

Dolby® Atmos™ Specifications

Issue 1

1	Introduction	1
2	Screen Loudspeakers	1
3	Screen Subwoofer	3
4	Surround Loudspeakers	4
5	Surround Subwoofers	14
6	Estimating Loudspeaker Output	15

Dolby Atmos Specifications

1 Introduction

Dolby® Atmos™ achieves unprecedented levels of audience immersion and engagement by offering powerful new authoring tools to mixers. Its new cinema processor features a flexible rendering engine that optimizes the audio quality and surround effects of the Dolby Atmos soundtrack to each room's speaker layout and characteristics. In addition, Dolby Atmos has been designed from the ground up to maintain backward compatibility and minimize the impact on production, distribution, and exhibition workflows.

The introduction of a new audio format allows for changes in the design of sound systems without breaking compatibility with existing practices. Dolby has revisited critical areas of soundtrack reproduction, including equipment performance, layout, and installation for dubbing theaters and cinemas. This specification provides the recommended and minimum performance requirements for Dolby Atmos installations. In many cases, exceeding the minimum performance requirements can add value to system performance. This document replaces the previously issued *Dolby Atmos Technical Guidelines* document.

2 Screen Loudspeakers

Dolby Atmos does not place new demands on the screen loudspeakers. Existing best practice still applies. The loudspeakers must be capable of full dynamic range digital cinema content playback through a cinema screen, with a response that conforms to ISO 2969:1987/SMPTE ST 202:2010 specifications.

To ensure this performance, the following specifications are provided.

2.1 Number of Screen Loudspeakers

A minimum of three screen speakers is required. For a screen wider than 12 meters (approximately 40 feet), we recommend the addition of left center and right center speakers.

2.2 Sound Pressure Level: 105 dB

Each screen loudspeaker system and associated amplifiers must have a maximum output capability of 105 dB continuous sound pressure level (SPL) at the reference listening position. Loudspeaker capability must be determined, as described in Section 6. We recommend an amplifier with 3 dB of headroom (that is, twice the required continuous power). If the system specifications are not known or not provided by the manufacturer, use the following guidelines for SPL at the reference listening position to assess each component:

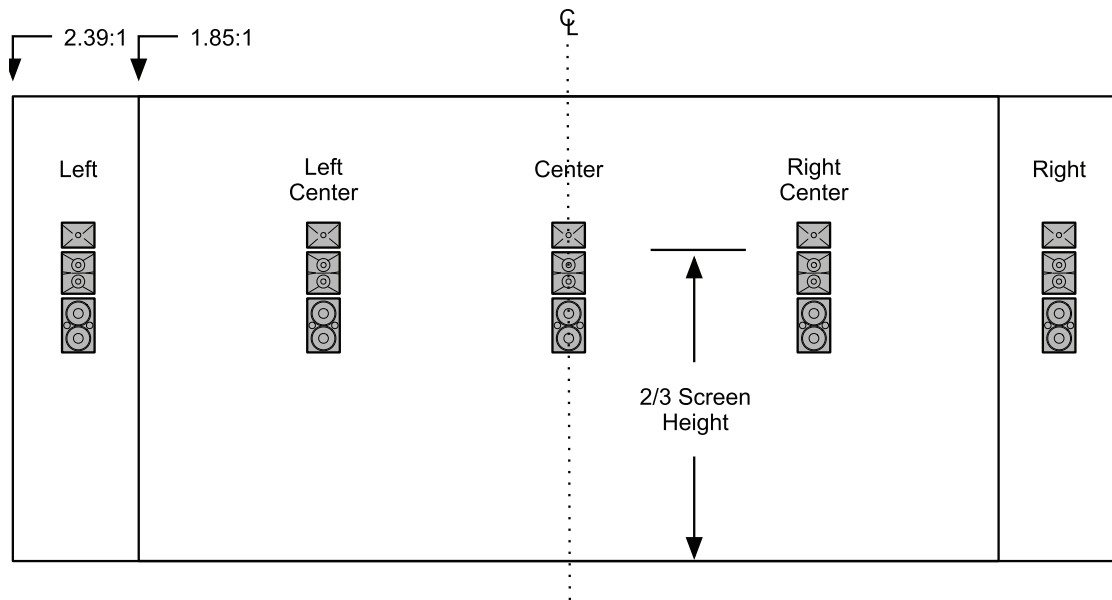
- Two-way/biampfier: 105 dB for the low-frequency section, 101 dB for the middle-frequency and high-frequency sections
- Three-way/triampfier: 105 dB, 101 dB, 98 dB for the low-frequency, middle-frequency, and high-frequency sections, respectively
- Four-way/quad amplifier: 105 dB, 101 dB, 98 dB, 92 dB for the low-frequency, middle-frequency, high-frequency, and ultra high-frequency sections, respectively

2.3 Frequency Range: 40 Hz to 16 kHz, +3/–6 dB

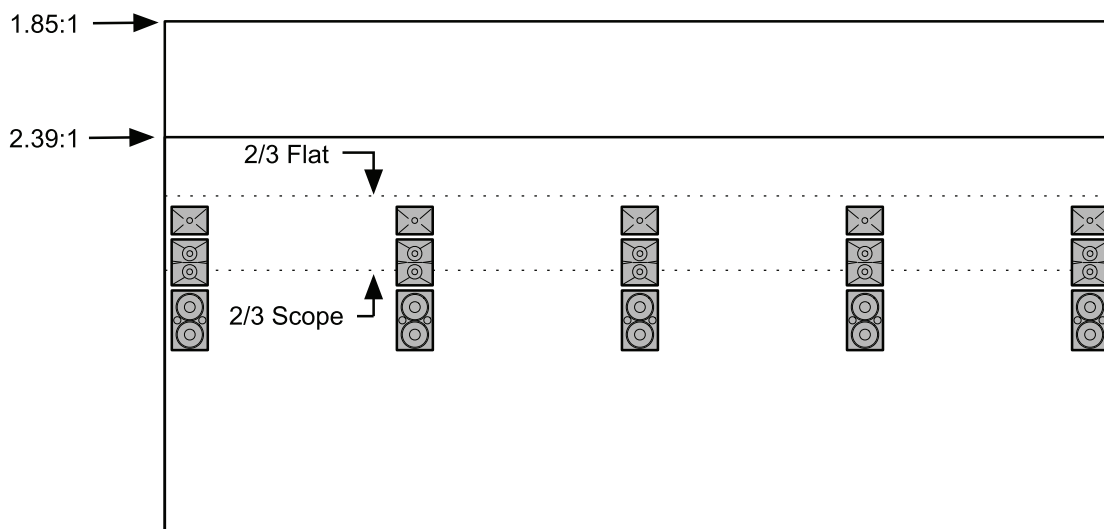
2.4 Frequency Response: 80 Hz to 16 kHz, ± 3 dB

2.5 Position

Always place the center speaker at the screen center line. Place the left and right speakers equidistant from the center speaker, regardless of the position of the screen within an auditorium. If installed, place the left center and right center speakers midway between the center speakers and the left and right speakers, respectively. Place all screen speakers vertically at the same height. In auditoriums with a fixed image height, position the left and right screen speakers midway between the 1.85:1 (flat) and 2.39:1 (scope) images, with the acoustic center placed at approximately two-thirds of the screen height.

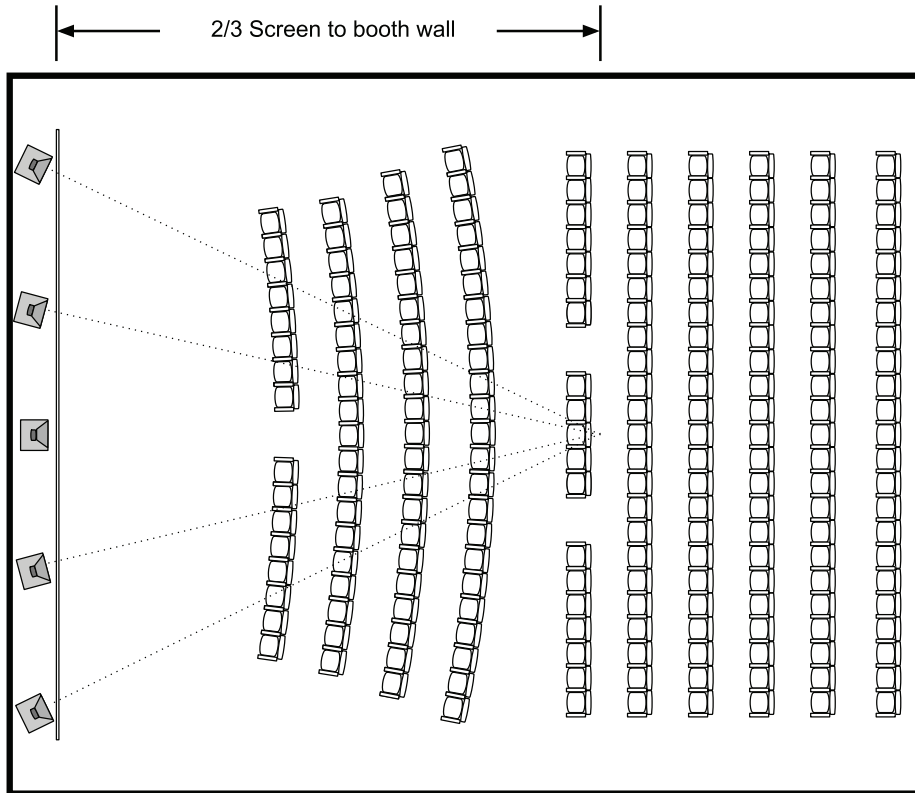


In auditoriums with a fixed image width and top moving masking, place the left and right screen speakers just inside the edge of the image, with the acoustic center midway between the two-thirds image height for the flat and scope images.



2.6 Aiming

The screen speakers must be rotated horizontally so that the axis of the speaker is oriented at a point two-thirds of the distance to the back of the auditorium, along the screen center line. Only the horns should be rotated horizontally for speakers mounted in a baffle wall, keeping the low-frequency section flush with the wall.



3 Screen Subwoofer

3.1 Sound Pressure Level: +10 dB (Compared to Center Speaker)

The Low-Frequency Effects channel subwoofer must have a flat response over the range of 31.5 to 120 Hz. When compared with a full-range screen channel, the subwoofer channel must be capable of producing +10 dB of in-band gain (for example, as viewed on a real-time analyzer).

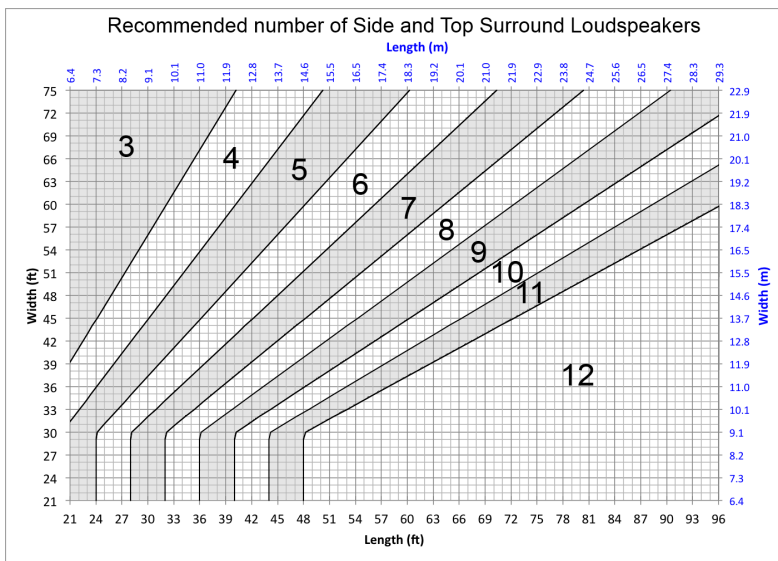
3.2 Frequency Response: 31.5–120 Hz, ± 3 dB

4 Surround Loudspeakers

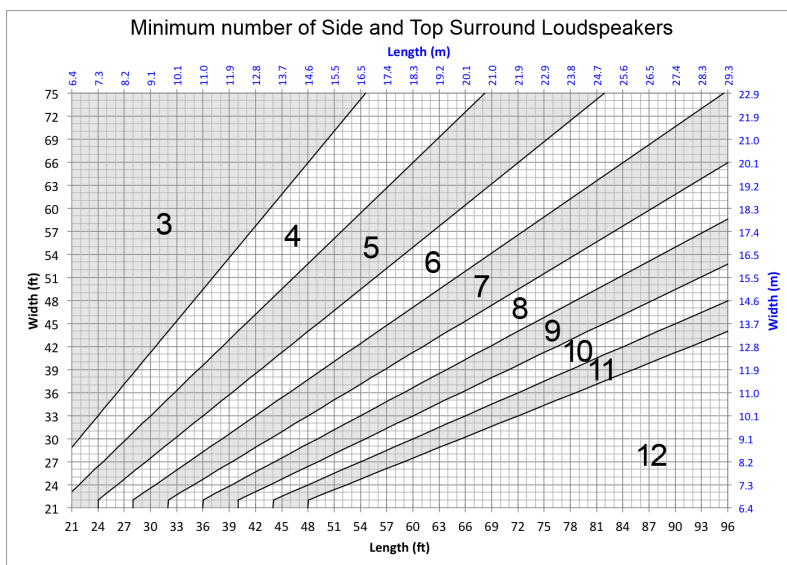
The figures in this section indicate the recommended number of surround loudspeakers and the minimum number of surround loudspeakers for each side wall, ceiling array, and rear wall. The number of loudspeakers is a function of the room length and width.

4.1 Number of Side and Top Surround Loudspeakers

The following figure indicates the recommended number of loudspeakers for each side wall and each side of the ceiling, as a function of room length and width (shown in feet and meters). Meters are in blue text.

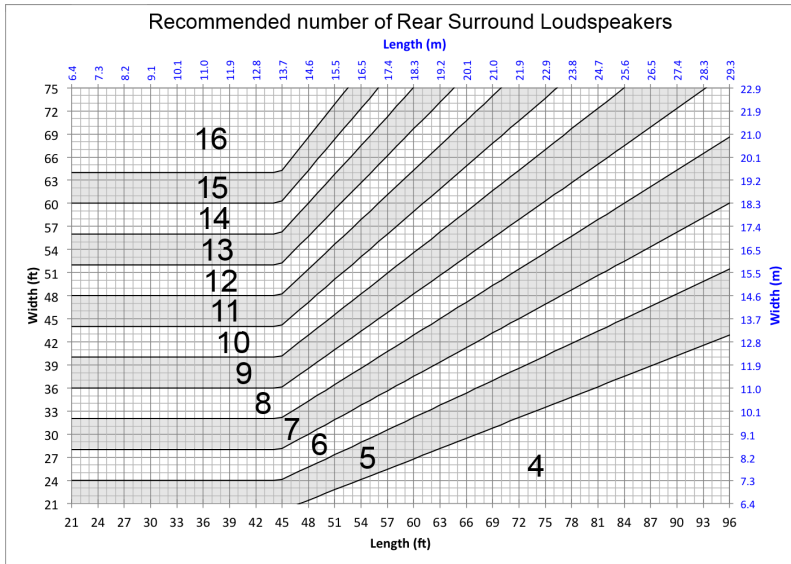


The following figure indicates the minimum number of loudspeakers required for each side wall and each side of the ceiling, as a function of room length and width (shown in feet and meters). Meters are in blue text.

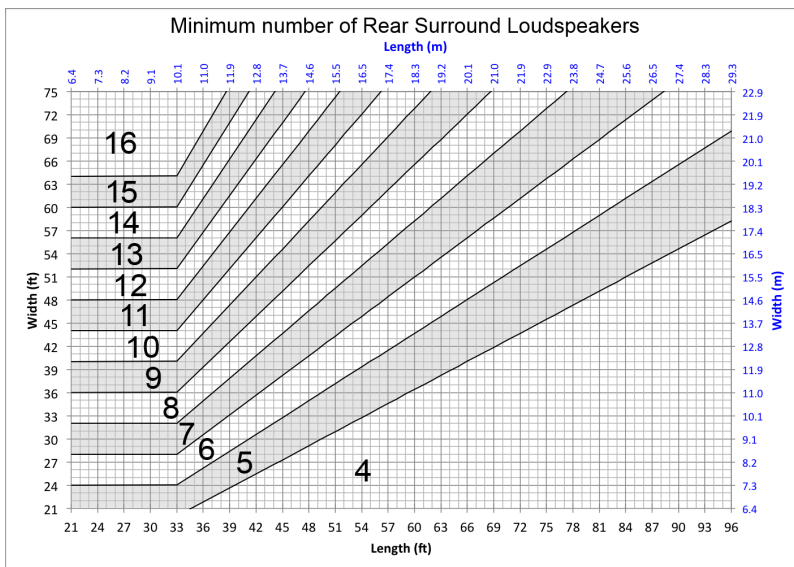


4.2 Number of Rear Surround Loudspeakers

The following figure indicates the recommended number of loudspeakers for the rear wall, as a function of room length and width (shown in feet and meters). Meters are in blue text.



The following figure indicates the minimum number of loudspeakers required for the rear wall, as a function of room length and width (shown in feet and meters). Meters are in blue text.



4.3 Surround Loudspeaker Sound Pressure Level: 99 dB

Each loudspeaker and associated amplifier must have a maximum output capability of 99 dB continuous SPL at the reference listening position. Loudspeaker capability must be determined, as described in Section 6. We recommend an amplifier with 3 dB of headroom (that is, twice the required continuous power).

4.4 Surround Array Sound Pressure Level: 105 dB

Each surround array and the associated amplifiers must be able to produce 105 dB continuous SPL at the reference listening position. To meet this requirement for surround arrays with fewer than four loudspeakers, each loudspeaker must be able to produce more than 99 dB continuous SPL.

4.5 Surround Sound Frequency Response: 40 Hz to 16 kHz, +3/-6 dB

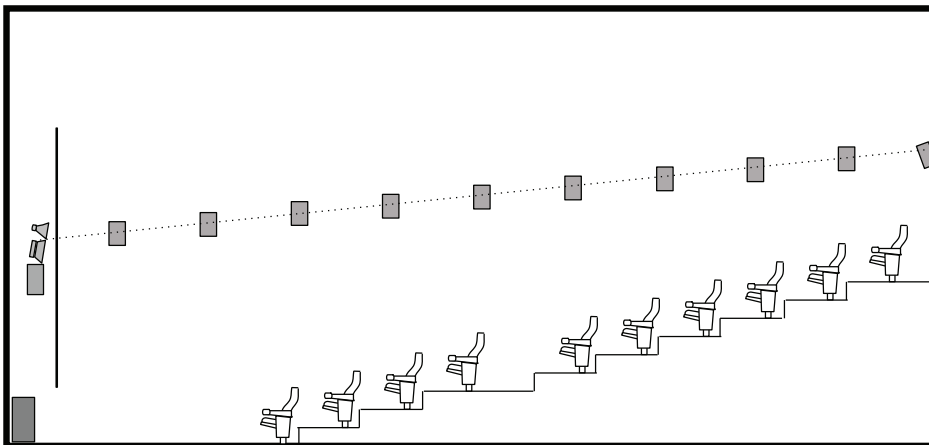
Dolby Atmos auditoriums must support playback of full-range surround signals. To meet this specification standard, cinema surround loudspeakers with limited bass response require bass management. If bass management is used, the surround loudspeakers frequency response (± 3 dB) must extend to 90 Hz or lower. The crossover frequency should be set based on the capabilities of the surround loudspeakers, but must not be higher than 100 Hz.

4.6 Rear Surround Elevation

The rear surround loudspeakers must be positioned at a uniform height. The position should be sufficiently high to maintain good coverage across the seating area according to the directivity of the speaker and be out of the reach of patrons, where possible, to prevent tampering, damage, or theft. One-quarter room-width is a good guideline.

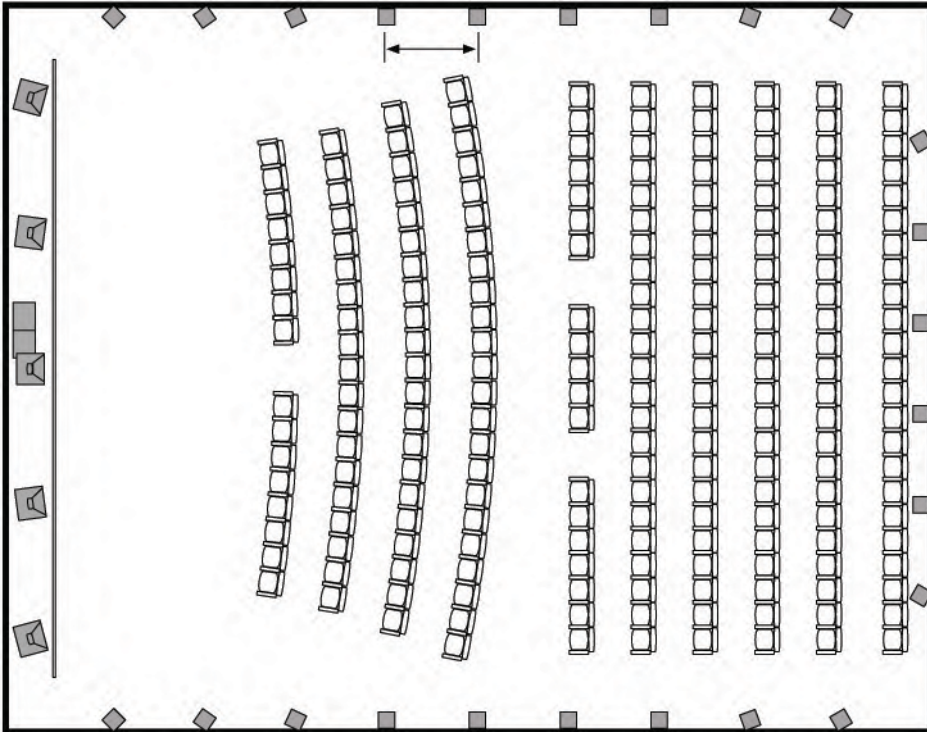
4.7 Side Surround Elevation

The elevation of the side surround speakers should form a straight line from the acoustic center of the screen loudspeaker array to the rear surround loudspeakers.



4.8 Side Surround Spacing

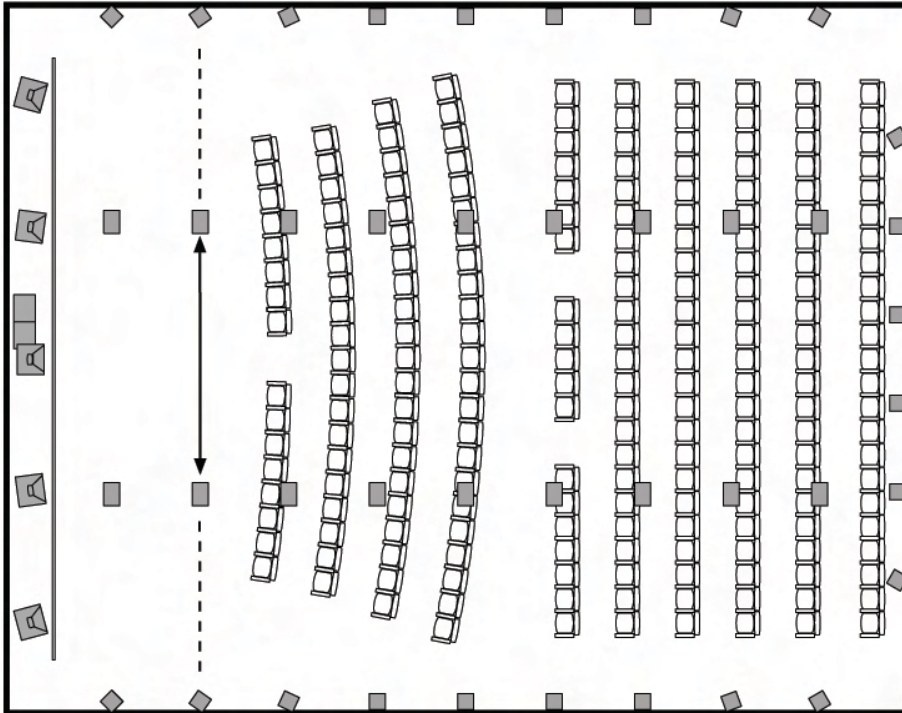
Side surround speakers must be placed as left/right pairs, with the left speaker and right speaker at the same distance from the front wall. The interspeaker spacing, the distance between the loudspeakers within a side or top surround array, must be between the value of $L \div N$ and the value of $L \div (N + 1)$, where L is the room length and N is the number of loudspeakers in the array. The distance between the front-most loudspeaker and the screen must be between 50 and 100% of the interspeaker spacing. Likewise, the distance between the rear-most loudspeaker and the rear wall must be between 50 and 100% of the interspeaker spacing.



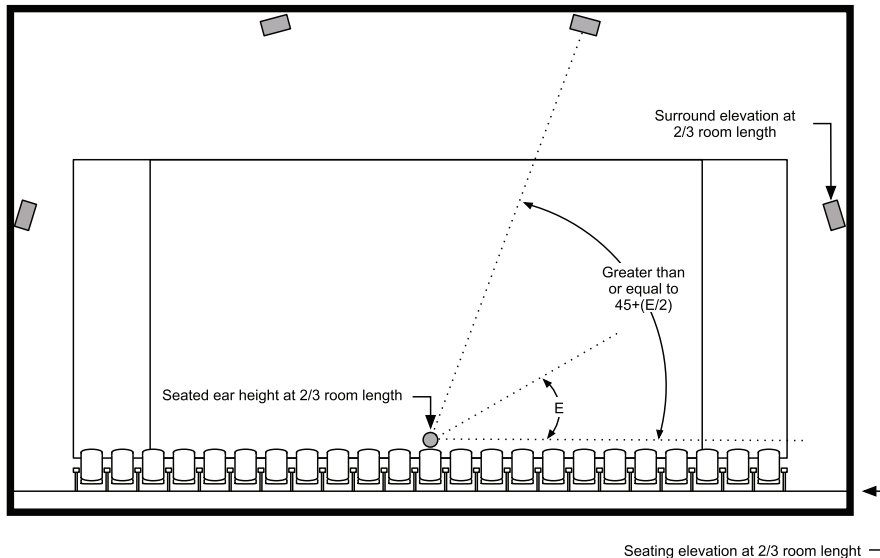
4.9 Top Surround Position

Top surround speakers must always be placed as left/right pairs, with the left speaker and right speaker at the same distance from the front wall. The top surround loudspeakers should typically be placed in line with the corresponding side surround loudspeaker pairs, and must conform to the interspeaker rule described for the side surrounds.

The top surround speaker pairs must be placed symmetrically with respect to the screen center line. The top surround arrays should typically be placed in line with the left center and right center screen loudspeakers, which is the minimum width.



The maximum width between top surround speakers should be determined based on elevation angles as follows: Let E be the elevation angle of the nearest side surround speaker measured from the reference position, a point two-thirds back in the auditorium in the middle of the seating area. The elevation angle of the corresponding top surround array should be greater than or equal to 45 degrees plus half of angle E . For example, if E is 20 degrees, then the elevation angle of the top surround array should be greater than or equal to 55 degrees.



4.10 Rear Surround Spacing

The rear surround interspeaker spacing, which is the distance between the loudspeakers on the rear wall, must be between the value of $W \div N$ and the value of $W \div (N + 1)$, where W is the room width and N is the number of loudspeakers on the rear wall. The distance between the outside loudspeakers and the side walls must be between 50 and 100% of the interspeaker spacing.

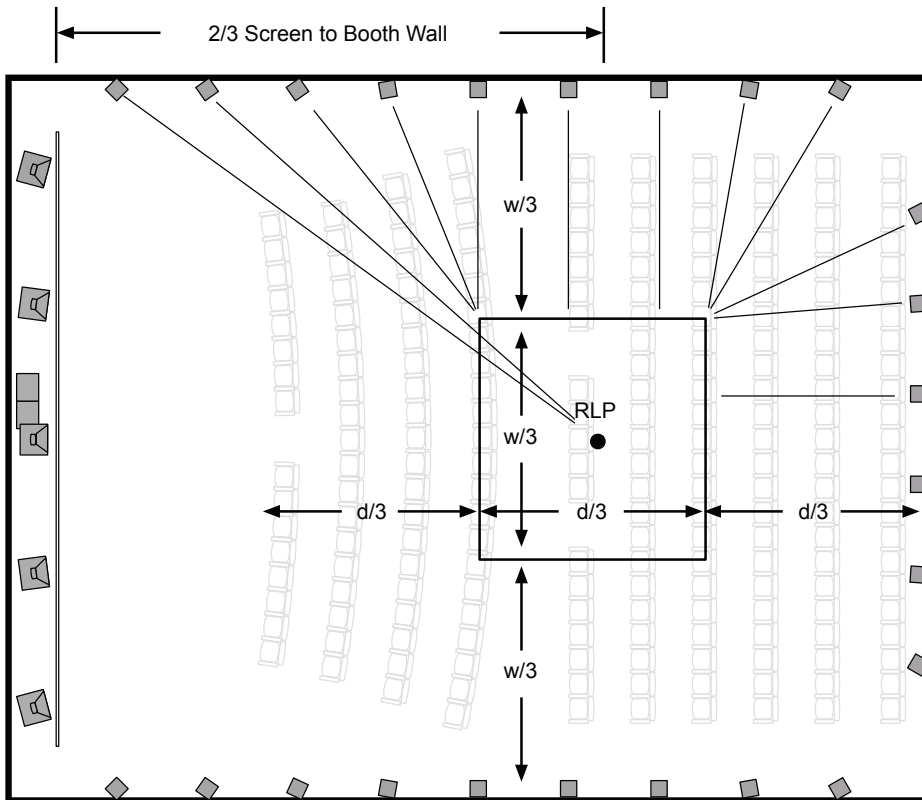
4.11 Side and Rear Surround Horizontal Aiming

To determine the proper horizontal aiming for the side and rear surround loudspeakers, define a rectangle in the central listening area, as follows:

- Central listening area width is $W \div 3$ (one-third the room width).
- Central listening area length is $D \div 3$ (one-third the distance between the first and last row).
- Central listening area is centered on the reference listening position.

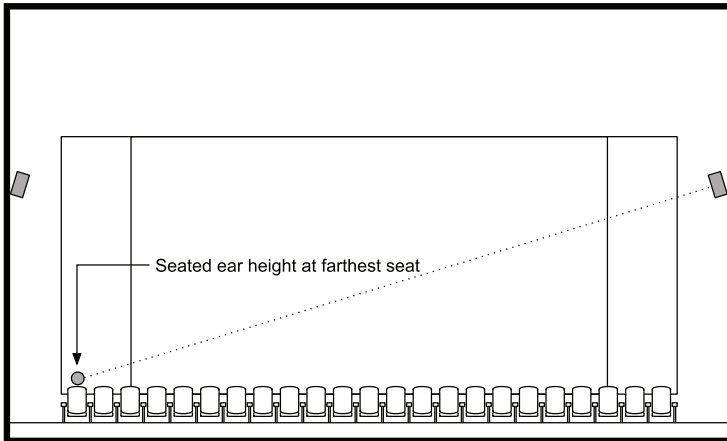
Side and rear surround loudspeakers adjacent to the central listening area must aim directly into the room (that is, 0° from perpendicular), $\pm 10^\circ$.

The remaining side and rear surround loudspeakers must be angled horizontally toward the nearest corner of the central listening area, but not beyond the reference listening position, $\pm 10^\circ$. Avoid abrupt changes in horizontal aiming ($\geq 30^\circ$) from speaker to speaker. Left/right loudspeaker pairs should have the same aiming.



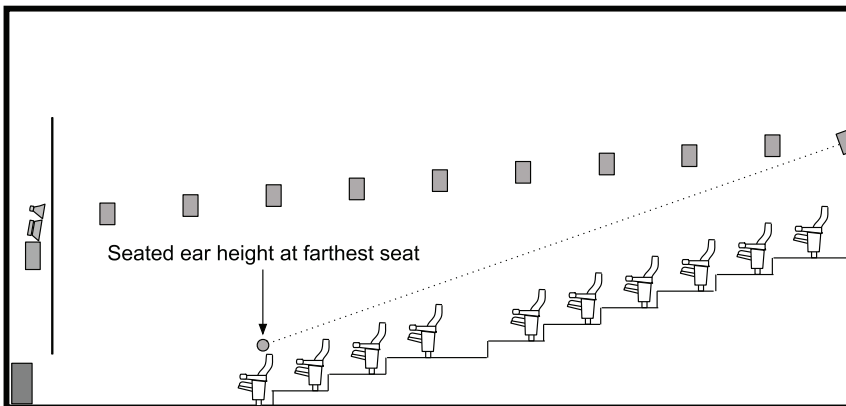
4.12 Side Surround Elevation Aiming

Side surround speakers should be tilted to orient the axis of each speaker to the ear height of a seated listener in the farthest seat, based on the horizontal aiming. The speaker can be aimed higher, but not by more than half the loudspeaker vertical coverage angle.



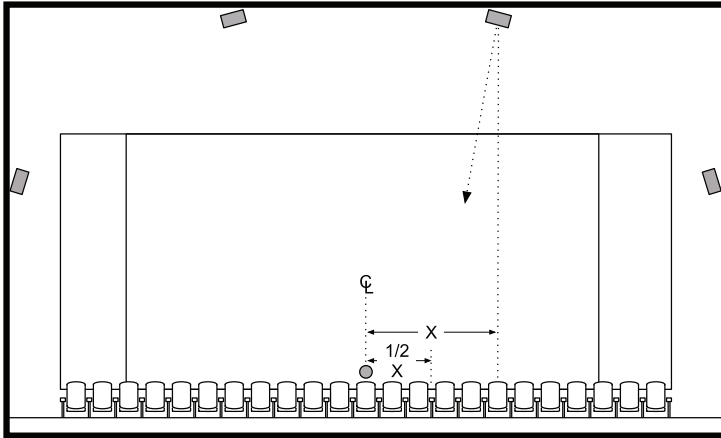
4.13 Rear Surround Elevation Aiming

Rear surround speakers must be tilted down to orient the axis of each speaker to the ear height of a seated listener in the front row. The speaker can be aimed higher, but not higher by more than half the loudspeaker vertical coverage angle.

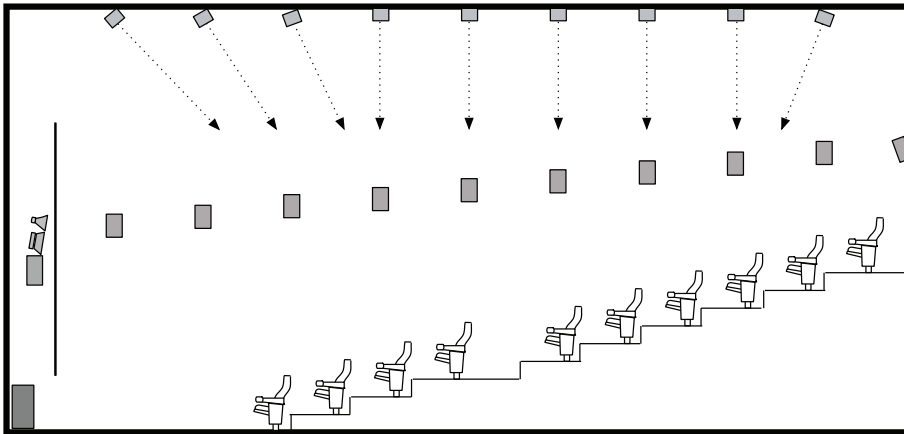


4.14 Top Surround Aiming

The top surround speakers must be angled laterally (across the auditorium) to a position halfway between the lateral position of the top surround speaker and the screen center line, $\pm 10^\circ$.



Top surrounds should be angled longitudinally (along the length of the auditorium) in a manner similar to the angling of the side surrounds (taking 0° as aiming vertically downward):



- Speakers over the central listening area should aim neither forward nor backward. (That is, they should be aimed at 0° .)
- Speakers in front of and behind the central listening area should aim toward the front and back of the central listening area, respectively.
- Abrupt changes in aiming (≥ 30 degrees) from speaker to speaker should be avoided.

4.15 Surround Loudspeaker Coverage Angles

To provide uniform coverage across the listening area, we recommend the following nominal surround loudspeaker coverage angles. Use these guidelines to select the most appropriate loudspeaker model from the manufacturer's line. In all of the following cases, coverage angle refers to the nominal angle between the loudspeaker -6 dB points.

4.15.1 Horizontal Coverage Angle, Front Side Surround Loudspeakers: 60°

Each front side surround loudspeaker that is forward of the listening area should have a horizontal coverage angle $\geq 60^\circ$.

4.15.2 Vertical Coverage Angle, Front Side Surround Loudspeakers: 40°

Each front side surround loudspeaker that is forward of the listening area should have a vertical coverage angle $\geq 40^\circ$.

4.15.3 Horizontal Coverage Angle, Side Surround Loudspeakers: 90°

Each side surround loudspeaker that is adjacent to the listening area should have a horizontal coverage angle $\geq 90^\circ$. For best audience coverage, we recommend a wider dispersion, $> 100^\circ$.

4.15.4 Vertical Coverage Angle, Side Surround Loudspeaker: $50^\circ, \pm 10^\circ$

Each side surround loudspeaker that is adjacent to the listening area should have a vertical coverage angle of $50^\circ, \pm 10^\circ$.

4.15.5 Coverage Angle, Front and Rear Top Surround Loudspeakers: 50°

The front-most top surround loudspeakers (those in front of the first audience seats) and the rear-most top surround loudspeakers should have vertical and horizontal coverage angles $\geq 50^\circ$. A conical dispersion horn should have a coverage area $\geq 50^\circ$.

4.15.6 Coverage Angle, Top Surround Loudspeaker: 100°

The top surround loudspeakers directly above the listening area should have vertical and horizontal coverage angles $\geq 100^\circ$. A conical dispersion horn should have a coverage area $\geq 100^\circ$.

5 Surround Subwoofers

Dolby Atmos auditoriums must support playback of full-range surround signals. Surround loudspeakers with limited bass are acceptable if surround subwoofers and bass management are used. For practical installations, this is the most common approach. When using bass management, the surround subwoofers must meet the following requirements.

5.1 Number of Surround Subwoofers

At least two surround subwoofers are required. For larger auditoriums (>500 seats), additional subwoofer pairs should be used.

5.2 Surround Subwoofer Frequency Response: 40–120 Hz, +3/–6 dB

Each surround subwoofer (if bass management is used) must have a frequency response of 40–120 Hz.

5.3 Surround Subwoofer Sound Pressure Level: 0 dB (Compared to Center Speakers)

The left surround subwoofers and right surround subwoofers—loudspeaker and amplifier—must be capable of producing the same in-band gain as a wideband channel (for example, as viewed on a real-time analyzer).

5.4 Surround Subwoofer Placement

The following guidelines pertain to the placement of surround subwoofers in auditoriums:

- Locate subwoofers in the back half of the auditorium along the side walls, rear wall, or ceiling.
- For rear wall or ceiling placement, the surround subwoofers should be placed wider than the top surround arrays.
- Avoid placing subwoofers in the rear corner of the auditorium. The minimum distance from a surround subwoofer to the rear corner should be one meter.
- Avoid placing the subwoofers near any listening position. Placement high on the side walls or on the ceiling is best. For a steeply racked theatre (with rear seats near the ceiling), we recommend placing the subwoofers closer to the front-to-back halfway point.

6 Estimating Loudspeaker Output

The SPL performance guidelines in this document are provided with respect to the reference listening position and are based on the capabilities and demands of a calibrated cinema auditorium. Many variables affect playback levels, including B-chain processing, amplifier and speaker capabilities, and the room itself. Existing speaker and amplifier performance standards cannot account for the unique characteristics of each cinema auditorium (screen loss, room equalization, SMPTE standards for level calibration and characteristic amplitude response, and so on). As a result, it is impossible to state with any certainty the speaker performance requirements for achieving standard cinema levels in all cases; one can only estimate.

To assist you in determining the required speaker output capability, we recommend the following:

1. Determine the speaker maximum continuous output SPL (SPL_{max}). This is often specified in the documentation provided by the speaker manufacturer. If SPL_{max} is not stated, compute it using the rated sensitivity of the speaker (1 W at 1 m) and power handling (IEC noise, with AES duration of two hours), as follows:

$$SPL_{max} = \text{sensitivity} + \log_{10}(\text{power handling})$$

2. Measure the distance in meters (D2) from the speaker to the reference position, a point two-thirds back in the auditorium in the middle of the seating area.
3. Using this distance information, calculate the sound pressure attenuation from the speaker to the reference position, as follows:

$$\text{Distance attenuation} = 20 \times \log_{10}(D1 \div D2)$$

In this equation, D1 is one meter, D2 is the distance measured in step 2, and distance attenuation is a negative number representing the level change (in decibels).

4. Add the values for distance attenuation and SPL_{max} to determine the level at the reference listening position.

Corporate Headquarters

Dolby Laboratories, Inc.
Dolby Laboratories Licensing Corporation
100 Potrero Avenue
San Francisco, CA 94103-4813 USA
Telephone +1-415-558-0200
Fax +1-415-645-4000
dolby.com

European Licensing Liaison Office

Dolby International AB
Apollo Building, 3E
Herikerbergweg 1-35
1101 CN Amsterdam Zuidoost
The Netherlands
Telephone +31-20-651-1800
Fax +31-20-651-1801
dolby.co.uk

Asia Offices

Dolby Japan K.K.
NBF Higashi-Ginza Square 3F
1-13-14 Tsukiji, Chuo-ku
Tokyo 104-0045 Japan
Telephone +81-3-3524-7300
Fax +81-3-3524-7389
dolby.com/jp/ja/

Dolby Laboratories International Services
(Shanghai) Co., Ltd.
05-07a, Floor 18
The Center
989 Chang Le Road
Shanghai 200031 China
Telephone +86-21-6113-3456
Fax +86-21-6113-3400
dolby.com/cn



Dolby and the double-D symbol are registered trademarks of Dolby Laboratories. Dolby Atmos is a trademark of Dolby Laboratories. All other trademarks remain the property of their respective owners.

© 2013 Dolby Laboratories, Inc. All rights reserved. S13/27333