



Performance Media Industries, Ltd.

Bringing Up the Rear
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5.1-channel audio was rocking right along when all of sudden the artists and engineers in the film industry brought us a new challenge: Surround EX. Initially, many people thought that this new format was just a gimmick or marketing ploy, but time and experience have demonstrated that it provides the missing link to a seamless 360 degree soundfield. Like it or not, Surround EX (EX stands for "extended") is here to stay!

Surround EX resurrected many of the surround speaker placement questions that were first asked following the introduction of 5.1, only with regard to rear speakers this time. How many speakers should be used? What type of speakers should be used? Where should the speakers go? How should the speakers be calibrated? These are the issues confronting us today.

However, before we can even begin to address them, we have to answer another question: How do we know that spending the additional money on a Surround EX system is *really necessary*? The answer becomes very obvious if we simply follow the logic used by those who created Surround EX in the first place! 5.1 can very effectively convey a soundfield with smooth soundstage transition between the front of the room and the sides of the room. However, two surround channels cannot effectively carry soundstages from the sides of the room around to the back, particularly for more than one listener. Thus, a 5.1 system has a hole in the rear soundfield! This hole not only makes it impossible for discrete sounds like flyovers to move past the listeners, but it also makes it impossible for ambient sounds to completely envelope the listeners and create the illusion that they are part of the action. Some of us could live happily enough without perfect flyovers, but a hole at the rear of the soundfield is ultimately too much of a distraction. One solution might be to move the surround speakers further back to close up the hole, but then the sides of the soundfield end up with a discontinuity. No matter how you slice it, we need additional vector points in the sound system to achieve believable results. Surround EX fills this requirement by adding a matrix-encoded Surround Back channel, making a true 360 degree soundfield achievable for a number of listeners.

After we understand the necessary benefits that Surround EX offers, we have to achieve those benefits effectively and decisively. Here, the big technical questions raised earlier come into play.

How many speakers should be used? According to those who created Surround EX, the answer is very often two. In certain cases, such as when the listeners are right against the back wall, a single speaker may be used. There should always be a good reason for dropping the second speaker, though.

What type of speakers should be used? Again, according to those who created Surround EX, the answer depends on the room. Because of room acoustics, there is no one-type-fits-all solution. The reflection patterns of the room will affect the way the rear speakers integrate with each other and with the side speakers. Acoustic treatment and control of the reflection character of the room will go a long way to improve integration no matter what type of speaker is used. The key is for the speakers to disappear but the soundstages to remain. Discrete sounds should clearly come from a specific direction, but not from a specific speaker box. In a large room that is very reverberant and has many reflections, direct speakers should probably be used. Direct speakers in smaller rooms are very localizable and distracting, so dipole or bipole speakers would work better. If possible, experiment with the various types in the room, and choose the one that provides the right balance of directionality and soundfield smoothness.

Where should the speakers go? This is the most complex of the questions. Those who were the first to experiment with placing rear speakers tell us that they should go about 150 degrees from front center of the listeners, and at the same height as the side speakers. They also tell us that side speakers and rear speakers form the most seamless, integrated soundfield when they are all about 5 to 6 feet from the floor. In the majority of rooms where rear speakers are employed, the side speakers should be positioned between 90 and 110 degrees from front center. Again, be prepared to experiment since room acoustics and listener positions have a significant effect on the results. There can be no hard and fast rules here.

One huge challenge with rear speaker placement is overcoming a psychoacoustic effect called "inversion." Inversion occurs when a sound that is reproduced from a pair of speakers behind the listeners is perceived to be coming from front center because the listeners' ear-brain mechanisms are unable to detect whether the sound is coming from directly behind them or directly in front of them! The cause of psychoacoustic inversion is too complex to explain here, but its effect can often be lessened by offsetting the rear speakers vertically and/or horizontally so that they do not project a strong phantom

image. The ultimate solution is to use only one rear speaker, but this approach may leave larger rooms with inadequate coverage.

How should the rear speakers be calibrated? In almost all applications, bass management should also be applied to the rear speakers to increase their output capability and extend their frequency response. The ubiquitous 80 Hz crossover found in many A/V controllers is sufficient for most rear speakers, but some speakers in some rooms may benefit from higher or lower crossover frequencies.

Since the rear speakers may be at different distances from the listeners, the speakers should be time-delayed so that their sound arrives at the listeners' ears at the same time as the sound from all the other speakers. A/V controllers that have rear speaker outputs will offer time delays for them. Be sure to set them along with the time delays for the other speakers.

The locations of side and rear speakers near or on walls may result in a thick spectral balance that doesn't match the front speakers very well, causing deterioration in the front-to-side and side-to-rear soundstages. Equalization can very effectively correct the spectral balance and restore the appropriate soundstages. Always use pink noise and a spectrum analyzer to set the equalizers. Don't try to adjust them strictly by ear!

Sound pressure level adjustment is the final step in the calibration process. The rear speakers' levels should be set so that together they produce 75dB SPL, just as any other speaker does by itself. Most A/V controllers, however, provide separate level adjustment controls and internal test noises for each speaker that are to be used in conjunction with an SPL meter to set levels. In this case, go ahead and adjust the level of each rear speaker individually to 75dB. The controller is configured in such a way that, when an actual soundtrack is playing, the resulting level from both speakers together is 75dB. It's a very good idea, though, to use a third-party test DVD (such as the PMI/Gold Line *5.1 Audio Toolkit*) with Surround Left, Surround Back, and Surround Right channel test noises to verify that the controller is behaving properly. With the controller in Dolby Digital Surround EX or DTS-ES mode (depending on the audio format of the test disc), the test noises for all three channels should measure 75dB SPL. Please note that the various THX post-processing modes and any DSP simulation modes may alter the accuracy of this test and should be disabled.

Surround EX systems with rear speakers are an important step forward in our industry. A seamless, 360 degree soundfield is now possible, so go for it! What could be better?

This article is based on a column published by A. Grimani in Residential Systems magazine July 2004. Chase Walton contributed to this article.