



# Performance Media Industries, Ltd.

Home Theater Audio System Standards – What are we trying to do?

by A. Grimani

So you claim that you're putting together a high performance home theater. But do you fully understand what that comprises? Do you know all the little ins and outs of why some products work better than others in selected applications? I know that it's hard to take time to read through technology reports, research papers, and product reviews to learn how to design the best possible theaters. So I'm going to help: I'll give you some facts along with my honest unbiased opinion of what a home theater is supposed to be. And of course everyone reading this will agree with me... NOT! I know there will be tons of hate mail criticizing this or that position, but we gotta start somewhere; shoot now – we'll talk later.

Let's first cover what the theater is *supposed* to do. It is supposed to reproduce sound and pictures as closely as possible to those intended by the creators of the program material. If the creator was good at it, you can get a realistic representation of naturally occurring soundscapes and landscapes. All it takes is for the playback system to do the same thing to the program material as what the creator's system was doing. Then presumably you will hear and see the program the same way as he or she did. The good news is that there actually are standards and specifications for the audio-visual monitoring system used by program creators. For films the standards are pretty ironclad, and are outlined in documents from several organizations (SMPTE, ISO, BBC, AES, etc.). In some cases the standards don't translate directly because they are made for large room sound and picture perception. There are ways in which we experience these things differently in small rooms, but a sufficient amount of research out there documents the differences. Some of the research is hard to read (unless you have serious insomnia), and may even be in a different language (lots of it in German, ya). I have spent some time with the issue over the last 15 years and I feel that it is possible to produce home theater sound and picture that would make even the pickiest film director agree to the translation.

As for music production standards, things are a little more slippery, especially for multichannel music. There are less clear standards in the industry, but there are plenty of de-facto practices established by the movers and shakers. Usually the guy who gets the most Grammy awards gets to have a say on what's the right monitoring approach this month...

Trade publications like Mix Magazine, Surround professional, and more, are filled with articles on the right layout and calibration methods for multichannel audio monitoring systems. They tend to be in the same direction as those established for film monitoring systems, with the exception of occasional differences in locations of the surround speakers. That doesn't matter too much after all because surrounds are usually much less important to the soundfield story than the front speakers, so we don't have to go all hoopy over the differences.

Let's talk about sound monitoring standards in film studio production environments, as that's what most of our clients are looking to emulate.

- 1) **Front Channels:** There are three or five identical loudspeakers across the front stage, behind the screen. Their tweeters are 5/8<sup>th</sup> of the way up the screen. The Left/Right pair forms a 45-degree angle to the main seating area of the auditorium (2/3<sup>rd</sup> of the way back in the room). The speakers cover the frequency range of 40Hz to 16kHz. The gains of the electronics are calibrated so as to produce 85dB SPL when playing a reference level test signal. The Frequency response of the system is calibrated through equalization to yield a specified curve in the main seating area. The curve is a flat response up to 2kHz then -3dB per octave slope above that up to 10kHz, then -6dB per octave slope above that (known as the X-Curve). This is not the response curve of the signal sent to the speakers, but the resulting electro-acoustic response in the auditorium, far from the screen. The picture screen is reasonably acoustically transparent, and any losses are compensated by electronic correction. The speakers should be able to play up to 105dB SPL in the auditorium, which is 20dB above the calibrated reference level. The front speakers cover the audience area with uniform sound so that all the listeners get the same experience. At the same time, those front speakers have built-in directivity so that they don't send too much useless sound energy towards the walls and ceiling of the room, where it would just bounce around and cause excessive reverberation. The front speakers produce good intelligibility and clear localization of sounds accompanying the on-screen action. There are more details to the practices, but we'll stick to broad strokes here!
- 2) **Surround Channels:** There are up to three line arrays of smallish speakers placed on the left, right and rear walls of the auditorium. In fact the rear array is split into two halves so that the room can be switched between 5.1 and 5.1 EX sound reproduction. Each array has anywhere from four to more than twenty speakers in it. The surrounds are placed high enough in the room to cover the listening area with uniform sound energy. There are enough surround speakers to produce 105dB peak sound pressure levels. The speakers cover the frequency range of 40Hz to 16kHz. The gains of the electronics are calibrated so that each array produces 83dB SPL when playing a reference level test signal. The Frequency response of the system is calibrated through equalization to yield the specified X-curve in the main seating area. The surround speakers usually have broad dispersion for smoothest coverage of the audience and to enhance envelopment. These speakers are clearly different to the front speakers, and they fulfill a different role: that of presenting enveloping, diffused sound fields with general directionality towards the left, right, or rear areas of the room. Sound engineers are usually under strict scrutiny to build sound fields that never pull the audience's attention away from the screen, so the speaker array solution works well in providing surround sound energy without distracting localization.
- 3) **LFE Channel (Low Frequency Effects):** There are as many subwoofers as needed to reproduce the content of the LFE track. The sound levels can be up to 115dB SPL in the 20Hz to 80Hz region so these units need to be pretty darned ballsy! The gains of the electronics are calibrated so as to produce 95dB SPL when playing a reference level test

signal in the subwoofer's pass-band. The frequency response of the subwoofer is calibrated through equalization to yield a flat curve from 20Hz to 80Hz in the main seating area. Note that in most studios and theaters the Subwoofers play the LFE track only, and don't play back the bass from the main channels. That's OK because the main channels make it down to 40Hz. Also, since the rooms are fairly large, the bass standing-wave resonances are at such low frequencies that they aren't usually audible; so the Subwoofers can be placed along the front wall without particular location optimization. This is all quite different in Home Theaters, and we will talk about it all later.

- 4) General Acoustic Characteristics: The Auditorium is very quiet, with a noise floor below NC25. The sound isolation is complete so that there are no distractions from the outside world. Sound reflections, echoes, and reverberation are all controlled so that you hear primarily the speakers and not the room around them. There are actually guideline reverberation times based on room size, so that your auditory senses are best matched to the environment. Ultimately, the place where the direct sound from the speakers and the total reflected sound energy from the room are equal falls somewhere in the middle of the audience area (that's known in acousticians' circles as the Critical Distance).

So there you have the basic specifications for audio monitoring in film studios. If you want to hear the movie right, your home theatres should yield the same sonic experience as those studios. The tricky part is that the specs can't be used directly in smaller rooms with consumer speakers. You need to translate the standards to account for the inherent electro-acoustic differences, and I will cover that in another paper.

We also need to talk about the picture standards they use around Hollywood. That's a topic for a separate document...

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