# Dolby Laboratories Information

## Some guidelines for producing music in 5.1 channel surround

### What's new: stereo transitions to 5.1 channels

DVD offers, for the first time, a practical means to deliver discrete high quality multichannel audio to the consumer. The concept of 5.1 multichannel audio originated in the film and cinema world, so it is inevitable that some of the terms used will be carried over. These guidelines are an attempt to give some basic starting points for mixing music in 5.1, by explaining the relevance of these terms and pointing up some of the areas where there are alternative courses of action where the outcomes may not be immediately apparent.

### Origins in the cinema

Unlike virtually any other recording and playback format for consumers, film sound is mixed in the same environment as it is reproduced. All aspects have been standardized and calibrated to maintain uniformity between what the mixers create on the dubbing stage and what is heard in the cinema. For purposes of this discussion, this includes the recording levels on the film soundtrack itself and the overall loudness during playback.

When it became important to improve the sound in cinemas years ago, the level and calibration standards had to be maintained to ensure uniformity and interchangeability. Even though it became possible to reproduce a higher quality of sound in the cinema due to the continuous evolution of power amplifier and loudspeaker technologies, strong bass was still not easy to deliver or reproduce. The best soundtracks of the day (70 mm magnetic) were already recorded to their maximum capability, so it was not possible to significantly increase the amount of bass they carried with causing overload. Additionally, the main screen speakers used in cinemas do not reproduce much below 40 Hz even today, so if the main soundtracks carried more bass to the amplifiers, the speaker systems wouldn't necessarily reproduce it.

To supplement the bass capabilities of the screen speakers, subwoofers were installed. To get the bass signals to them, a separate channel was added in the soundtrack. This is known as the LFE channel (for Low Frequency Effects). It handles bass created especially for subwoofer "boom" effects and may also be used to carry bass derived from the other channels in order to help enrich the overall soundtrack presentation.

Consumer delivery formats like CD differ in some significant ways from a cinema system. CDs do not have a calibrated loudness when played—the consumer decides where to set the volume control. Nor do CDs do have a calibrated recording level—if a music producer wants to add more bass to a recording, the overall levels are simply adjusted accordingly to ensure the bass can fit without causing overload. The CD and LD digital audio formats have proven very capable of delivering substantial bass when desired for a particular program, whether it be music or a movie soundtrack.

Each main channel in the Dolby Digital system is likewise able to carry substantial bass content. So why is there an LFE channel in a consumer audio delivery format? Quite simply,

Dolby
Signal Processing and Noise Reduction Systems

100 Potrero Avenue
San Francisco, California 94103-4813
Telephone 415-558-0200
Facsimile 415-863-1373
www.dolby.com

Wootton Bassett
Wiltshire SN4 8QJ England
Telephone (44) 1793-842100
Facsimile (44) 1793-842101
www.dolby.com

Dolby and the double-D symbol are trademarks of Dolby Laboratories

it allows movie soundtracks to be transcribed directly and without alteration to the home video format. Does this mean the LFE channel should not be used for music recordings? No. But it does suggest that the LFE channel may not be the only, or even the best way to provide loud, deep bass in a music recording. This point will become clear as you begin mixing multichannel music in a studio with a properly configured and calibrated monitor system.

**A five-channel monitoring environment**

There are aspects of multichannel studio monitor setup that are well understood and accepted, but others that are still under discussion and debate as to the best approach. Herewith are some basic suggestions.

Front speakers

Instead of one pair of stereo speakers, there are now three speakers across the front. They should be identical in the same way the L and R speakers in conventional stereo must be matched to promote good imaging. If they cannot all be the same model, the center speaker could be a smaller speaker from the same product line.

The speakers ideally should all be at the same height and distance from the listener. If the center speaker is not the same distance as the L/R pair, time delay may be used to obtain coincident arrivals.

The front speakers must exhibit the same acoustic polarity through the entire monitor/amplifier chain.

Surround speakers

Ideally, the surround speakers will sound the same as the front speakers. This may be most easily achieved by using the same speakers all around. If that is not possible, the surround speakers may be smaller than the front speakers but should maintain the same character, i.e., they could be smaller speakers made by the same manufacturer.

The surround speakers should again achieve coincident arrival with the front speakers either as a result of equal path lengths or through alignment with time delays. The surround speakers must be “in phase” with each other and with the front speakers.

Subwoofers

Assuming some or all of the speakers used do not adequately cover the deepest bass found in recordings, it is important to include one or more subwoofers and proper bass management in the monitor system. The bass from each and every channel that is not reproduced in the main speaker for that channel must be redirected to the subwoofer(s). There are now various products that handle bass management (crossover filters, bass mixing, and combining with the LFE channel in the proper mixing ratio) that can be used to achieve a proper monitor setup in the studio. It is important to achieve a correct integration of the subwoofer with the main speakers to ensure a wide, smooth and uniform frequency response from all five main

channels. It is also important to have the LFE channel reproduced in the proper relation to the other channels.

Overall system

The ITU-R[1] has a specification for listening room layout intended for critical evaluation of multichannel programs. These recommendations also appear to be a good starting point for mixing room setup, and have been informally adopted as such. Aside from time alignment, a specific geometry is described. With the center speaker directly in front, the L/R speakers are each positioned 30 degrees away from center, forming a 60-degree angle. This angle may be reduced somewhat (say, 45 to 50 degrees) and give equally successful results. The surround speakers are each positioned 110 degrees off center. This puts the surround speakers to the sides and somewhat behind the listener, which is not only what often happens in typical homes, but has proved to be a good way to achieve overall front/back soundfield integration and envelopment. If the surrounds are too far to the rear, the listener finds himself lost somewhere between two separate soundfields, rather than wrapped inside one cohesive soundfield.

All 5 main speakers are calibrated in the same way. Once each speaker is in position and equalized (if necessary), the balance among the channels is adjusted such that equal signal levels in each channel at the output of the console results in equal loudness at the listening position. There are no dictates on how loud the system must play, but the power amplifiers and speakers should be chosen to allow all of them to play as loud and as clean as is required by the mixers. The subwoofer system and its power amplifier must be capable of the same result.

**Use of the channels: some insights and suggestions**

Front channels

In a stereo program there was only one way to obtain a centrally placed sound image: mix the signal equally to the L/R channels. In a multichannel system, there are three ways to achieve this.

- Create a phantom center just as with stereo.
- Use the center channel alone.
- Use all three front channels equally or in some varied proportion.

Each approach offers advantages, and drawbacks.

The phantom center is well understood, as it has been used since stereo began. Its main disadvantage is that the center image is very dependent on the listener being seated equidistant from the L/R speakers. This is not always the case in consumer homes and is never possible in an automotive environment. One other disadvantage is that the timbre is not the same as from a direct speaker source due to cross-cancellation effects.

[1] BS.775-1 “Multichannel Stereophonic Sound Systems With and Without Accompanying Picture”.

Using the center speaker alone creates a stable center image for every listener no matter where they sit. To prevent the center image from sounding too focused or narrow, its reverb can be spread to the L/R channels, for instance.

Using all three front speakers in combination can allow the range of spatial depth and width to be controlled. A phantom center can be reinforced by some additional signal in the center channel, or a center channel signal can be enhanced with some additional signal spread into the L/R pair. As more channels are used to carry the same signal, the more likely that there may be side effects caused by these signals interacting with each other, or the phantom image conflicting with the true center image. In systems using dissimilar speakers or in cases where the listeners are seated off the central axis, the sound arrivals from all three speakers may not blend well. Differences in arrival time can lead to a comb filtering effect, shifts in tone color, or a smearing of the image, for example. It is advisable to consider this when placing the exact same signal in all three front channels. To counteract this, the additional signals may first be processed somewhat to change their spatial character, timbre, or prominence relative to the main center signal.

Surround channels

Whereas center signals were always part of mixing for stereo, the surrounds are a completely new dimension to consider. There is lots of room for experimentation, so no one knows where multichannel music will ultimately lead. One thing we can say is that it does not take too much to enhance the sense of depth over what conventional stereo could achieve. The subtle ambience and room reflections of a concert hall delivered from the surround speakers can change the listener's perspective from that of peering through a window to actually sitting in the concert hall.

Popular music often benefits from a more creative use of the surrounds, such as with background singers or instruments. But as with any new tool or effect, it can be overdone and become tiresome if used to excess. Maybe the principle that has served so well for the film industry can also work for music mixing: don't use the surrounds to distract the listener's attention away from the story.

LFE channel

What's the difference between the LFE channel and the subwoofer signal? The LFE channel is a separate, limited frequency range signal *created by the mixing engineer* and delivered alongside the main channels in the mix. A "brickwall" filter at 120 Hz in the Dolby Digital encoder limits its use to handling the bottom two audible octaves. Dolby generally recommends limiting the signal to 80 Hz in the console to ensure best uniformity no matter how the program is delivered.

The subwoofer signal is *created in the decoder product* based on the use of bass management crossover filters as needed for the particular speaker complement in use. A subwoofer signal may comprise bass from any channel or combination of channels. If no subwoofer is present, the bass (including the LFE channel if present) will be redirected to the speakers best able to handle it, usually the main stereo pair.

In most music productions, there is unlikely to be a technical need to use the LFE channel. Since the overall program level may be adjusted to allow for any proportion of bass to be perfectly rendered, the LFE channel might only be an advantage for something like the famous cannon shots in the *1812 Overture*. In such a case, the overall program level might have to be reduced several dB just so the last few minutes can make the desired impact without overload. By using the LFE channel, the orchestra can be recorded at a more normal level, with some of the loudest, deepest bass of the cannons carried in the LFE channel. Of course, the main channels must still carry the cannon shots so that they will be heard from the appropriate locations.

There is another benefit to using the LFE channel when carrying explosive bass signals, in that smaller stereo systems may not be able to handle such high levels of deep bass without significant stress. Since the LFE signal is discarded in the Dolby Digital downmix process, these bass signals will not present any difficulty. The remaining portions of the cannon shots mixed into the main channels will convey the essential aspects of the performance for the downmix listener.

While it may be of no particular consequence for cannon shots, the fact that the LFE channel is separate from the others means that its ability to blend seamlessly with the higher frequencies from the other channels can be affected by filters used to generate the LFE signal, for example. The best way to ensure a cohesive audio signal across the entire audible spectrum is to keep the entire signal together in the main channel or channels.

**Stereo playback remains**

Even with the popularity of 5.1 systems, there will always be a need to address stereo reproduction. There are three basic ways to do this.

- Prepare a new stereo mix from the original multitrack elements
- Prepare a studio adjusted downmix from the multichannel mix
- Let the decoder derive a stereo downmix.

The first option is no different from today's conventional stereo mixing sessions.

The second option takes advantage of all the work that has gone into the mixing of the 5.1-channel version, and allows the mixing engineer to quickly derive a stereo version while retaining flexibility in the exact proportions of each channel represented in the final stereo mix.

The third option is to make no separate stereo mix at all. In this case the decoder will derive a stereo downmix based on preset formulas in the decoder. Consumer decoders can apply a degree of dynamic range reduction during the downmix process if necessary to prevent overload. The downmix options and dynamic range control effects are all able to be previewed in the production studio, and a range of adjustments are possible. Therefore the results can be checked in advance.

One other aspect of previewing how the production will sound to the consumer has to do with checking the mix on a "budget" surround system, in the same way that small speakers have

traditionally been used in stereo mixing to check TV and small stereo playback compatibility. Having a “home style” surround system on hand may prove useful in evaluating how well the mix translates to more modest playback systems.

**Further information**

For more information see the *Dolby Digital Encoding Manual* available from Dolby Laboratories or from the Dolby web site at www.dolby.com. Details include Room Layout, Speaker Placement, Channel Calibration, Subwoofer Calibration, and Setting Center & Surround Delays.