



**HPS-4000®**

HIGH PERFORMANCE STEREO

Sound IS the Experience !™

**A FEW NOTES:  
THE IMPORTANCE OF GAIN STRUCTURE;  
“A” CHAIN UPDATE;  
DOLBY SURROUND EX;  
AND AN EPILOGUE  
ON WHY MOVIES ARE NOT TOO LOUD**

**BY**

**JOHN F. ALLEN**

HIGH PERFORMANCE STEREO™



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## HIGH PERFORMANCE STEREO

*FIRST IN DIGITAL STEREO*

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**GAIN STRUCTURE**

Whether it be an amplifier, a processor, a cable TV system or a cinema sound system, the relative level of the signal as it passes from one stage to another is critical. This is often referred to as gain structure. A good designer makes sure that the signal is amplified, processed or transmitted with as little added noise or distortion as possible. Indeed, it is the limits of noise and distortion that define the dynamic range of the final system.

In sound systems, noise and distortion are a constant presence. For instance, if we record music on an audio cassette at too low a level on the tape, we will hear a large amount of noise in the form of hiss. If we record at too high a level, we hear distortion. This is pretty familiar stuff to be sure. But when designing or installing a motion picture sound system, gain structure is just as important and yet is often overlooked. We can't change the internal workings of a processor or an amplifier, so most of the gain structure of such a system is defined by the manufacturers of these devices. In addition, the gain structure of the various sound pickups in the “A” chain are defined by the non adjustable digital readers, or the setting of Dolby level for the analog reader.

This leaves the cinema processor-to-amplifier stage as the one area where the sound system designer or technician is responsible for obtaining a proper gain structure. Unfortunately, there is little (if any) guidance to go by.

Some years ago, the practice of setting the amplifier's input controls to their maximum began. The logic was that the maximum position was the easiest setting to restore should someone change or tamper with the adjustment of the control. At first glance, this makes very good sense. How else can we be certain that the input controls and the sound levels in the theatres will remain where they belong? The problem with this approach is that with the amplifiers running, in a sense, wide open, the signal levels out of the processor will

need to be quite low. So low, in fact, that we can sometimes hear hum and noise from the processor itself. This noise is the noise floor of the processor. If the signal level is too low then the ratio of signal to noise is too low.

When the amplifier's inputs are set to maximum, a second source of hum caused by ground loops becomes far more evident. It is most troubling that most of the power amplifiers in movie theatres today do not provide a ground lift to disconnect the audio-ground from the chassis-ground. Such a connection should only be made once in a sound system - at the processor. Connecting the audio-ground to the chassis-ground not only at the processor, but again and again at each amplifier, creates ground loops as well as audible hum.

The proper way to eliminate this hum is for the amplifier to provide a ground lift. Professional audio equipment provides ground lifts. It's one of the things that makes professional audio equipment professional. Without such a ground lift we are forced to either live with the hum or install transformers at each input of each amplifier. The latter, of course, never happens due to cost. As a result, we have hum in a lot of theatres.

**...not only can we set an ideal gain structure, there is no ground loop induced hum.**

One way to at least mask the hum, is to turn down the input controls on the amplifiers. Since the hum signal is coming in on the input cables, its level can be effected by the input controls. However, if one turns these controls down too far, the processor will need to be turned up too high and begin distorting. So there must be a happy medium, and there is. For some years now, I have been setting the output of each channel of the processor at 500 millivolts, except the digital subwoofer which is set 10 dB lower at 160 millivolts. This is done by simply using the processor's pink noise generator as the signal source. The processor's fader is set to its normal position during these adjustments - typically "7". These levels represent an excellent signal to noise ratio for the processor as well as allowing us to turn down the amplifier's input controls low enough to pretty well, though not entirely, cover up ground loop induced hum.

Once these levels are set, the processor's output levels are not touched. All sound levels in the theatre are then set with the amplifier's input controls. The only exception to this is the optical subwoofer level which is set by the processor's optical subwoofer level control *after* the digital subwoofer level is set by the subwoofer's amplifier input controls.

Of course, in setting the gain structure using the amplifier's input controls, we loose the ability to know that these controls will stay where they belong. There are several solutions

to this: First is to use a small ball of plumber's epoxy to lock the control knobs in place. This works beautifully since this epoxy hardens into virtual concrete in a few minutes. Second is to use amplifiers with their input controls on the rear panel instead of the front. One should still use epoxy in this case as well. A third option is to use special "XLR" input connectors with built-in variable attenuators. Unfortunately, these special connectors are more expensive than transformers.

The best solution is to equip cinema amplifiers with two different sets of input controls. One set of controls is on the front panel. These are normally set to maximum. The second set is on the rear panel. It is these rear controls that are actually used to set the sound levels in the theatre. The rear panel controls should be the locking shaft type for security. This solution is ideal because the sound system has an excellent gain structure for each and every channel, plus the technician still has complete control of the amplifier with the front panel controls. To my knowledge, BGW is the only amplifier manufacturer offering this option with their Millennium 3-HPS, GTB-HPS and 750-HPS amplifiers. In addition to the dual input controls, these amplifiers all have ground lift switches. So, not only can we set an ideal gain structure, there is no ground loop induced hum.

#### **"A"CHAIN UPDATE**

In the November, 1996 issue of BOXOFFICE, I wrote an article entitled EXCITER LAMP AND IR/LED OPTICAL READER "A" CHAINS AND THEIR SETUP PROCEDURES. In that article I recommended the use of black and white based pink noise test film. Several people have asked me where to get it since Dolby has discontinued this version of their CAT-69 film. USL, Inc. (Ultra Stereo Labs. 805-549-0161) now offers a black and white optical pickup test film with both pink noise and tone tracks. I have tested this film against my reference CAT-69 films and found it to be accurate.

#### **DOLBY SURROUND-EX**

At the recent Showeast convention in Atlantic City, Dolby Laboratories introduced a modified digital format being called Surround EX. Rather than just the traditional left surround and right surround channels, this format adds a derived center surround channel. Derived because the center surround channel is not recorded in the digital soundtrack as a separate channel. It is instead the sum of the left surround and right surround channels. This is done using the same technique that derives the center screen channel from the two channel matrixed optical stereo format. Information that is common to both surround channels is steered to the surround speakers on the rear wall, while it is also suppressed from the left and right surround speakers. Both an additional stereo

amplifier and an adaptor to the cinema processor are required. If a theatre has no surround speakers on the rear wall, they will need to be installed.

Surround EX has been developed in response to Lucasfilm's sound designer Gary Rydstrom who wanted to expand control of the surround channels for the upcoming release of STAR WARS: EPISODE 1. While this marks the first use of a sound format with more than two surround channels in a modern general release, the use of three or more surround channels is not a new idea.

**I began to wonder if TWISTER was the best choice, but it was too late.**

My own thoughts and experiences with three or more surround channels go back over 18 years. In my very first article written for BOXOFFICE in 1980, I recommended a third surround channel. I even suggested that in certain limited cases the speakers for the third surround channel could be placed down the center of the ceiling. During the 1988 SMPTE deliberations concerning the new digital sound film format, I once again suggested three surround channels. But the feeling was that two surround channels were enough. Since then, I have heard a home theatre system demonstrated with a ceiling surround source and was surprised to find that it worked better than I had imagined. Several years ago, I was finally able to put some of these ideas into practice myself when I began mixing some special venue films in formats with both three and four surround channels.

Actually, the use of multiple surround channels is one of the oldest notions in cinema sound. All of these ideas, including a ceiling surround channel, steering as well as the original pan pot were originally done by the truly pioneering engineers at Disney and RCA in 1939, during the development of the Fantasound system for FANTASIA.

From my own more recent experiences, I can report that there is some enhancement gained with three or more surround channels. However, with the exception of a hard rear source, the enhancement is limited. This is especially true with well designed surround arrays. Ironically however, with the all too common poorly designed surround arrays found in today's theatres, the addition of a third surround channel should offer an even greater improvement, particularly with directional effects. This is because these typical surround arrays presently fail to deliver such effects convincingly. I should also report that, in my opinion, the demonstration heard at Showeast seemed out of balance with the rear speakers sounding weak when compared to the sides. Those who heard this demonstration might be encouraged to know that Surround EX can indeed add more than what they might have heard that afternoon.

## LOUD MOVIES EPILOGUE

My November, 1998 article explained why the distortion created by inadequate speakers and amplifiers was a principal cause of patron complaints that movies are too loud, when for the most part they are not. At about the time the article appeared, I had a chance to put this notion to what turned out to be a severe test in a refurbished theatre in Westhampton Beach, New York. The Westhampton Beach Performing Arts Center is a dream come true for many dedicated citizens of the Long Island community. Built in 1933, the theatre has been mostly used for movies in the last few years. Much of the building was in bad repair when a group was formed to raise the funds needed to restore the theatre and create a facility for live performances as well as occasional film premieres and festivals. I was honored to be asked to design the motion picture sound system by Gerry Ferrara, who served as the cinema consultant and technician for the project. Gerry is president of Production Screenings, Inc. in Southampton, New York. His principal activity is providing the equipment needed to screen dailies during film productions.

During the final planning for my trip to the theatre to perform the tuning and calibration of the system, I was informed that the management wished to have a demonstration screening. Gerry and I decided to use the film TWISTER. Since the soundtrack of this particular film is so demanding and dynamic, we thought that it would provide a terrific demonstration. In addition to being a movie about tornadoes, this film has the loudest and most powerful surround track I have ever encountered. In fact, TWISTER is known for destroying speakers all over the country on the day it opened.

When I arrived, I was surprised to discover that there would be an invited audience of some 100 to 200 contributors, benefactors and board members. Indeed, I began to wonder if TWISTER was the best choice, but it was too late. On the night of the screening, I was asked to make some comments before the film began. I noticed that there was a generous number of people in attendance who were over 70. Considering the number of complaints heard from older patrons about sound levels, I thought that this audience was going to provide much more of a test of me than anything else.

In my remarks, I brought up the subject of "loud movies." I explained that this was a loud movie but that since the sound system was big enough so that it would never distort, I believed that they would not mind the loudness. The film was played in its entirety at the normal fader setting of "7". It was never turned down (or up, needless to say). The digital format was DTS.

As soon as the film ended, people began coming up to congratulate me on the sound.

Without exception, each and everyone who spoke to us at the reception that followed stated that they thought the sound level was perfect: that they would not have changed it. The most striking of these comments came from a woman who rushed to stop me as I walking up the aisle at the end of the film. She showed me a set of commercial grade earmuff type hearing protectors; the kind people wear around heavy machinery and jet aircraft. I was stunned. She said that she had to wear these things in movie theatres because she so hated the loudness that she could not go to movies without them. I was about to dissolve when she told me that she hadn't used them once during the evening. She said that the film was loud when it was supposed to be loud, but that the sound was so clear that it didn't bother her. She told me she wouldn't have changed anything.

This audience was made up of philanthropic people who had literally paid thousands of dollars to see this film. Had they been unhappy about anything, we certainly would have known. Even the newspaper accounts that followed echoed the approval of the audience. The sound system they heard is designed to have at least 6 dB, or four times, the dynamic range of the loudest digital motion picture. In this medium size theatre, this means that the acoustic power required of the sound system is equivalent to eight symphony orchestras - all playing at once. Six dB may sound like a lot, but in reality it isn't. It's about the difference in raising your voice. The purpose of this additional output power is to ensure that the sound will, at all times, be reproduced with effortless clarity and an absence of overload or distortion. My November article made the case that the distortion resulting from the lack of such capability in today's movie theatre sound systems is a major contributor to patron complaints about loud sound. With the experience at the Westhampton Beach theatre, I believe I can rest my case.

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