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EXCITER LAMP AND IR/LED OPTICAL READER "A" CHAIN SETUP PROCEDURES

BY

JOHN F. ALLEN

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EXCITER LAMP AND IR/LED OPTICAL READER "A" CHAINS PLUS THEIR SETUP PROCEDURES

by
JOHN F. ALLEN

In two past articles, published years apart, I have covered the basics of the venerable analog optical soundtrack readers and their associated setup procedures. The first article, entitled THE FIFTEEN MINUTE 'A' CHAIN, covered the conventional exciter lamp based readers. The second was more recent and concerned the advent of the infrared light emitting diode, or ID/LED, based readers. Several readers and manufacturers have asked for reprints of these articles. In fact, reprints of these two articles have been requested more than any others in the 16 plus years I've been writing for BOXOFFICE.

Since some of the most important information contained in the setup procedures is unpublished anywhere else, I thought it would be a good idea to update and combine these two articles into one comprehensive piece so technicians and others would be able to refer to the important information they contain more easily.

"A" CHAIN DEFINED

For some time now, motion picture sound systems have been described in two parts. The "A" chain encompasses the initial fixed stages of the system, such as the sound pickup and preamplifier. The adjustments for these components are generally about the same in any theatre. The "B" chain has come to refer to the equalizers, faders, amplifiers, speakers and acoustics. Adjustments of these elements will vary depending on the speakers used and the size of the theatre itself.

The "A" chain requires the most maintenance because it employs a mechanical soundhead with moving parts and a lamp of limited life. The general consensus is that the "A" chain and the soundhead should be serviced every six months or anytime anything in the soundhead is replaced, including the lamp. Rather than approaching this service as a troubleshooting exercise, it is better and much faster to initially ignore any specific technical complaint and perform a specified complete alignment procedure. This will not only fix most complaints, but will ensure that the entire mechanism is in proper alignment. In most cases this can be done in about 15 minutes.

REQUIRED EQUIPMENT

A word about the equipment required. Theatre technicians are quite familiar with the use of real-time analyzers and dual trace oscilloscopes. However, differences have been found in the accuracy of the adjustments achieved with different analyzers. The most suitable analyzer is one with the most stable display; a display which does not move up and down. The Ivie IE-30, as an example, has a long enough averaging time to provide a rock solid and completely repeatable display.

Devices which only provide one or two 1/3 octave bands are not recommended because they do not provide enough information. The entire audio band must be displayed on an analyzer anytime a soundhead is serviced.

PREPARATION

The following procedure is quite precise. It requires a 1/3 octave real time analyzer, a dual trace oscilloscope and a DC volt meter. The analyzer should be checked by connecting a pink noise generator to its input. With the unit set for the greatest resolution and longest averaging time, the display should be entirely flat.

The analyzer should be connected to the left channel of the optical preamplifier, while the oscilloscope is connected to both the left and right channels. The cables should be long enough to allow these instruments to be placed next to the projector.

The test films required for an "A" chain alignment are: SMPTE Buzz Track, Dolby CAT-69 and Dolby CAT-97. These test films are best used in large loops which can be run through the entire projector. Small loops are less stable due to the greater splice frequency.

ALIGNMENT PROCEDURE

The precision required of an "A" chain alignment cannot be overemphasized. The ultimate result desired is a flat frequency response across the widest possible bandwidth. It is vitally important to optimize the "uncorrected" frequency response in order to obtain the clearest sound.

As an example, the uncorrected response of one optical pickup may be flat up to 4,000

Hertz (HZ), while a second is flat to 8,000 HZ. Using the slit loss correction of the optical preamplifiers, both systems can be "corrected" to be flat to 12,000 HZ. Even though both systems can be made to measure the same, the second system (with the better uncorrected response) will sound clearer in the higher frequencies.

This also points to the recommendation for narrow slit lenses. The size of the slit determines the high frequency response of the optical pickup. The smaller the slit, the better the response. In the past, I have specified 1/2-mil slit lenses in all our sound systems equipped with exciter lamp based soundheads.

When properly adjusted, the uncorrected frequency response of an optical pickup fitted with a 1/2-mil slit lens is flat to 8,000 HZ and 1 dB down at 10,000 HZ. If a .7 mil slit lens is used, the uncorrected response should be flat to 6,300 HZ and 1 dB down at 8,000 HZ. Slit loss correction should not be done until these uncorrected performance levels are attained.

The brackets holding the exciter lamp bases in some Century soundheads are mounted with three rubber grommets. Check the condition of these three grommets. The grommets (part # GM-0051) should be replaced if they show any signs of hardening. As they age, their shape can distort, allowing the lamp's position to change and droop. This often makes it impossible to adjust the lamp position for a full frequency bandwidth. (This problem may be encountered so often that having these grommets on hand when servicing theatres is recommended).

The following eight steps assume that the soundhead is in good mechanical condition and is not exhibiting any audible wow or flutter.

EIGHT STEPS

Step 1. Set the optical preamplifier gain controls and the slit loss controls to minimum. (If using an older Dolby CAT-108 preamplifier, set gain controls to maximum). If using a Sony DFP-3000, set the optical gain adjustements to -5.0, and the slit loss to 20 kHz. This provides the oscilloscope 2 channels with the same gain and high frequency characteristics. These initial calibration settings are essential even if these adjustments are thought to be correct.

Step 2. Check the rollers, bearings and sound drum for proper rotation and play. Adjust or repair as needed. In projectors so equipped, be sure the damping fluid level is correct and that the rubber grommets have not hardened. Finally, clean the slit lens.

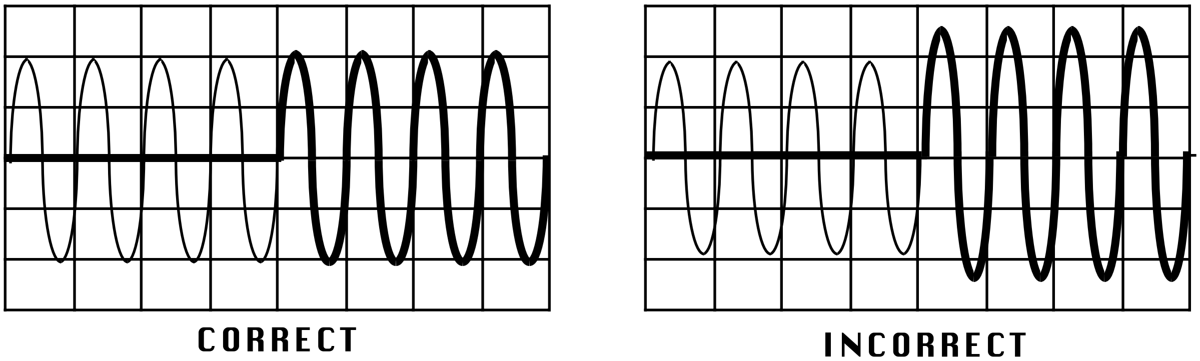


Fig. 1

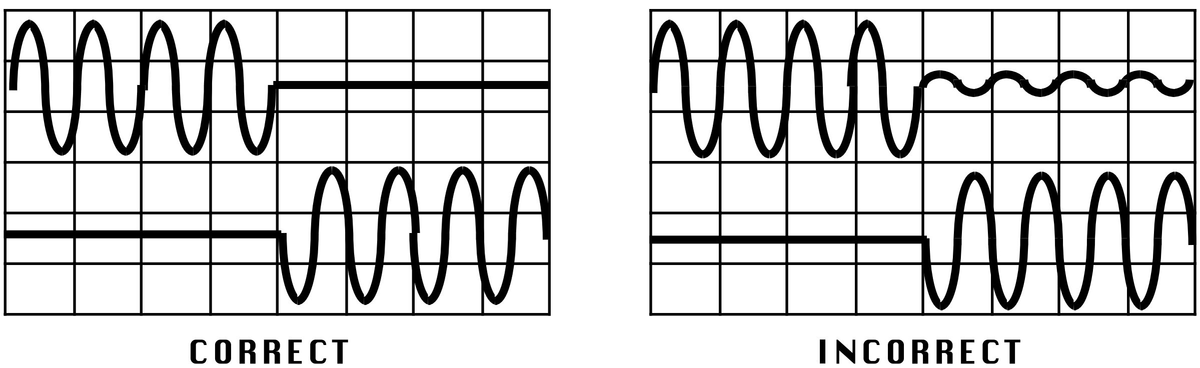


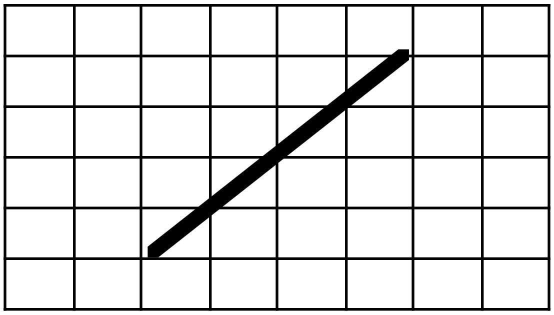
Fig. 2

Step 3. Replace the exciter lamp. Break the old one to avoid accidental use. Measuring at the lamp, adjust the exciter lamp voltage to 85 per cent of the bulb's rating (a 9 volt lamp should be operated at 7.65 volts.) This provides good illumination uniformity across the length of the filament.

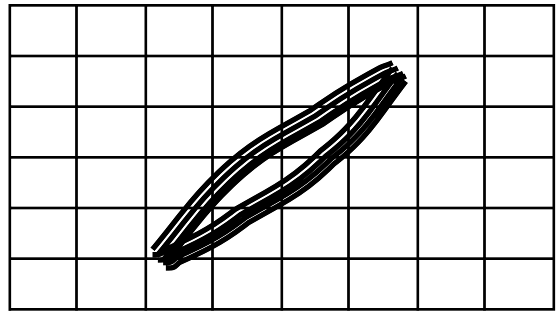
Step 4. Lace up and run a full loop of SMPTE Buzz Track. Loops should be run through the entire projector and sound-head path, skipping no more than the gate and intermittent for less noise and reduced loop wear. Do not use short sound-head only loops as they may not be stable enough for accurate adjustments.

Adjust the sound-head's lateral film guide for equal and minimum high and low frequency tones or a total absence of tones. Remove Buzz Track when finished.

The lateral guide positions the soundtrack with respect to the light beam. This must be done first since other adjustments cannot be assured unless proper film position has been verified.



CORRECT



INCORRECT

Fig. 3

It is suggested that a small dot of red nail polish be placed at the top edge of the lateral guide's adjustment knob. This provides a means to visually confirm the proper position of the guide.

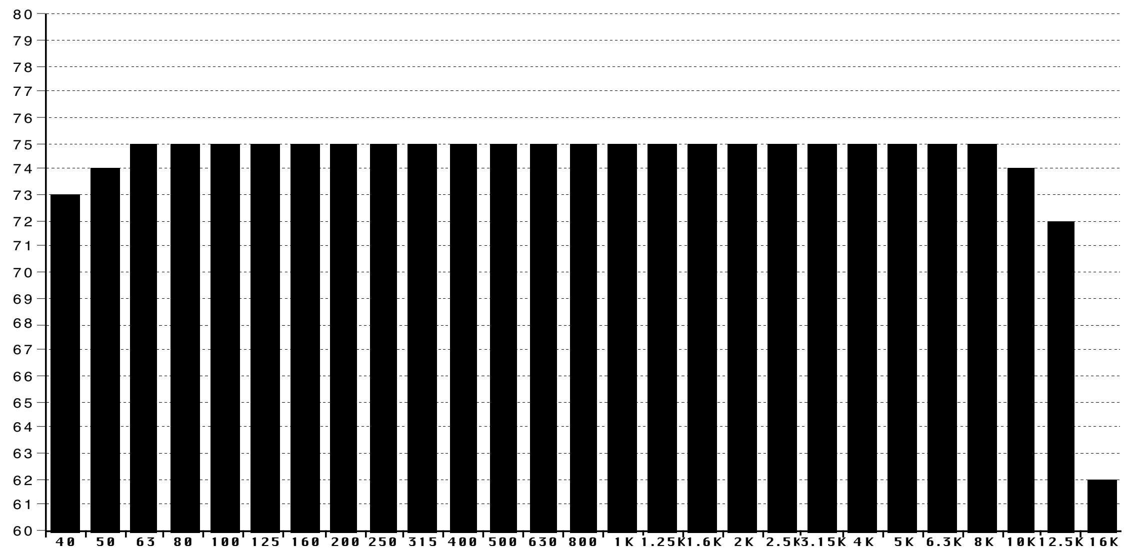
Step 5. The next step sets the lateral, or side to side, position of the exciter lamp itself and then the stereo solar cell. The optical preamplifier's gain controls (see step one above) and the 'scope input settings must be matched.

Lace up and roll the Dolby CAT-97 “left/right” loop. This film provides short tone bursts alternating between the left and right channels. Using the oscilloscope in the dual trace mode, adjust the positions of the two traces so that they overlap, one on top of the other. (See Figure 1) The two tone bursts should be equal in amplitude. If they are not, adjust the lateral position of the exciter lamp so that the amplitudes of both the left and right channels are equal.

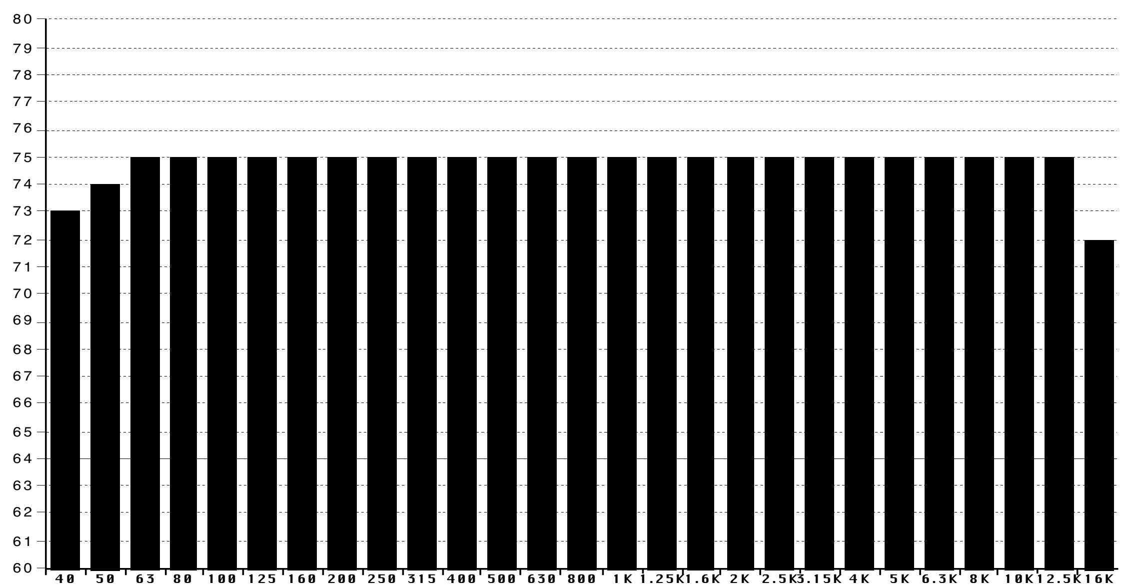
(NOTE: One of the traces in Figure 1 is drawn with a heavier line. This is to help distinguish the two traces.)

After this is done, separate the two traces on the 'scope. Adjust the lateral position of the solar cell for minimum and equal crosstalk between the two channels. (See Figure 2) Be sure the light beam strikes the upper half of the cell when this adjustment is complete.

Step 6. Lace up and roll the pink noise side of a black and white Dolby CAT-69 film loop. Set the 'scope for X/Y operation and turn on the real time analyzer. The analyzer should be set for its greatest resolution and longest averaging time. This would mean 1 dB per division (LED) and Decay Time #3 on an Ivie IE-30, for instance. Unlike SPL measurements, no “A” or “C” weighting should be applied to the display. The 1/3 octave display must be unweighted.



1/2 MIL SLIT LENS, UNCORRECTED RESPONSE



1/2 MIL SLIT LENS, CORRECTED RESPONSE

Figure 4

(Pink noise recorded on color stock is not recommended, as it has a poor high frequency response when compared to the older black and white CAT-69. This will cause the slit loss correction to be set too high, resulting in an excessive high frequency level and an audible treble mismatch between optical and digital soundtracks). Ultra-Stereo's B&W pink-noise/tone test film is also acceptable.

First, adjust the vertical height of the exciter lamp to obtain the highest output and the widest frequency bandwidth as seen on the analyzer. Next adjust the focus and azimuth of the slit lens for the best high frequency response as seen on the analyzer and the best azimuth as seen on the 'scope. If the slit lens has a key on its side which prevents azimuth adjustment, remove the key. (See Figure 3)

At this point, with a 1/2-mil slit lens, the analyzer should show a flat response to 8,000 HZ, dropping down 1 dB at 10,000 HZ. A .7 mil lens should measure flat to 6,300 HZ, dropping down 1 dB at 8,000 HZ. If this is not the case, carefully adjust the vertical height of the lamp and observe the analyzer. On rare occasions, maximum output and widest bandwidth do not occur at the same bulb height. Always adjust for the best frequency response (widest bandwidth), even if the output level drops a few dB. (See Figure 4) Moving the lamp closer to the lens, or trying another lamp altogether, may also help. The point is that once the lens is properly focused, careful selection and adjustment of the lamp is required for the best high frequency response. While adjusting the vertical position, do not disturb the lateral position of the lamp. It may be necessary to perform the focus and lamp height adjustments more than once.

Step 7. When the specified uncorrected response is achieved, adjust the preamplifier's left and right slit loss correction. It is important to keep in mind that the high frequency limit for an optical pickup is about 14,000 HZ. Therefore it is useless to attempt to increase the flat response beyond 12,000 HZ as seen on the analyzer. Attempting to go beyond this will actually result in an excessive high frequency level in the 12,000 to 14,000 HZ range which the analyzer will not indicate. This is due to the poor high frequency resolution of the analyzer's highest 1/3 octave filters. (See Figure 4)

Note: If the cinema processor is equipped with an older Dolby CAT-108 optical preamplifier, it was not designed for narrow slit lenses. Do not attempt to achieve a response out to 12,000 HZ with these preamplifiers. Due to their filter designs, older Dolby CAT-108 optical preamplifiers should not be expected to exhibit a useful response above 10,000 Hz. For best results, the processor should be updated with a CAT-108-C.

Step 8. Lace up and roll the Dolby Tone side of the Dolby CAT-69 loop.

To be certain that the film is laced up on the Dolby tone track, be sure to listen to the tone through the monitor, anytime Dolby tone is adjusted. This assures that the tone track is running and the levels will not be accidentally set with the pink noise track.

Refer to the manual for the processor (if necessary) and adjust for proper "Dolby level". Dolby cinema processors must be in the MONO mode (format 01) when adjusting Dolby level. Once Dolby level is set, place the processor in optical stereo (format 04) and observe the meters in the processor. They should not deviate very much. If one meter does show a large difference, replace that channel's noise reduction module. If the problem is corrected, leave the new module installed.

Slowly insert a business card in front of the sound lens. Observe the meters. The right channel should drop first.

As always, it is a good practice to leave a loop of Dolby CAT-69 film in the theatre. The managers or projectionists should be fully familiar with its use so that Dolby level can be checked and adjusted as needed in each stereo system on the first of every month.

IR/LED OPTICAL READERS

Known for their reliability and simplicity, exciter lamp and slit lens based optical readers are also prone to exhibit a host of problems and deficiencies. Poor slit lenses, uneven light distribution, diminishing light output as the lamp ages and poor high frequency response, are just a few of the drawbacks exhibitors and technicians have had to live with.

Of these, limited high frequency response is probably the most frustrating. Without compensation circuits in the optical preamplifiers, the upper frequencies begin to disappear at around 6,000 HZ (Hz) and sometimes as low as 3,000 Hz. Considering that the upper limit in most audio is somewhere between 15,000 and 20,000 Hz, optical transducers rank among the worst still in use today.

This is primarily due to the height of the "slit" of light projected on the film through the slit lens. The higher the frequency, the smaller the waveform of that frequency. At some point the frequency will be high enough, and the waveform small enough, that the entire positive and negative portions of the tiny waveform will fit within the height of of the slit of light on the film. Being equal, these positive and negative portions will add together and cancel each other. When this occurs, the signal disappears and the output from the

pickup solar cell is mute at this frequency. This point is called the cancellation frequency. As the cancellation frequency is approached, a greater proportion of a complete waveform can fit within the slit. So a gradual cancellation actually begins at a lower frequency. This varies and can be as low as 2,000 to 3,000 Hz, particularly with older slit lenses.

While slit loss correction can restore the level reduction caused by partially canceled frequencies, it cannot restore the audio quality lost. In other words, the more slit loss correction required by an optical pickup, the less the clarity of the sound. In recent years, 1/2 mil slit lenses have become available. Uncorrected, the high frequencies with 1/2 mil lenses will begin to cancel at 10,000 Hz, meaning that the frequency response will be flat to 8,000 Hz and -1 dB down at 10,000 Hz. (See Figure 4).

Another problem with optical readers has been the exciter lamp itself. As much as half a shipment of these lamps can be rejected due to misaligned filaments. Once a good lamp is installed, the light output decreases with age. Without regular checks and recalibration, the signal level drops as well. While increasing the position of the house fader may restore the overall sound level, the sound quality will be dull and lack dynamics due to mistracking noise reduction circuits.

IR/LED's

Recently Cinemeccanica US, Christie Inc., Component Engineering and Kel-Mar have been offering a totally new approach for optical readers. Originally developed by Dolby Laboratories, these devices replace the exciter lamps with an Infrared Light Emitting Diode (IR/LED). In the so called reverse scan configuration, the IR/LED is placed where the solar cell has been. The new pickup cell is placed in a sealed enclosure and located in the old exciter lamp's position. In most cases, this assembly is held in place in the slit lens clamp, making retrofits fairly simple.

There are many advantages to this system. For one thing, the light level is very stable for the first time. As long as alignment is not disturbed and the lens is kept fairly clean, the signal level should not drift. Routine replacements of the exciter lamp are a thing of the past, as are show-stopping lamp failures.

Another plus is the sometimes significant improvement in sound quality. Crosstalk between the two channels on the optical soundtrack is eliminated. This maximizes the separation between the four channels played back in the theatre. Separation across the screen is wider. Surround channel sound quality and steering are superior to that attained in forward scan exciter lamp based systems.

Finally, the frequency response is improved requiring less slit loss correction. At worst, uncorrected response is equal to a 1/2 mil slit lens; flat to 8,000 Hz and -1 dB down at 10,000 Hz. Most units, however, are flat to 10,000 Hz and -1 dB down at 12,500 Hz. Units have been encountered which are flat to 12,500 Hz and -1 dB down at 16,000 Hz. This represents virtual perfection as no slit loss correction whatsoever is required in such cases, leaving the sound as clear as it can be.

SETUP INSTRUCTIONS FOR IR/LED STEREO-OPTICAL SOUND READER

What follows is a general set of installation and setup instructions for IR/LED optical readers. While units from the different manufacturers differ in certain adjustments, performing the steps in the order listed here will make the operation more efficient and ensure the best possible results.

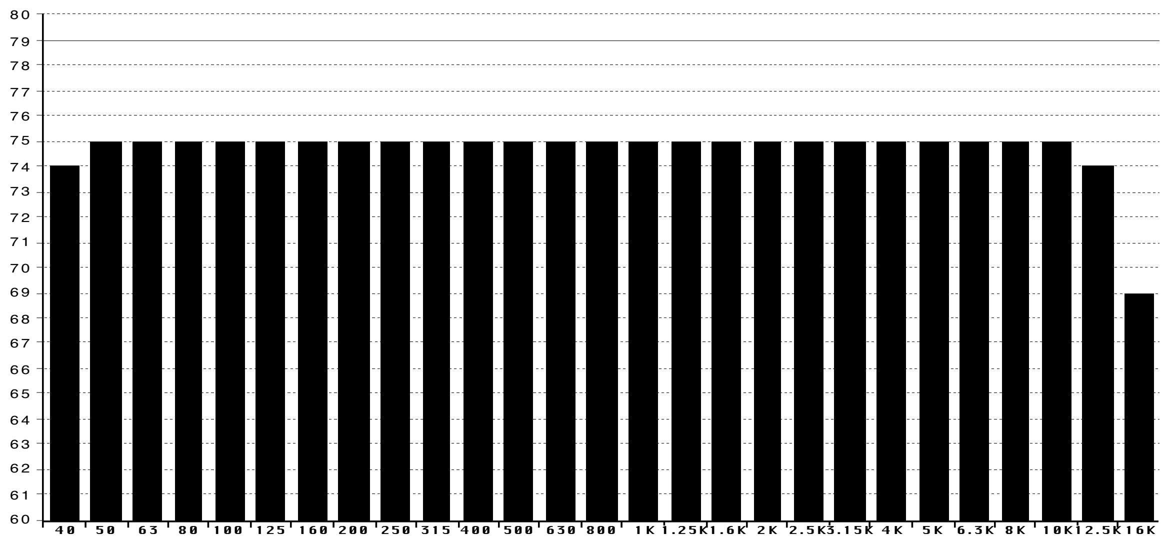
PERFORM STEPS 1 THROUGH 3
BEFORE INSTALLING THE NEW READER.

Step 1. Set optical preamplifier left and right gain and HF controls to their minimum positions. If the cinema processor is outfitted with an older Dolby CAT-108 optical preamplifier, set the gain controls at their maximum positions and the HF controls to minimum.

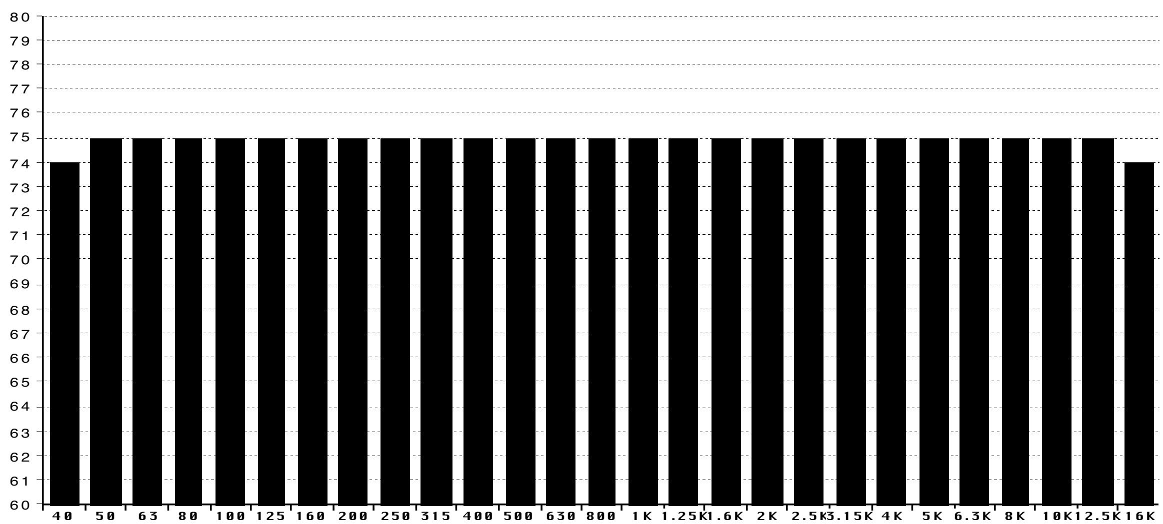
Step 2. Connect a real-time-analyzer (RTA) and oscilloscope to the optical preamplifier in the normal way. The RTA should be connected to the left channel. The cables should be long enough to allow the instruments to be positioned next to the projector.
The vertical sensitivity of both channels of the oscilloscope should be matched during the entire calibration procedure. Be sure that in addition to matching the volts/division settings, that both of the variable controls are in their “cal” positions.

Step 3. Lace up and run a full loop of SMPTE Buzz Track. Loops should be run through the entire projector and sound-head path, skipping no more than the gate and intermittent for less noise and reduced loop wear. Do not use short sound-head only loops as they may not be stable enough for accurate adjustments.

Adjust the sound-head’s lateral film guide for equal and minimum high and low frequency tones or a total absence of tones. Remove Buzz Track when finished.



IR/LED OPTICAL READER, UNCORRECTED RESPONSE



IR/LED CORRECTED RESPONSE

Figure 5

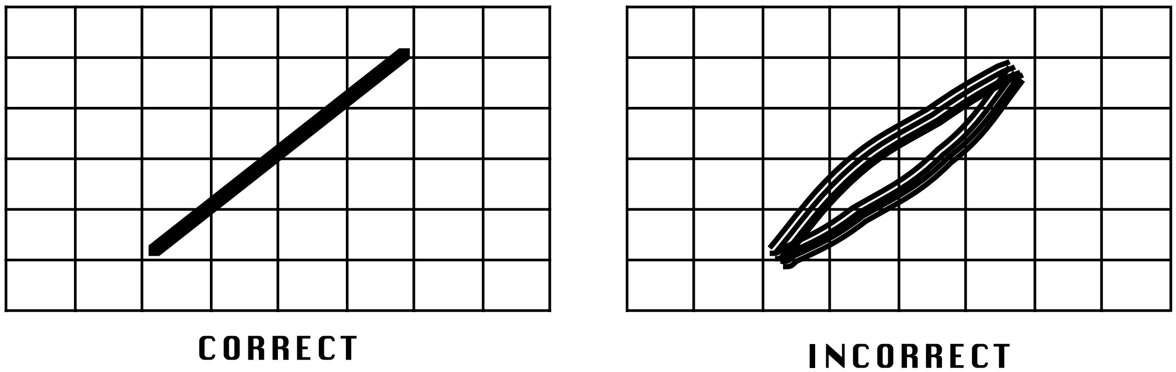


Fig. 6

Step 4. Install the IR/LED reader as per instructions. Tighten the assembly in the slit lens clamp just enough to hold it in place, yet loose enough to move it.

Step 5. Lace up and run a loop of black and white Dolby CAT-69 pink noise. Turn on the RTA and oscilloscope. Set the RTA for maximum resolution, typically 1 dB per division. The RTA averaging or decay time should be set to be just long enough to provide a stable display. This would mean 1 dB per division (LED) and Decay Time #3 on an Ivie IE-30. Set the 'scope for "X/Y" operation.

Adjust the position and azimuth of the reader in the slit lens holder for the widest possible frequency response on the RTA as well as the tightest 45° pattern on the 'scope. (See Figures 5 and 6).

If installing the Kel-Mar, Cinemeccanica or Christie units, adjust the vertical position of the LED bracket itself for the maximum output as measured on the RTA.

Step 6. If installing the Kel-Mar, Cinemeccanica or Christie units, using the adjustments at the rear of the reader, observe the RTA and adjust the vertical height of the reader for maximum amplitude as well as a frequency response which is flat to 10,000 Hz and -1 dB down at 12,500 Hz, (the height adjustment effects both). The azimuth may be further refined as needed with the adjustments at the rear of the reader. Check the position of the LED with respect to the film. Slight adjustments up or down may help maximize the amplitude and high frequency response. If installing the Component Engineering unit, adjust the LED position itself at the end of its support bracket for maximum amplitude and bandwidth. The focus, azimuth and vertical height adjustments may need to be touched up more than once for optimum results.

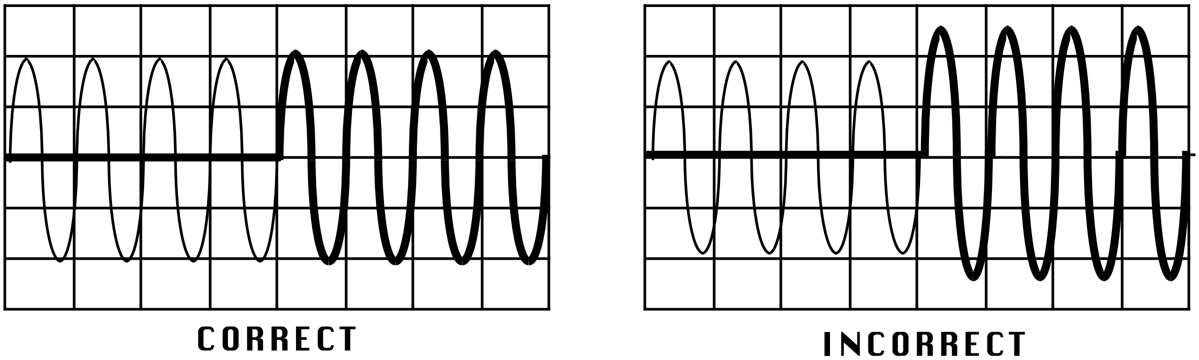


Fig. 7

Step 7. When the proper frequency response is obtained, tighten the reader assembly in position, typically with the slit lens clamp screw. Also tighten all the lock screws for the preceding adjustments. Some installations may yield an uncorrected response which is flat to 12,500 Hz and -1 dB down or so at 16,000 Hz, in one or both channels. In such cases, no further adjustment for high frequency slit loss is required for that channel.

(Pink noise recorded on color stock is not recommended, as it has a poor high frequency response when compared to the older black and white CAT-69. This will cause the slit loss correction to be set too high, resulting in an excessive high frequency level and an audible treble mismatch between optical and digital soundtracks). Ultra-Stereo's B&W pink-noise/tone test film is also acceptable.

Step 8. As necessary, carefully adjust the optical preamplifier's left and right slit loss correction controls for a frequency response with is flat to 12,500 Hz and -1 dB to -2 dB down at 16,000 Hz. (See Figure 5.) Avoid adjusting for a response which is flat to 16,000 Hz as this is a false reading with optical soundtracks when measured with 1/3 octave real time analyzers and will result in an excessive optical soundtrack high frequency level.

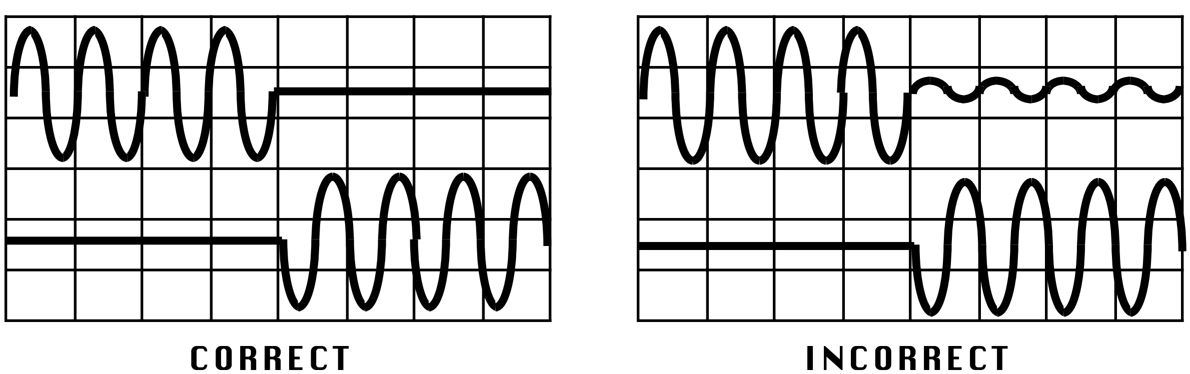


Fig. 8

Note: Due to their filter designs, older Dolby CAT-108 optical preamplifiers should not be expected to exhibit a useful response above 10,000 Hz. For best results, the processor should be updated with a CAT-108-C.

Step 9. Lace up and run a full loop of SMPTE Buzz Track. Adjust the sound-head's lateral film guide, if necessary, for a total absence of tones. Place a "dot" of red paint or nail polish at the top of the lateral guide adjustment to mark its correct position. This enables one to visually detect if the lateral guide has been moved.

Step 10. Lace up and roll a loop of Dolby CAT-97 "left / right" film. Set the oscilloscope for dual-trace operation and adjust the display so the two tone bursts overlap each other. The trace should now look like a continuous sine wave with a horizontal line though it. (See Figure 7). Again, it is imperative that the volts/division controls on the 'scope are in the same positions.

(NOTE: One of the traces in Figure 7 is drawn with a heavier line. This is to help distinguish the two traces.)

If using the Kel-Mar, Cinemeccanica or Christie units, adjust the reader's lateral position on the back of the reader until the two bursts have equal amplitude and no crosstalk. When complete, tighten the reader's lateral position locking screws. If installing the Component Engineering unit, adjust the lateral position of the LED at the end of the support bracket until the two bursts have equal amplitude. Adjust the 'scope display so that the traces are one above the other. There should no crosstalk. (See Figure 8).

Step 11. Lace up and roll the Dolby Tone side of the Dolby CAT-69 loop.

To be certain that the film is laced up on the Dolby tone track, be sure to listen to the tone through the monitor, anytime Dolby tone is adjusted. This assures that the tone track is running and the levels will not be accidentally set with the pink noise track.

Refer to the manual for the processor (if necessary) and adjust for proper "Dolby level". Dolby cinema processors must be in the MONO mode (format 01) when adjusting Dolby level. Once Dolby level is set, place the processor in optical stereo (format 04) and observe the meters in the processor. They should not deviate very much. If one meter does show a large difference, replace that channel's noise reduction module. If the problem is corrected, leave the new module installed.

Slowly insert a business card in front of the new sound lens. Observe the meters. The right channel should drop first.

(The black and white Dolby CAT-69 tone track is acceptable. However the Dolby tone recorded on color stock provides a better balance and reduces or eliminates any tendency for dialog to spit into the left channel.)

John F. Allen is the founder and president of High Performance Stereo in Newton, Mass. He is also the inventor of the HPS-4000® cinema sound system and in 1984 was the first to bring digital sound to the cinema. John Allen can be reached by E-mail at JohnFAllen@aol.com..