Film-Tech

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Surround Sound Past, Present and Future

A history of multichannel audio from mag stripe to Dolby Digital

DOLBY®

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Film sound, television audio, and music playback formats used to be distinctly different products of industries often working in isolation. Recently, however, this has changed. The popularity of surround sound in the home has brought these sound formats closer together. And now new digital multichannel technology is poised to foster an even more consistent approach to sound reproduction, easing the burden on both consumer and producer while providing high fidelity not just to the tonality of live sound, but also to its spatiality.

Origins of surround sound

The first commercially successful multichannel formats were developed in the early 1950s for the cinema. At the time, stereophonic sound, a concept new to the public, was heavily promoted along with new wide-screen formats by a film industry feeling threatened by the rapid growth of television. Unlike the two-channel format later adopted for home stereo, film stereo sound started out with, and continues to use, a minimum of four channels.

With such film formats as four-track CinemaScope (35 mm) and six-track Todd-AO (70 mm), multiple sound channels were recorded on stripes of magnetic material applied to each print. To play these prints, projectors were fitted with playback heads like those on a tape recorder, and cinemas equipped with additional amplifiers and speaker systems.

From the outset, film stereo formats featured several channels across the front, plus at least one channel played over speakers towards the rear of the cinema. At first the latter was known as the effects channel, and was reserved for the occasional dramatic effect—ethereal voices in religious epics, for example. Some formats switched this channel off by means of trigger tones when it wasn't needed because the track on the film was particularly narrow, and thus very hissy.

Although film stereo lost favor in the 1960s and early 1970s due to high costs of the magnetic formats and a slump in the film business, sound mixers continued to experiment with the effects channel. Formats such as six-track 70 mm magnetic (see sidebar next page) provided consistent signal-to-noise ratios on all channels, so mixers could use the effects channel to envelop the audience in continuous low-level ambient sounds. The effects channel came to convey greater sonic realism overall, not just the occasional dramatic effect.

This expanded, more naturalistic practice came to be known as surround sound, and the effects channel as the surround channel. The extra speakers at the rear—and now along the sides of the theater as well to create a more diffuse soundfield—came to be known within the industry as "the surrounds."

Home stereo and "quad"

Bell Laboratories' famous early experiments with stereo sound in the 1930s used three channels. Cinema stereo in the 1950s was using no less than four channels, and as many as seven. Yet when stereo finally made it into the home in 1958, only *two* channels were used. This was not because of listener preference, or some predisposition on the part of audio professionals. Rather, two channels (left and right) were all that the then-prevalent LP phonograph record could accommodate.

Two-channel stereo music reproduction was such a dramatic advance

By Joseph Hull
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over mono—and so comparatively easy to implement—that it soon became the norm, even as filmmakers continued to regard four channels as the minimum necessary to create a lifelike soundfield. A few years later two-channel stereo FM broadcasting was introduced, further entrenching two channels in the consumer's mind as "stereo." Indeed, as time went on, only film buffs were aware that film stereo, rare as it had become, continued to use more than two channels.

As home stereo grew in popularity, equipment manufacturers began to look for ways to expand their market. This was one motivation behind the ill-fated four-channel, or quadraphonic ("quad"), home format promoted in the early 1970s. It required two more speakers in the rear corners of the listening room to reproduce two extra channels from specially encoded program sources.

Because the existing home stereo media had only two channels and could not easily accommodate more, several schemes were developed to encode the basic two channels with additional sound information. Most were based on matrixing techniques which enabled "hiding" extra channels within the two regular channels by recording them with different relative phase.

Quad failed to capture much of a market. There were several incompatible encoding/decoding systems, creating confusion. Producers and recording engineers couldn't decide on how to best utilize the extra channels. And most significant of all, few consumers perceived any real advantage from the format.

Quad was never associated with the multichannel stereo formats used in movie theaters, and the term "surround sound" still wasn't heard outside the film industry. After all, the only popular home visual medium at the time was broadcast TV, which provided distinctly low-quality mono sound. For the next decade home stereo, movie stereo, and TV sound would remain separate entities supported by essentially isolated industries.

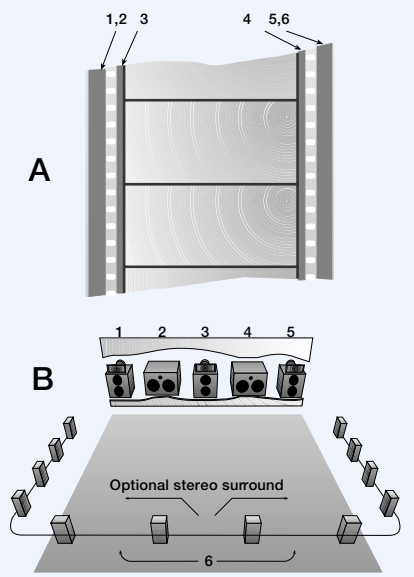
Dolby and film sound

In the mid-1970s, Dolby Laboratories introduced a new sound technology for 35 mm prints originally called Dolby Stereo. Instead of magnetic striping, it was based on the photographic, or optical, soundtrack technology used to put mono sound on film since the 1930s.

For compatible playback in mono theaters, the new stereo soundtrack had to fit the same space on the print occupied by the mono track. Experiments showed that two tracks, treated with Dolby A-type noise reduction, could give excellent fidelity. But trying to squeeze in more than two tracks raised noise to an unacceptable level, even with noise reduction.

Two channels, however, were not enough for movie stereo. As well as left and right channels, a separate center channel and speaker are necessary to localize dialogue for viewers seated off-center. In addition, "stereo" and "surround" had become synonymous to most of the film industry, so a surround channel was also a must. Thus a way had to be found to encode just two physical tracks on movie prints with four channels of information—left, center, right, and surround.

The solution was found in the matrixing techniques first tried for quad home stereo, but with the channels configured in the cinema stereo norm—left, center, right, and surround—plus some sophisticated new "steering" techniques.

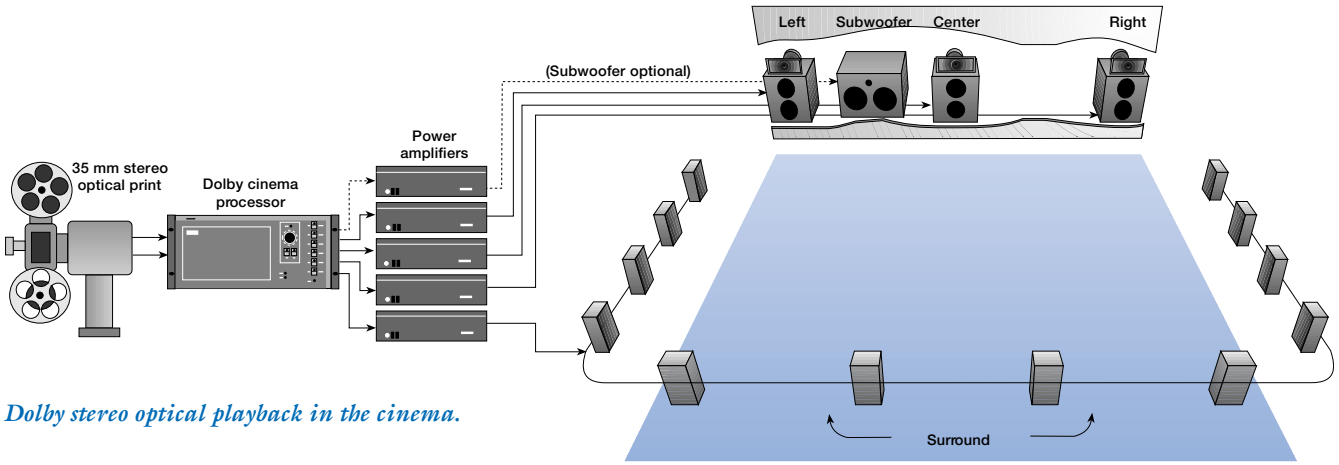


70 mm Magnetic: Forerunner of Today's Digital Sound

In the 1950s, movie prints with magnetic stripe soundtracks provided the first multichannel sound ever heard by the public. 70 mm prints (**A**), for example, featured six tracks, originally configured as five identical channels across the front plus a surround channel to the sides and rear of the auditorium (**B**).

As screens became smaller, reducing the need for five screen channels to carry dialogue, Dolby Laboratories proposed the configuration shown above, which has been standard since the late 1970s: left, center, and right main screen channels (1,3,5), one surround channel (6), and two low-frequency-only "bass extension" channels (2,4).

Dolby also developed a technique enabling 70 mm prints to carry two surround channels, instead of the usual one, at the option of a film's producers. This "stereo surround" 70 mm format thus became the forerunner of today's "5.1"-channel Dolby Digital surround format with its three front channels, two surround channels, and low-frequency effects channel (see page 5).



Dolby stereo optical playback in the cinema.

Dolby stereo optical proved so practical that today there are tens of thousands of theaters worldwide equipped with Dolby processors, and almost every major title is released in the format. What's more, the film industry experienced a kind of renaissance in the 1980s, helped by a new commitment to high-quality presentations exemplified by the adoption of Dolby Stereo. That rebirth was also helped by the "video revolution."

The video revolution

The first videocassette machines were introduced in the early 1970s, promoted initially as time shifting devices to record TV broadcasts for viewing at more convenient times. Before long, however, they took on another, hugely popular function—the playback at home of theatrical films. This created a voracious appetite for program material (which the film industry was more than happy to satisfy), and a whole new business around the production, sales, and rental of prerecorded videocassettes.

While the increased penetration of broadcast television had contributed to the film industry's woes in the 1950s and 1960s, the videocassette did the opposite. Movie attendance actually *increased* with the growth of the videocassette. Films that proved popular in theatrical exhibition proved just as popular for home viewing, and in some instances, fared even better in video release.

The videocassette was not the only element of the video revolution. More homes than ever were connected to cable systems, providing viewers with still more program sources (and the film industry with still more program-producing opportunities). The laser disc, the highest-quality home video program source ever, was introduced. Television set manufacturers began to offer products with what might be called high-fidelity picture quality, and consumers bought them. Thus "television" became "video," and the home TV set became a "video monitor" to display a wide variety of visual program sources, much as stereo systems play music from a variety of sources.

Stereo comes to video

As the video revolution got underway, consumers were not only accustomed to high-quality stereo sound from their music systems at home, but were also becoming used to high-quality stereo sound in the cinema as the Dolby multichannel optical soundtrack format spread throughout the film industry.

While at first the videocassette offered only relatively low-fidelity mono sound, machines and prerecorded tapes with stereo sound were soon offered, first by means of linear soundtracks and then by the "HiFi" technology. The laser disc was conceived from the outset to provide high-quality stereo sound.

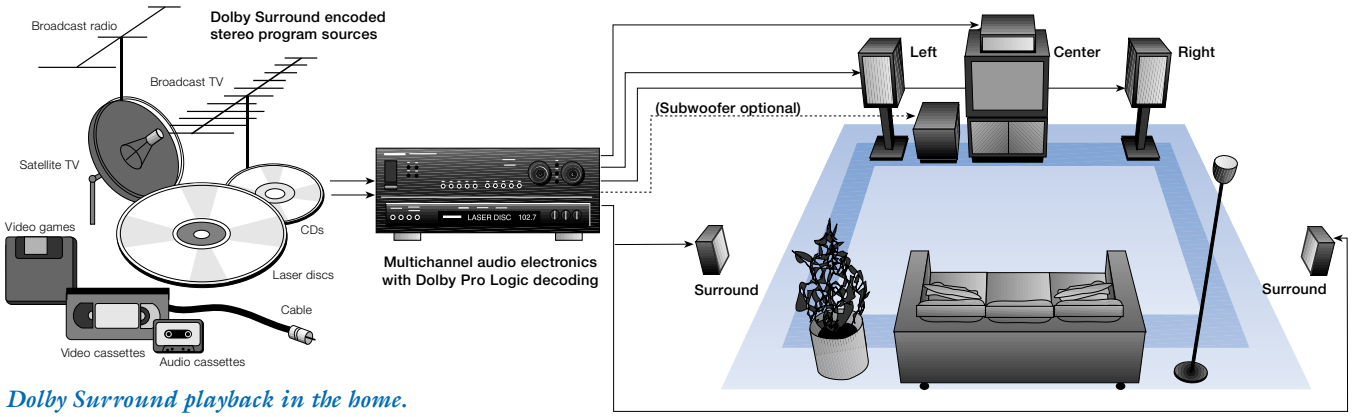
In addition, a stereo TV broadcasting system was soon adopted for over-the-air and cable use. Thus the familiar two-channel stereo format long established for home music reproduction was adopted for all video media.

Surround sound comes home

By the early 1980s, high-performance stereo music systems were the norm. Audio as well as video had expanded to include new program sources (audiocassettes, CDs). Car stereo was coming of age, and personal headphone portables were providing a new way to listen to music. A generation had grown up listening to rock music that was as dependent upon audio technology as musicianship—the same generation that was now being regularly exposed to multichannel surround sound in the cinema. Against this background, Dolby Surround was introduced late in 1982 for playing videos of theatrical films originally produced with Dolby encoded soundtracks.

The original four-channel Dolby encoding remains intact when such films are transferred to stereo videocassettes and laser discs, or broadcast on stereo TV. At first, simple Dolby Surround decoders made it possible to decode the surround channel at home, in addition to left and right. Soon more sophisticated Dolby Pro Logic decoders made it possible to decode the center channel as well, and utilize the advanced steering circuitry developed originally for theatrical use.

Unlike quad, Dolby Surround gained, and continues to gain, considerable marketplace acceptance. For one thing, the channel configuration and how to best utilize it were firmly established within one industry (film) in advance of its introduction to another (home theater). For another, it was developed with a clear objective, specifically to enhance the viewing experience. And third, software and hardware standards for both the film and consumer electronics industries are defined by one organization—Dolby Laboratories—



Dolby Surround playback in the home.

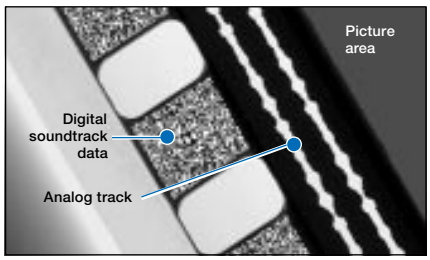
which is independent of, and has credibility with, both.

Today Dolby Surround includes TV broadcasting—not only of films with Dolby encoded soundtracks, but also regular TV series, specials and sports events transmitted in Dolby Surround. And although Dolby Surround was developed as a sound-with-picture format, record companies such as Delos, RCA Victor/BMG Classics and Concord Jazz release music-only CDs and audiocassettes encoded with Dolby Surround. It is also providing more excitement and viewer involvement for an increasing number of video games and other multimedia applications.

In other words, surround sound has crossed the traditional format boundaries, to the advantage of not only the consumer, but also of the film, prerecorded software, consumer electronics, and PC industries.

Dolby Digital– the next generation

In the late 1980s, Dolby undertook to apply digital audio technology to 35 mm film in response to growing interest from the film industry. In order to retain an analog track so that release prints could continue to play in any cinema, it was decided to place a separate new Dolby Digital optical track between the sprocket holes. It was also decided to provide "5.1" channels, which by now had been documented by various film industry groups as best satisfying the requirements for theatrical film presentation.



Dolby Digital prints feature both digital and analog soundtracks.

Since Dolby Digital debuted in 1992, nearly 1,000 films have been released or announced, and more than 10,000 cinemas in 50 countries have been equipped for Dolby Digital playback (as of June 1997).

Dolby Digital in the home

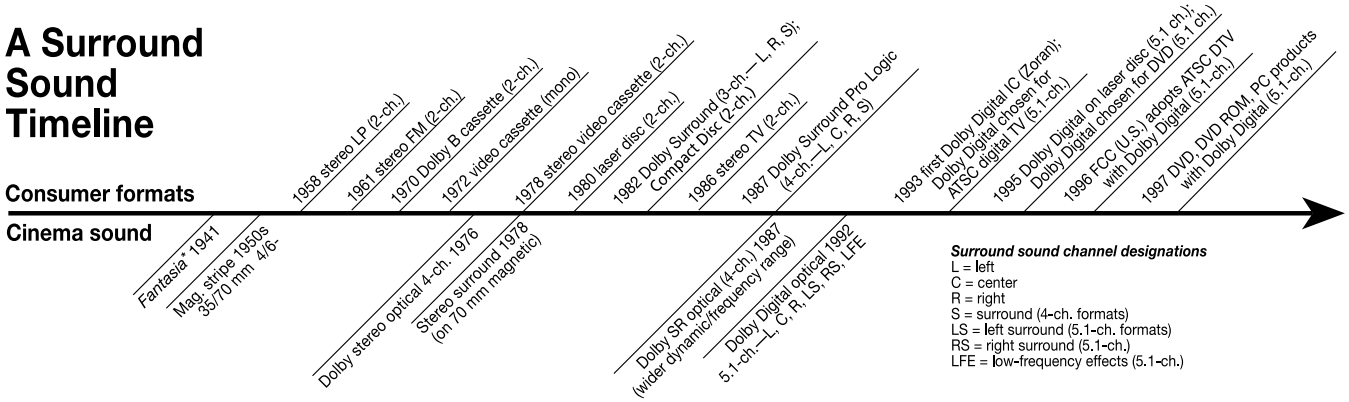
Much like Dolby's analog film sound formats, Dolby Digital in the cinema has provided a springboard for consumer formats, beginning with laser discs in 1995. Film sound as the starting point for Dolby Digital has enabled the accumulation of invaluable experience in mixing, recording, and distributing multichannel digital audio, and has fostered a library of program material immediately available for consumer release.

The consumer equivalent of Dolby Digital film sound is the final link from multichannel program producer to home listener. Like film, it provides separate channels for left, right, and center speakers at the front; two surround speakers at the sides; and a low-frequency effects channel that can be fed to a subwoofer at the listener's option.

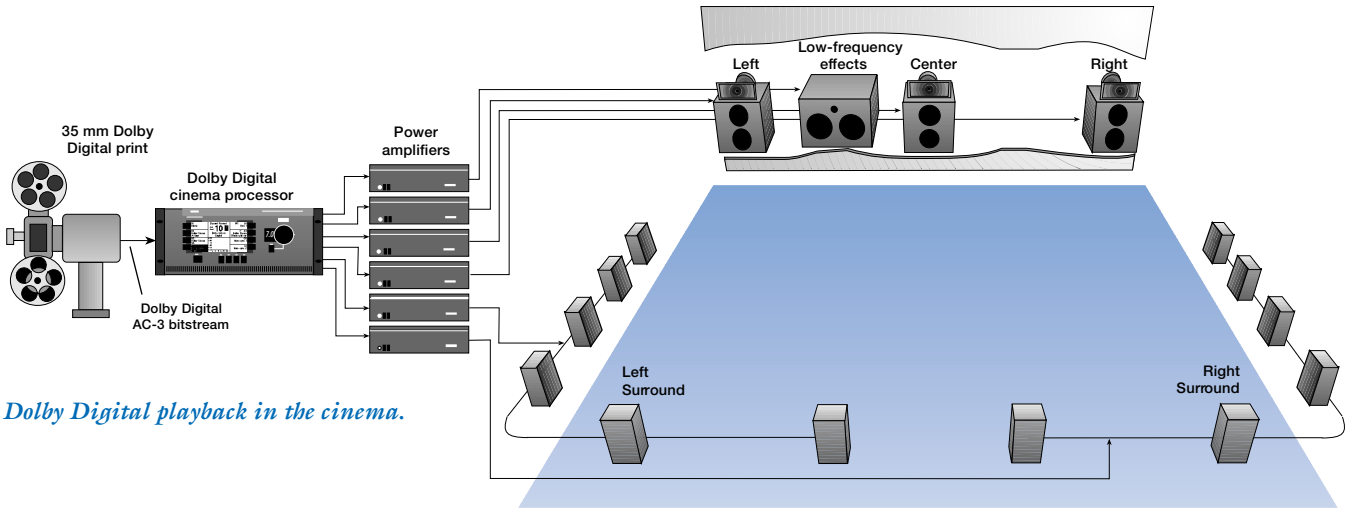
Unlike analog Dolby Surround with its single band-limited surround channel (usually played over two speakers), Dolby Digital features two completely independent surround channels, each offering the same full-range fidelity as the three front channels. As a result, true stereo surround effects can be achieved for an expanded sense of depth, localization, and overall realism.

Dolby Digital also incorporates

A Surround Sound Timeline



**Walt Disney's animated feature* Fantasia *was the first film shown publicly with stereo sound, utilizing three optical tracks on separate 35 mm film played in sync with the picture.*

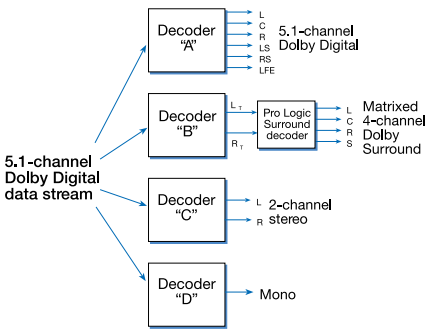


Dolby Digital playback in the cinema.

special features to satisfy listeners using anything from small, mono products up through full home theaters. While the same multichannel audio is delivered to every system, the decoder can optimize the sound for the particular circumstances. For example, decoders can provide optimium downmixes from multi-channel programming, such as a matrix-encoded two-track mix for analog Dolby Surround decoding, a conventional stereo mix, or even mono.

In addition, the system can apply dynamic compression to preserve low-level content and prevent dramatic passages from getting too loud when it's necessary to keep the overall playback volume low. What's more, the listener can program the Dolby Digital decoder to route non-directional low bass only to those channels in the system which have wide-range speakers or subwoofers.

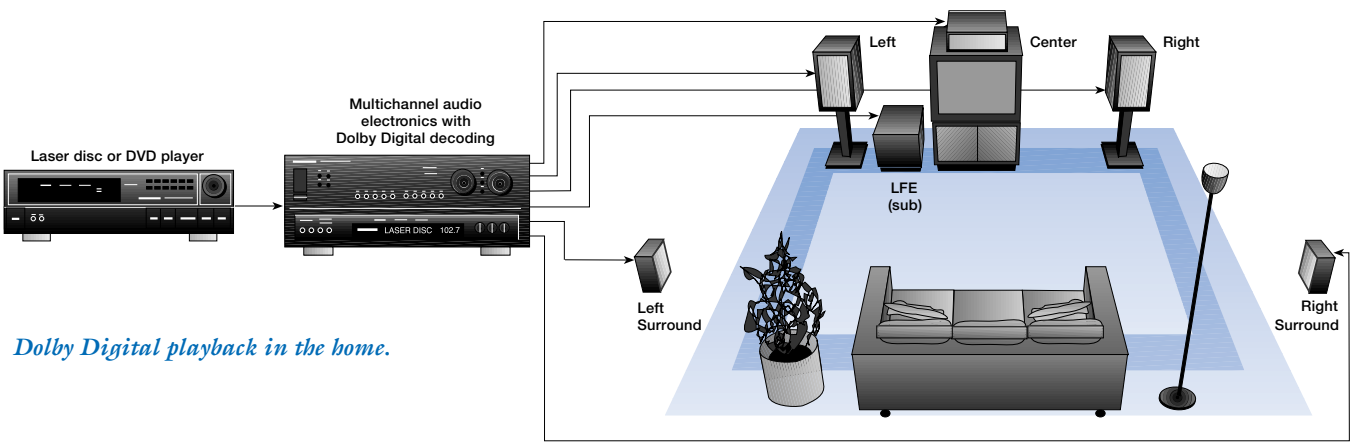
As well as being available on laser disc, Dolby Digital has been specified for both high-definition and standard-resolution TV broadcasting as part of the ATSC digital TV standard adopted by the FCC for the U.S. The new DVD video disc also provides Dolby Digital audio as standard in NTSC territories (North America and Japan) and is fast becoming the *de facto* multichannel standard elsewhere. Other applications include DVD ROM games and other interactive titles, new digital cable TV systems in the U.S., and a variety of direct broadcast satellite (DBS) systems.



Dolby Digital's downmixing feature ensures listening satisfaction for all.

A bright future for multichannel audio

So far, digital technology's most direct benefit for the home listener has been the CD. Yet for all its other virtues, CD sound quality is only incrementally superior to the best analog formats. Multichannel digital surround sound, on the other hand, is well on its way to bringing about a true revolution in the way sound is heard and enjoyed in the home.



Dolby Digital playback in the home.

When is it surround sound?

Programming encoded for multi-channel Dolby Pro Logic playback.

Home playback equipment equipped with Dolby Pro Logic multichannel decoding.

Films and cinema presentations utilizing Dolby analog technologies.

Films, cinema presentations, consumer programming, and home playback equipment utilizing Dolby Digital technology.

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