



Dolby Atmos[®] for Compact Entertainment Systems:
Immersive Surround Sound from a Stereo Form Factor

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Dolby Atmos[®] is a revolutionary cinema sound technology that has come to home theaters, bringing a new and exciting sense of total immersion and reality to your favorite movies, music, video games, and other programming. With Dolby Atmos, content creators now have the tools to precisely place and move sounds anywhere in your living room, including overhead, to make entertainment incredibly immersive and lifelike.

Dolby Atmos is based on the concept of sound objects. Every sound in a scene—a child yelling, a helicopter taking off, a car horn blaring—can be represented as an independent and discrete sound object. Each of those sounds comes from a specific location in the scene, and in some cases, they move.

Using sophisticated content creation tools that represent the sound objects in a three-dimensional space, filmmakers can isolate each of the sound objects in a scene and decide exactly where they want it to be and how they want it to move. In the final sound mix, the sound objects are combined with positional metadata—additional data that describes a variety of parameters about the sound object, including its location, its size and movement, if any.

During playback of a Dolby Atmos soundtrack, the object audio renderer (referred to as the OAR and a key ingredient in Dolby Cinema[™] processors and home theater playback devices) references the positional metadata in the mix to scale the object-based audio presentation to the specific speaker layout in the room. With Dolby Atmos, you are no longer confined to the past limitations of channel-based audio where sounds are assigned to a specific speaker. This is a key ingredient that defines the flexibility and adaptability of Dolby Atmos.

The Lifestyle Challenges of Traditional Home Theater

Dedicated home theater speaker systems, (for example, a high-resolution display and multi-channel speaker system) are the reference point for premium audio and video experiences today. To date, however, the adoption of dedicated home theaters worldwide has been limited by a number of form factors including:

- The limited number of rooms in the home restricts the adoption of a dedicated home theater system
- Many consumers globally rent and live in an apartment or condominium complex and cannot support a dedicated home theater system. Likely rules regarding sound permeation restrict the ability to install a high-powered multi-speaker entertainment system.
- As is often the case, rooms in consumers' homes are too small to support the added speaker needs required for a dedicated home theater speaker system, or they must serve multiple functions that prohibit the adoption of a large entertainment system.
- Finally, the multiple speaker connections, inputs, and setup functions required to install a dedicated home theater can often intimidate the average consumer. Smaller and easier is often better!

These limiting factors, which consumers define as obstacles towards adopting a dedicated home theater system, should not be interpreted as a lack of perceived value for the experience of a home entertainment system. The fact is consumers appreciate high quality, immersive experiences from their movies and music and would embrace technologies that enabled such an experience—provided the form factor complemented their lifestyles.

Stereo Home Entertainment Systems Abound!

Consumers have accepted the familiar stereo form factor into their homes globally. Consisting of just two or three speakers, the stereo form factor is often the “go-to” configuration for consumers that want a “home theater” like experience minus the investment or the hassle of managing the connectivity needs required of a home theater system. A wide variety of stereo form factors exist today, including high-resolution stereo systems, designs that incorporate a receiver with tower or bookshelf speakers, and even “all-in-one” packaged mini-systems.

What if you could bring a highly compelling surround movie and music playback experience to the stereo form factor—and have an experience that is even more realistic—an experience that immerses viewers in their favorite entertainment media?

The answer is here: Dolby Atmos for compact entertainment systems.

Introducing Dolby Atmos for Compact Entertainment Systems

Dolby Atmos offers a solution for home theater in a genuine consumer lifestyle-friendly form factor. The essence of Dolby Atmos technology is that it automatically adapts and scales the soundtrack to take full advantage of the number and location of speakers in your home entertainment system.

The scalability of Dolby Atmos combined with advanced virtualization and the added dimension of overhead sound offers an audio experience that is intense and compelling, and it can deliver that excitement across the entire spectrum of playback configurations that complement consumer lifestyles globally, including the stereo form factor. This is the foundation behind Dolby Atmos for compact audio devices.

A key identifying feature of Dolby Atmos is the introduction of the dimension of height—hearing sounds coming from above you—combined with sound coming directly at you and wrapping around you.

Now, with the introduction of Dolby Atmos signal processing and a pair of Dolby Atmos enabled speakers (explicitly designed to recreate that layer of sound above the listener), a living room or family room equipped with a traditional stereo playback system can be transformed into a highly immersive home theater experience. Music and movies will come to life with a new sense of detail and precision previously unavailable.

Design

A Dolby Atmos compact entertainment solution may be configured in two distinct form factors.

2.1.2 Configurations

A 2.1.2 system will incorporate left and right primary speakers in addition to Dolby Atmos enabled speakers, which may be built into the primary speakers (integrated design) or included as an add-on module.



Figure 1: A traditional 2.1 speaker layout with two listener-level speakers and two Dolby Atmos enabled speakers (2.1.2)

3.1.2 Configurations

Lack of dialogue clarity has been at the forefront of consumer complaints, especially when they are listening to inferior speakers embedded in today's flat panel TVs. A benefit of the 3.1.2 system is its ability to incorporate a center speaker below the display device; the center speaker is capable of reproducing dialogue (60 percent of what you hear in a movie soundtrack) with a higher degree of fidelity and volume levels.



Figure 2: A traditional 3.1 speaker layout with three listener-level speakers in addition to two Dolby Atmos enabled speakers (3.1.2)

A typical system may be scalable in its size, performance capabilities, and structure. For example, Dolby Atmos decoding, rendering, and amplification may be built into the subwoofer or integrated into a stand-alone box the size of a DMA or integrated into the traditional form factor of a stereo receiver or 5.1 A/V receiver.

Supporting speaker components could be bookshelf- or tower-type designs with integrated Dolby Atmos speakers or modules affixed to the top of the speaker, or they may be bundled with a receiver and included in compact audio package.

The Intelligence of the System

Once you have chosen the best speaker configuration for your system, you will need to make a decision regarding the processor. This is the intelligence of your system and where the magic of the Dolby Atmos experience begins. Switching between each of your playback sources occurs here; Dolby Atmos object-based audio is decoded and scaled to the 2.1.2 and 3.1.2 speaker system and legacy channel-based content is upmixed for playback through the entire system.

Possible systems include:

- Compact design
 - This could be a small form factor device supporting either 2.1.2 or 3.1.2 playback or both. The device must be equipped with HDMI[®] inputs and may support wireless output or include built-in digital amplifiers.
It may or may not be bundled with a speaker system when packaged for retail.
- Modified stereo receiver
 - Adding complementary amplifiers, Video Pass Through, Dolby Atmos decoding and processing capability and HDMI inputs and output, Dolby Atmos support for 2.1.2 (or even 3.1.2) could be integrated into stereo receivers, including those that support “high-resolution audio.”
- A traditional 5.1 Audio Video Receiver form factor supporting Dolby Atmos decoding and rendering
 - A 5.1 channel Audio Video receiver with HDMI inputs and outputs and Dolby Atmos functionality could be modified to support 2.1.2 and 3.1.2 speaker configurations.
- Integrated design where all electrical components are built into the subwoofer or one of the main speakers, further reducing the footprint of the playback system.

Speaker Solutions for a Dolby Atmos Compact Entertainment System

Essential to the experience is the reproduction of sound above the listener. Through Dolby’s knowledge of psychoacoustics and sound physics, we have developed technologies that create overhead sound from speakers located only a few feet off the floor.

Employing a combination of unique physical speaker design and special signal processing, Dolby Atmos enabled speakers allow you to experience overhead sounds from speakers that are placed at the same level or slightly above traditional speakers. This speaker design directs sound upward and uses the reflection of sound off the ceiling to create a faithful reproduction of audio coming from above.

Integrated speaker designs combine traditional front-firing speakers with upward-firing Dolby Atmos enabled drivers in a single cabinet.

If you are satisfied with the performance of your existing stereo speakers, you could add a pair of Dolby Atmos enabled speaker modules . These may be placed on top of, or nearby, your primary speakers.

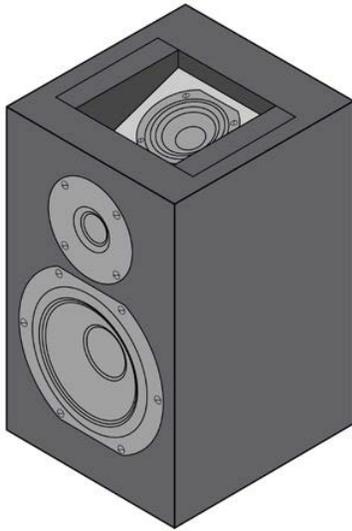


Figure 3: Dolby Atmos enabled integrated speakers include both traditional front-firing speakers and upward-firing speakers. Both sets of speakers have their own binding posts to connect to your A/V receiver.

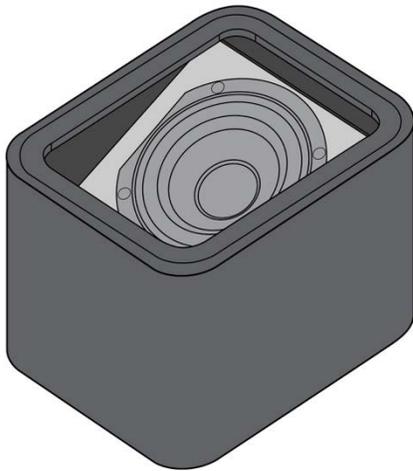


Figure 4: Dolby Atmos enabled add-on modules include only upward-firing elements. You can place them on top of your traditional front-firing speakers or on another surface near them.

With either configuration, you will often have a system that incorporates larger speakers than what is incorporated into other designs, such as a sound bar or on-board speaker system in the television. A pair of external stereo speakers will provide a wider frequency response with deeper and richer bass performance. Combine that with a subwoofer designed to reproduce the deepest lows of a string bass or even an explosion and you have a recipe for the beginnings of a great home entertainment system that will fill the room with natural, full-range sound and ambience.

Key Electrical Ingredients of a Dolby Atmos Compact Entertainment System

Dolby Atmos Object Audio Rendering

This is the intelligence of a Dolby Atmos enabled compact entertainment system. Dolby Atmos content consists of both audio objects and positional metadata, which includes information describing where those sounds should be placed and move, along with other data such as the type of audio object represented. The Dolby Atmos object audio renderer is informed of the types of speakers and their location. Programmed with this information, the object audio renderer scales and adapts Dolby Atmos encoded content to the specific speaker configuration of the playback system.

The adaptability of the Dolby Atmos object audio renderer is the key to scaling object-based audio mixes.

Dolby TrueHD

Dolby expanded the Dolby TrueHD format employed in Blu-ray Disc™ media through the addition of a fourth substream to support play back of Dolby Atmos content. This substream represents a lossless encoded, fully object-based mix.

Dolby Atmos signals encoded in Dolby TrueHD are transmitted from a Blu-ray™ player to your Dolby Atmos compact audio system through an HDMI connection. The Dolby TrueHD soundtrack and its associated object-based audio and positional metadata is decoded, processed, and rendered to the specific speaker configuration in the home.

Dolby Atmos audio can be encoded with Dolby TrueHD at multiple sampling rates (including 48 kHz and 96 kHz) and bit depths (16-bit and 24-bit). Dolby Atmos enabled compact audio systems will also support legacy Dolby TrueHD bitstreams at multiple sampling rates (including 48, 96, and 192 kHz) and bit depths (16-, 20-, and 24-bit) to provide full backward compatibility with legacy Blu-ray Disc movie and Dolby TrueHD music files.

Dolby Digital Plus

Dolby updated Dolby Digital Plus™ to include a new decoder capable of processing content encoded for Dolby Atmos. This module employs new bitstream metadata to extract Dolby Atmos object-based audio and then outputs this information for further processing by the object audio renderer.

The sampling rate for Dolby Atmos content is 48 kHz, the same sample rate as for Dolby Digital Plus content.

Dolby Digital Plus is employed for over-the-air (OTA) and cable broadcast delivery and is the preferred audio codec for multichannel OTT or streaming media content.

Dolby MAT

A Dolby MAT encoder resides in a Blu-ray player to pack the variable bit-rate Dolby TrueHD bitstreams for transmission over the fixed bit-rate HDMI. A Dolby MAT decoder is concurrently employed in the Dolby TrueHD decoder in the receiver/processor to unpack the Dolby TrueHD bitstreams.

With the introduction of Dolby Atmos, we have expanded the Dolby MAT technology to support encoding and decoding of Dolby Atmos metadata incorporated in lossless pulse-code modulation (PCM) audio.

A key benefit of Dolby MAT 2.0 is that Dolby Atmos object-based audio can be dynamically encoded in real time and transmitted from a source device with limited latency and processing complexity.

Likely sources that will employ Dolby MAT encoding include broadcast set-top boxes and game consoles. The Dolby MAT 2.0 decoder outputs the object-based audio and its metadata for further processing inside the device. The Dolby MAT 2.0 container is scalable and leverages the full potential of the HDMI audio pipeline.

Dolby Surround Upmixer

Home entertainment enthusiasts have a wide selection of channel-based and Dolby Atmos content. The Dolby Surround upmixer is designed to maximize the listening experience of all of their channel-based content from stereo to 7.1 to re-create an accurate, spacious, and immersive rendering of music and movie soundtracks while simultaneously honoring and maintaining the artist's intent for the mix.

Unlike previous wideband upmixing technologies, which operated in the time domain, the Dolby Surround upmixer operates in the frequency domain, processing multiple perceptually spaced frequency bands for a fine-grained analysis of the source signal.

The Dolby Surround upmixer can individually steer frequency bands, producing surround sound with precisely located audio elements and a spacious ambience. Spatial imaging is complemented through the use of Dolby Atmos enabled speakers.

Dolby Surround Virtualizer

The Surround Virtualizer employs a combination of advanced head-related transfer functions (HRTFs) and crosstalk cancellation so that listeners hear the sounds as if they were coming from a multiple-speaker surround configuration.

The specific HRTFs used present an optimized experience for a large number of listeners in the room. The virtualization filters are carefully calibrated to produce an uncolored natural sound, even for listeners outside of the sweet spot.

Devices may also employ additional content processing to further enhance the listening experience including:

Volume Leveling and Modeling

The Volume Leveler feature is an advanced volume-control solution that maintains consistent playback levels regardless of the source selection and content.

When the playback volume level is adjusted, the Volume Modeler compensates for how people perceive loudness by analyzing incoming audio and grouping similar frequencies into critical bands and applying different amounts of gain to each critical band. As a result, changing the loudness level does not change

the perceived loudness of each frequency. A consistent and natural playback experience at varying volume settings is thus assured.

Dialogue Enhancer

The Dialogue Enhancer feature enhances the speech spectrum and suppresses interfering sounds, thereby improving dialogue perception and clarity for all users. The Dialogue Enhancer applies an algorithm that continuously monitors the audio being played to detect the presence of dialogue and dynamically applies processing to improve the intelligibility of the dialogue portion of a recording.

Intelligent Equalizer

The Intelligent Equalizer feature dynamically adjusts audio to provide consistency of spectral balance (also known as timbre or tone) during content playback. The result is often a warmer, richer, and fuller experience from movie and music soundtracks.

Conclusion

The Dolby Atmos enabled compact entertainment system follows in the footsteps of larger offerings for home theater, with the primary distinguishing feature being the ability to enable a highly immersive audio experience from just two or three speakers.

This solution can be integrated into the profile of a traditional 5.1 A/V receiver, a stereo receiver, a DMA (with wired or wireless connection), or even a combination receiver/Blu-ray player packaged with a pair of Dolby Atmos enabled speakers. The opportunity for new product designs and configurations is seemingly limitless.

Dolby Atmos enabled compact entertainment systems provide consumers worldwide with access to the experience and magic of Dolby Atmos—in a form factor that fits their lifestyles.

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