prints for both dubbing and exhibition theatres (ISO 2969), just as there is the "Academy" characteristic for mono prints.

An important advantage of the stereo optical format is that the sound-tracks are printed simultaneously with the picture just as are conventional mono prints. Thus a stereo optical release print costs no more to make than a mono print (although it is more expensive to record and mix in stereo than in mono). Theatre and projector conversion to stereo optical is relatively simple and, once the equipment has been installed, very little maintenance is required, particularly when compared to magnetic stereo playback systems. Moreover, print life is as long as that of conventional mono optical prints, unlike magnetic prints. The result is a format with the multi-track capability of four-track magnetic 35-mm (now made all but obsolete by the stereo optical format) and with consistently higher fidelity and few of the drawbacks of the magnetic sound track system.

Much of the new technology, including Dolby noise reduction and room equalization, is also applied today to Dolby Stereo 70-mm magnetic releases. Although 70-mm release prints are very expensive, the last several years have seen a resurgence of interest in this "big" format for road shows where the ultimate in picture and sound presentation is particularly likely to be reflected in box-office figures. There are six magnetic tracks on 70-mm film, two of which Dolby Stereo puts to use to extend the low-frequency response in the theatre. Some 70-mm films have also used a technique developed by Dolby Laboratories for stereo surround, resulting in two independent rear channels in addition to the left, center, right, and bass extension channels behind the screen. The Dolby CP200 processor is designed to accommodate 70-mm Dolby Stereo releases as well 35-mm stereo optical.

The Dolby Stereo release print formats and the special equipment which reproduces them are only links in a chain that takes the sound from the original location and studio recording, through mixing in the dubbing theatre, to the laboratory, and finally into the theatre. Just like high-quality phonograph records and home stereo equipment, Dolby Stereo is a medium that is capable of carrying a higher fidelity message than previously -- and it will reveal the quality elements of the recording, mixing, and dubbing processes. Taking advantage of the new formats has thus required new approaches to sound-track production. Admittedly, the results can vary -- the final reproduced sound-track can be no better than the elements that compose it -- but Dolby Stereo at its best means not only better quality sound but theatre sound that consistently realizes the director's original intentions.

Dolby Stereo first achieved wide recognition with the spectacular audio effects used in such films as George Lucas' Star Wars and Francis Ford Coppola's Apocalypse Now, but it means much more than just special or dramatic effects. The objective is high quality reproduction overall, whether it is dialogue, music, or effects. Dolby Stereo is a means, not an end unto itself, and there is no particularly characteristic "Dolby Stereo sound". It can be likened to an artist's palette that provides the director with a full range of colors, where before he had but a few. Dolby Stereo greatly enhances that very special experience of going to the movies