

Dolby Laboratories Information

Technical Requirements for Dolby Surround in Consumer Video Games

Introduction

Dolby Surround is a format that enables the production and delivery of multi-dimensional soundtracks for television, cable, consumer video games, interactive media and other stereo formats. Once created, Dolby Surround soundtracks can be recorded, broadcast, and reproduced the same as any normal stereo program, including compatible monophonic playback. Consumers equipped with Dolby Surround systems will experience the full measure of spatial dimensionality built into these programs, just as they do from thousands of Dolby Surround movies currently available on home video media.

The ability for games to offer an interactive experience has led to some new techniques in the production of Dolby Surround soundtracks that allow the game to incorporate active sound positioning to follow the on-screen action. This paper outlines the basic equipment and techniques necessary for video game programmers to produce soundtracks in Dolby Surround.

Definitions

Generally, audio for games consist of two elements. The first is the *music and ambiance*, the second is the *spot effects*. The *music and ambiance* tracks are usually pre-recorded and Dolby Surround encoded in the studio. They must be stored as stereo audio. For example, these tracks may be red book CD audio playing from CD ROM, or stereo WAV or AIFF files. In the case of console games this audio could be playing directly off the disc or from ROM. The *spot effects* need to be generated in real time depending on the action on the screen. They may be stored either as mono or stereo samples depending on the complexity of the effect required. Both these types of audio are discussed in more detail below.

The final Dolby Surround soundtrack delivered by the game is a two channel audio signal, with all the directional information "encoded" by the relative loudness and relative phase between the two channels. For more information on how Dolby Surround works, see the references listed at the end.

Music and Ambiance tracks

Many aspects of producing in Dolby Surround are the same as producing in stereo. The main difference is that the soundtrack will contain four channels of audio, so additional speakers and amplifiers are needed to monitor the center and surround channels via a Dolby Surround decoder. This enables the producer to know precisely how the consumer will hear the audio track when it is decoded in the home.

Dolby Surround encoded soundtracks can be handled like any other stereo file in the platform being developed for. They can be played back from a RAM buffer or streamed off of a CD ROM as red book audio. They can also be downsampled when lower resolutions are required. Producing the encoded soundtrack will require a Dolby professional matrix encoder and decoder (or equivalent) and will follow the same procedures for producing Dolby Surround soundtracks in video post-production facilities.



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Necessary Equipment

Dolby Surround Encoder/Decoder

The original tools for this purpose were the Dolby Model SEU4 and SDU4 surround encoding and decoding units, which are analog units. There is also a digital solution in the form of Digidesign Pro Tools TDM Plug-Ins for both encoding and decoding. Other digital audio workstations are expected to be supported in the future.

The encoder accepts four input signals (Left, Center, Right, Surround) and creates two output signals, Left total and Right total (Lt/Rt). The decoder decodes the two input signals (Lt/Rt) into four output signals (L, C, R, S) using Dolby Pro Logic Surround decoding technology. The decoder also provides switchable stereo and monophonic monitoring modes for evaluating compatibility, and a master volume control which allows all output channels to be varied together.

These units may be purchased from Dolby equipment dealers. Dolby can provide full engineering support if requested, and there are Dolby consultants throughout the world. For certain “one-time” productions, the units may be loaned by Dolby Laboratories, although availability is limited at any one time.

A note about Dolby’s products: The SEU4 and SDU4 are 1U high, 19" rack mount professional units. Both use XLR type connectors with balanced line levels adjustable from -10 to +8 dBr (0 dBr=0.775 Vrms). Pin 2 is “hot.” For unbalanced connections, pin 1 is tied to pin 3 for proper operation.

Mixing console

Mixing will be performed in four channels, so a four-bus output structure is needed, as shown in Fig. 1. A conventional stereo console with sufficient subgrouping and auxiliary sends may be used. Automation is not required, but may be beneficial for fine-tuning special effects. Four channel pan pots are also desirable for certain effects, although basic two channel panning will be adequate for most productions.

The SDU4 decoding mode and monitor level controls allow connection directly to monitor amplifiers. Fig. 1 shows typical signal flow.

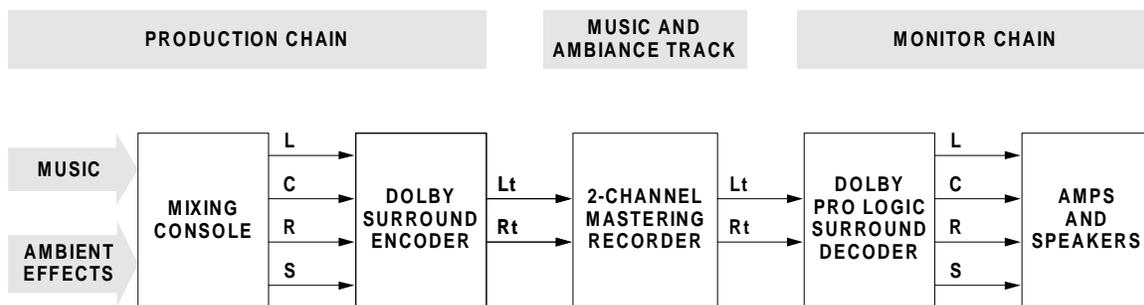


Fig. 1. Mixing in Dolby Surround.

Program meters (with peak and average weighting) are recommended to read the four encoder input signals and two encoder output signals.

Speakers and amplifiers (required for all productions)

A total of three speakers is needed across the front to reproduce the left, center, and right channels. Ideally, all three should be the same model for best acoustic matching. Unfortunately, this may not be possible for the center speaker due to space restrictions. In such cases, finding a center speaker that blends well sonically with the main left/right pair is important; trying a smaller model from the same product line as the left/right pair is recommended. A bass redirection option in the decoder will route the center channel bass to the left and right speakers to prevent the apparent loss of low frequencies in this case. Use of a magnetically shielded speaker is necessary when positioned near a video monitor.

The center speaker needs to be at the same height as the left/right pair for best imaging. It is also important to confirm that the polarity (phasing) is correct for all three front speakers so that panned effects create proper phantom images between the center/side speaker pairs.

At least two surround speakers will be used. Refer to the room layout in Fig. 2 for typical speaker arrangement. The required characteristics for the surround speakers are smooth response from 100 Hz to 7 kHz and wide dispersion. The same type of small speaker used for the center will often be used for the surrounds to assure sonic matching. Generally, good quality two-way bookshelf speakers are sufficient for surround channel use.

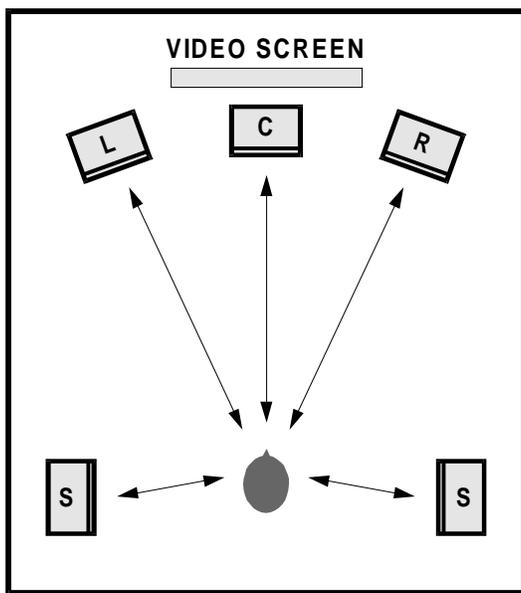


Fig. 2. Dolby Surround Monitoring.

Surround speakers are typically located two or three feet above ear level, and should not be aimed down at the mixing position. The goal is to create an evenly dispersed soundfield, with no prominent hot spots or “in the head” images. While the surround speakers should be “in-phase” with each other, their absolute polarity has no relevance to the front channels since the decoder introduces time delay into the surround channel.

The amplifiers used for the center and surround channels should be similar to the ones in the left/right channels. Note that only one amplifier is needed to drive all the surround speakers, since the total acoustic output requirement is no greater than in any other channel. Series-parallel wiring, as appropriate, may be used.

Ancillary Equipment

Most studios have an array of signal processors available, and some are indispensable for proper Dolby Surround production. Limiters top the list, and some may need to be dual- or triple-ganged in special cases. Time delays, phasers/flangers, echo/reverb, and equalization are also possibilities. A Dolby Surround consultant will be instrumental in sorting out specific processor needs for a given production.

Game Encoding

It is often desired to be able to control the spatial position of a sound in response to the game player's input. There are several techniques that can be used to achieve this in the game itself. The degree of complexity and resulting quality varies, and so the technique should be chosen based on what is appropriate for the intended effect.

The Palette

In Dolby Surround, the audio "field of play" may be depicted as a rectangle with three points across the front and one at the rear, as shown in Fig. 3. These are known as the cardinal points, Left, Center, Right, and Surround. A signal that moves from left to right (or right to left) is an L/R pan. A signal that moves from any front channel to surround is an F/S pan. A sound that is placed half-way between center and surround is an "interior" sound because it actually comes out all of the speakers equally, placing the listener *inside* the soundfield. With Dolby Surround it is possible to move sounds anywhere among the cardinal points, along the lines between them, and within their boundary space.

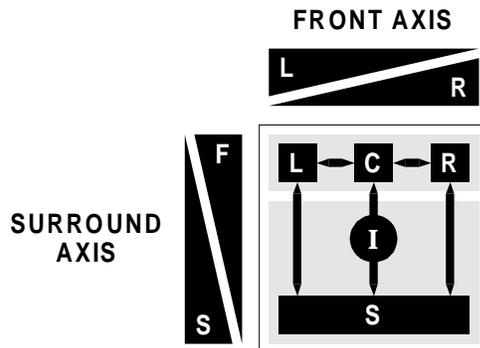


Fig. 3. The Dolby Surround soundfield.

Encoding Spot Effects

Spot effects such as door creaks or gun shots need to follow the action on the screen. These sounds occur less frequently, and are usually mono elements that are cached and looped. Sound placement can be handled within the game itself, using only basic controls. The front cardinal points, Left, Center, and Right, can be "encoded" by panning like any conventional stereo signal. Simple channel switching during game play allows the sound to be output from the left, right or center (both channels). If the game provides a variable balance control function, the sound may be smoothly panned across the front or positioned between channels.

This simple frontal positioning may be adequate for many sounds that need run-time control. The next section describes methods for obtaining surround effects.

Polarity inversion

Sounds appear in the surround channel when the Lt/Rt signals into the decoder are equal in level (much like a center signal), except one of the signals is inverted (180° out-of-phase) relative to the other.

By adding an inverter (multiplication by -1) to the game audio toolkit, it is possible for a sound to be placed at any of the four cardinal points. If the level of one of the two output signals can be attenuated, it is possible to move the sound across the front or down either side toward the surround channel. This degree of sound positioning is often adequate for many situations in game play. However, it does not allow for either interior sounds or center-to-surround pans. To achieve these effects, phase encoding is needed as described next.

Dolby Phase Positioner

If the game audio playback software allows for the creation of small time delays or certain filter or pitch-shift functions, these may be suitable for creating signals that appear to spread wider or otherwise occupy the interior space.

Alternatively, Dolby has prepared a simple C-code program in the form of a .dll file, or source code, that provides surround encoding during game play. This simplified encoding utility comprises three sections: a phase shifter, a surround positioner, and a downmixer. The shifter takes any mono signal and creates two new audio signal components, F (Front) and S (Surround), which are phase shifted relative to each other.

The positioner moves the F input signal along the front axis in response to the L/R input control. It moves the S input signal along the surround axis in response to the F/S input control. This “x/y” coordinate system allows the game to position the sound anywhere in the Dolby Surround soundfield. The positioner can either place sounds that come from the encoder part of the algorithm or from pre-Game Mode encoded material that has been prepared with Pro Tools or a modified SEU4. (Contact Dolby Laboratories for information on modifying the SEU4 for Game Mode) See below for more on Game Mode.

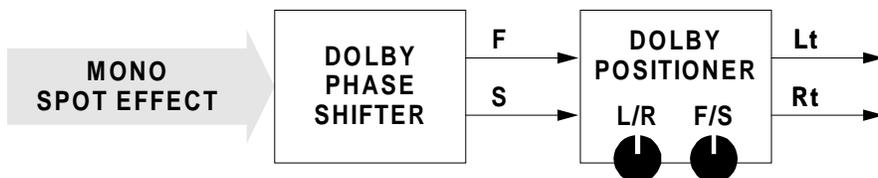


Fig. 4. Dolby Phase Positioner

The phase shifter is deliberately simple to minimize the impact on game speed. Since the shifter is needed only when a sound is placed or panned through the interior space, it need not run at other times. If the phase shifter is too much of a processing burden to run during game play, or if the sound quality is not deemed good enough for some reason, the positioner can also work with signals preprocessed in what is called “Game Mode” as described next.

If the sound engine being used can pan multi-channel material, we have provided the programmer a call to “downmix” within the .dll or source code material that comes from either Left, Center, Right, and Surround tracks or Left, Right, Left Surround, Right Surround tracks and the phase positioner code will output Lt/Rt.

Game Mode

This is a mode of the Dolby Surround encoder itself: a mono input signal (the audio that will be positioned by the game) is processed by the Game Mode encoder to produce a two channel output signal having the same F and S components as with the phase shifter just described. During game play, this two channel signal may be moved using the positioner as described above.

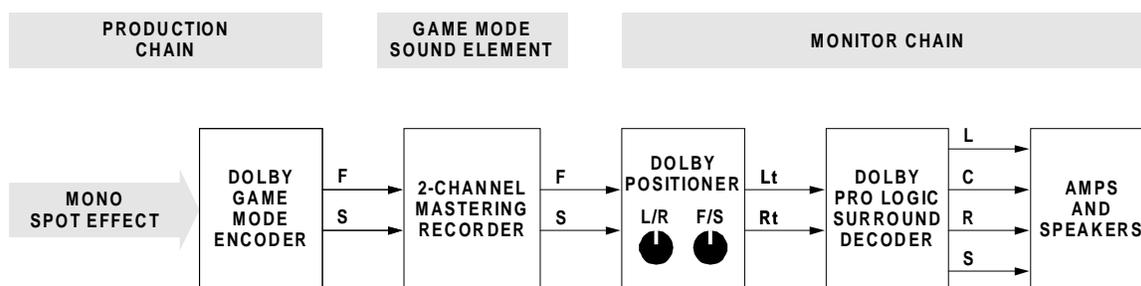


Fig. 5. Preparing a Game Mode signal.

The result is that this signal has the same audio processing as other true Dolby Surround encoded signals, and needs no extra phase shift processing during game play. The main disadvantage is that this “mono” element now occupies twice the audio storage space in the delivered program. For short duration sound clips, this may be acceptable.

The following table summarizes the basic methods discussed. No one method is necessarily perfect for all cases. The best judge is the final result. Please contact Dolby in case questions arise.

Game Characteristic	Studio Encoder*	Game Mode + Positioner	Phase Shifter + Positioner	Downmixer	Polarity Inversion
MIPs impact	none	medium	high	med	low
positioning range	n/a	very good	very good	n/a	mainly surround
sound quality	very good	very good	good	very good	very good
delivery impact	none	2x sound file	none	none	none

*Non-interactive pre-encoded material created with either SEU4 or Surround Tools TDM Plug-in

Table 1. Summary of Dolby Surround game encoding options.

Game Playback

A game may use any one or all of the surround encoding options described and still be a valid Dolby Surround game as long as the end result is consistent with the general quality found in other such games.

Fig. 6 shows how the various sound elements may join together in the final game. The final audio output is a complete surround mix in the Lt/Rt encoded form, which is output from the sound card. It is then the task of the Pro Logic decoder to extract the multichannel soundfield for reproduction over several speakers, or to be further virtualized for playback over a conventional pair of speakers.

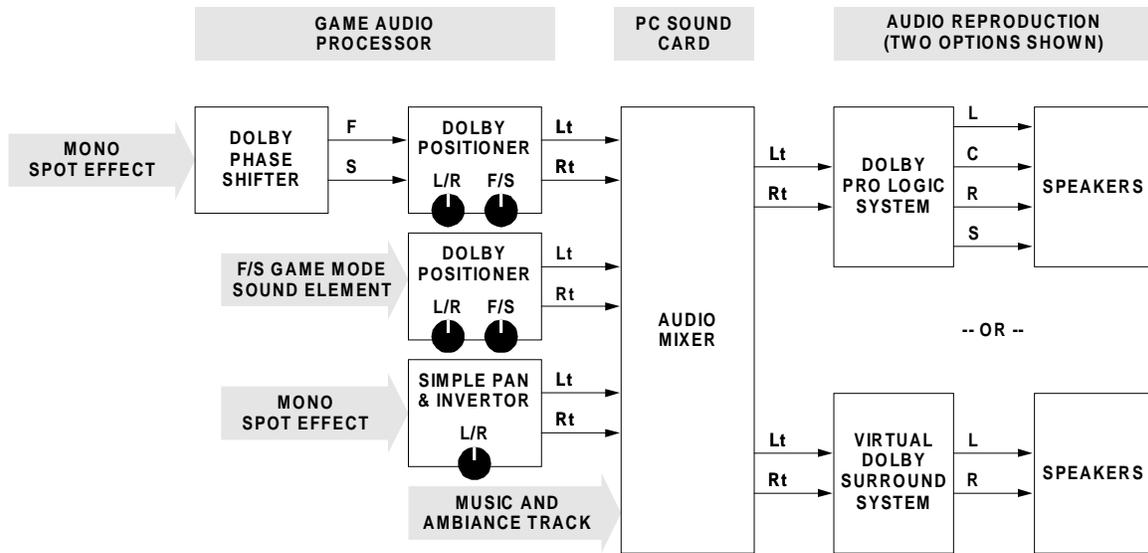


Fig. 6. Game audio creation and reproduction.

Dolby Surround Consultants

Dolby consultants are available to assist with the initial alignment of the encoder, decoder, and monitor system. Instruction on the use of the equipment may also be provided at this time. Dolby consultants are also available for production assistance or training on a service contract basis.

Agreements

The Dolby Surround program is administered by Dolby Laboratories Licensing Corporation under various agreements. Certain conditions apply to the use of Dolby logos for both quality assurance and trademark protection purposes. Please call the Dolby office nearest you for additional information: San Francisco, 415-558-0200; New York, 212-767-1700; Los Angeles, 213-845-1880; UK, 01793-842100; Tokyo, 03-35542-6160.

Further information

Dolby publications:

- What Is Dolby Surround? (basic overview)
- Dolby Pro Logic Surround Decoder Principles of Operation (how it works)
- Mixing in Dolby Surround (production techniques)
- Visit the Dolby web site at: www.dolby.com