Dolby Atmos Home Entertainment Studio Certification

Guide

Confidential information
30 January 2019

1 Introduction to this documentation

This documentation details the technical specification for studios wishing to employ a 7.1.4 home entertainment Dolby Atmos monitoring setup. In addition, the documentation provides a high-level overview of the Dolby Atmos home entertainment studio certification program.

1.1 About the certification program

The purpose of this Dolby certification program is to provide an industry recognized mark of technical excellence for the creation of Dolby Atmos content for home entertainment.

The program offers consultation and certification of room geometry, room acoustics, speaker positioning and electroacoustic performance, mix equipment, and Dolby Atmos rendering solutions. All of these factors ensure that each room is configured for optimum performance.

Additional benefits of the program include:

- Room commissioning performed by a Dolby engineer
- Ongoing technical support, including a yearly engineering visit and training
- Use of the Dolby brand on marketing material
- Dolby Atmos home entertainment studio certification wall plaque and trophy
- Listing on the Dolby.com website as a certified Dolby Atmos mix studio

1.2 Channel abbreviations

This documentation uses several channel abbreviations.

Abbreviation	Channel
L	Left
R	Right
C	Center
LFE	Low-Frequency Effects
Ls	Left Surround

Abbreviation	Channel
Rs	Right Surround
Lss	Left side surround
Rss	Right side surround
Lrs *	Left Rear Surround
Rrs	Right Rear Surround
Lts	Left Top Surround
Rts	Right Top Surround

* Lrs and Rrs correspond to Pro Tools Lsr and Rsr abbreviations.

1.3 Contacting Dolby

You can contact Dolby regarding this certification program and its supporting documentation.

To talk to Dolby concerning your studio, or to learn more about the program, please contact Content Services at Dolby: CSGStudios@Dolby.com.

If you have questions or comments about this documentation, please send an email to documentation@dolby.com.

2 Technical requirements

Technical requirements for the certification cover room geometry, room acoustics, speaker positioning and electroacoustic performance, mix equipment, and applicable Dolby Atmos rendering solutions.

2.1 About the technical requirements

The technical requirements are founded on the algorithms and function of the home entertainment Dolby Atmos Renderer engine. They detail the best practice for accurate mix and replay capability, and requirements for certification.

Facilities seeking certification are encouraged to contact Dolby early in the design process, as each room can have a unique geometry, as well as unique uses and requirements.

The specification can also be used as a guide for those studios not requiring certification. In addition, we recommend that the reader also consults the ITU R-REC-BS.2051 standard publication for immersive audio.

2.2 Room design dimensions, terminology, and fundamentals

The home entertainment Dolby Atmos room geometry and speaker layout specification takes into account several factors to provide a commercial facility an optimum space to mix within. These include speaker positions used by the home entertainment Dolby Atmos rendering engine, typical studio geometry, and multiperson production teams.

Although the geometric rules in this documentation should produce a satisfactory result for most professional environments, we encourage facilities to engage with Dolby to ensure that optimum speaker placement is achieved.

2.2.1 Room layout design

When considering minimum and maximums dimensions for a home entertainment Dolby Atmos studio setup, the distances considered should be of the speaker layout rather than the room dimensions.

These dimensions are considered:

- Speaker layout height: This is the distance from the floor to the top surround speaker baffle.
- Speaker layout width: This is the maximum width between side wall speaker pairs as measured between speaker baffles.
- Speaker layout length: This is the maximum length between screen and rear speakers as measured between speaker baffles.

To ensure an accurate mix environment for Dolby Atmos for home entertainment, you must meet the minimum and maximum layout dimensions and acoustic criteria.

Table 1: Required minimum and maximum layout dimensions

Dimension	Specification
Minimum layout height	2.4 m
Minimum layout width	3 m
Minimum layout length	3.5 m
Recommended room volume	>50 m^3
Speaker distance to mix position	Maximum 5 m (less than 4 m recommended)

For rooms that require greater distances to the mix position, consult with your local Dolby representative.

Additional room design terminology and fundamentals

1. Speaker layouts are referred to in the form x.y.z, where x is the number of standard plane speakers, y the number of subwoofers, and z the number of top surround speakers.
2. The preferred speaker layout for Dolby Atmos home entertainment certification is 7.1.4. To discuss alternative layouts, contact your local Dolby representative.
3. The mix position is the reference point from which all speakers are placed in a home entertainment Dolby Atmos speaker layout. The ideal location for the mix position is in the geometric center of the speaker layout.
4. All speakers should ideally be equidistant from the mix position. Where this is not possible, and the distance to the mix position varies between speakers, delay and amplitude compensation will be applied, to a maximum of 10 ms.

5. All speakers should be angled toward the mix position where possible. This is in both the horizontal and vertical planes. Where this is not possible, the mix position must be well within the dispersion angle of the speaker.
6. The standard plane speakers are defined as L, R, C, Ls, Rs, Lrs, and Rrs. The overhead plane speaker is defined as the Ltf, Rtf, Rtr, and Ltr.

2.2.2 Room layouts

There are two common types of room layouts: equidistant and orthogonal.

Equidistant layout

In this layout, the distance to each speaker is approximately equal. The mix position is generally central at between 0.4 and 0.6 of the speaker layout length. This layout more closely adheres to Rec. ITU-R BS.2051, but can deviate from a completely circular shape.

Orthogonal layout

In this layout, the room is usually longer than wide, and mix position is in the back half of the room. The mix position is typically between 0.5 to 0.7 of the speaker layout length.

The equidistant and orthogonal layouts both represent an accurate mixing environment and are possible within Dolby recommendations and requirements for certification. The choice between them is largely based on room shape, preferred mix position, additional seating layout, multiple uses of a room, and space available.

2.2.3 Acoustics criteria

To ensure an accurate mix environment for Dolby Atmos for home entertainment, you must meet the specified acoustic criteria.

- Maximum noise floor level of NC25, with all equipment on, plus all intermittent and continuous noise sources present. Audible discrete noise sources should be addressed where possible.
- Strong discrete reflections should be suitably treated with absorption or diffusion as applicable to reduce coloration.
- In terms of reverberation decay time, RT60 measurements are taken at 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, and 8 kHz. The results should fall between the upper and lower limits when plotted in the Dolby Audio Room Design Tool .xlsb Excel file.

2.3 Speaker layout design

The step-by-step process for designing your speaker layout is influenced by whether you are using an equidistant or orthogonal layout.

2.3.1 Screen speakers

The position of the screen speakers is dictated by three main design aspects.

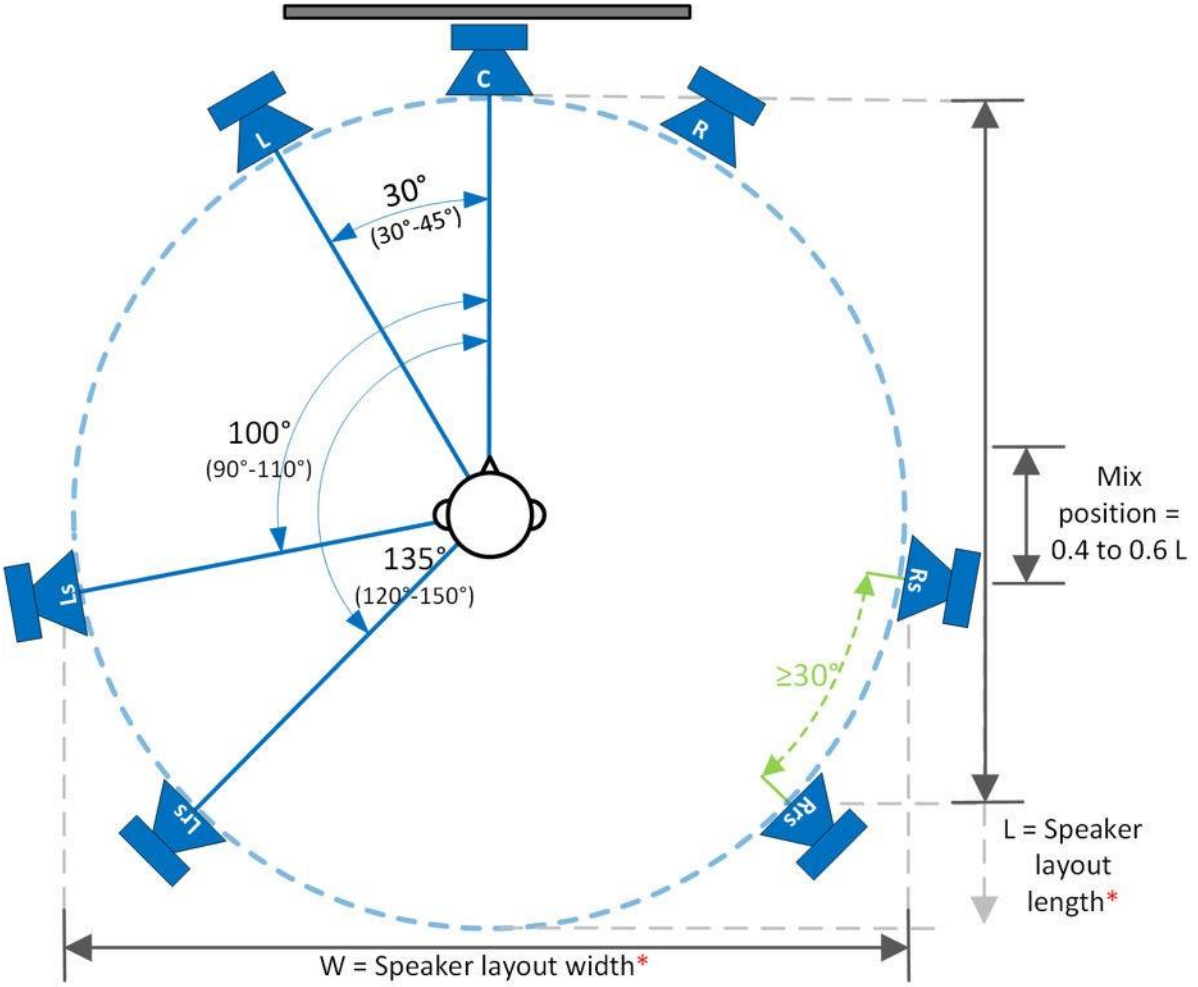
- Horizontal angular placement and angular separation from each other
- The desired angular elevation of the screen speakers to suit the needs of the studio
- The position and type of the display used

Screen speaker horizontal angles

The allowable ranges and the ideal horizontal angles from the center speaker are dependent on the layout type.

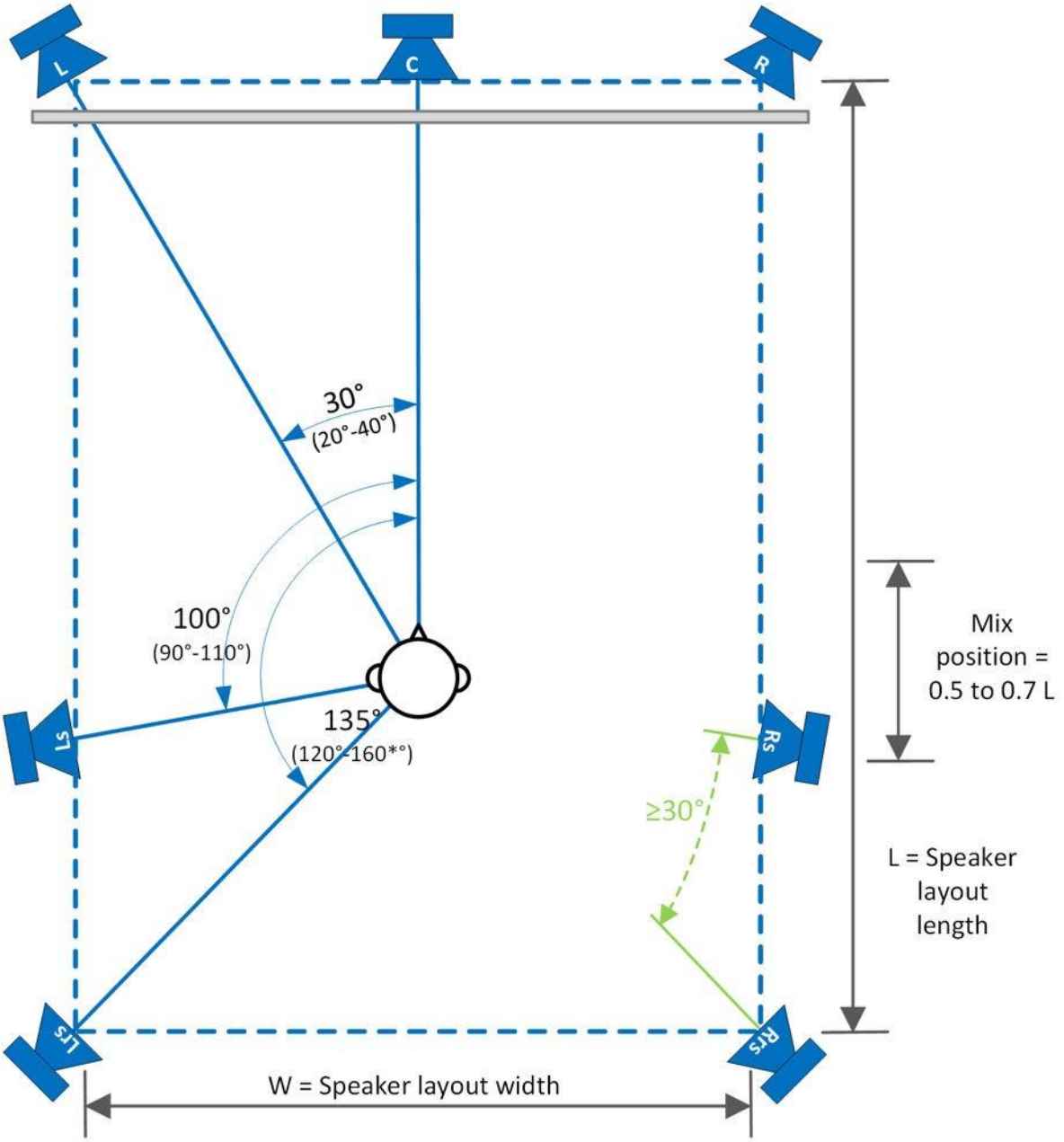
Refer to the drawing for your layout type.

Figure 1: Equidistant layout plan view showing screen and surround speaker positions



Key		
	Ls/Rs	Left/right side surround
	Lrs/Rrs	Left/right rear surround
	100°	The larger top number shows recommended angle
	(95°-120°)	The smaller bottom number shows angle limits
	W	Speaker layout width
	L	Speaker layout length
	≥n°	Minimum separation angle
	*	Layout width/length: For circular layouts, use the circle diameter. For other configurations use the width/length between speakers.

Figure 2: Orthogonal layout plan view showing screen and surround speaker positions



Key		
	Ls/Rs	Left/right side surround
	Lrs/Rrs	Left/right rear surround
	100°	The larger top number shows recommended angle
	(95°-120°)	The smaller bottom number shows angle limits
	W	Speaker layout width
	L	Speaker layout length
	*	120°-150° preferred but 160° is acceptable to enable rear wall positioning
	≥n°	Minimum separation angle

Screen speaker elevation

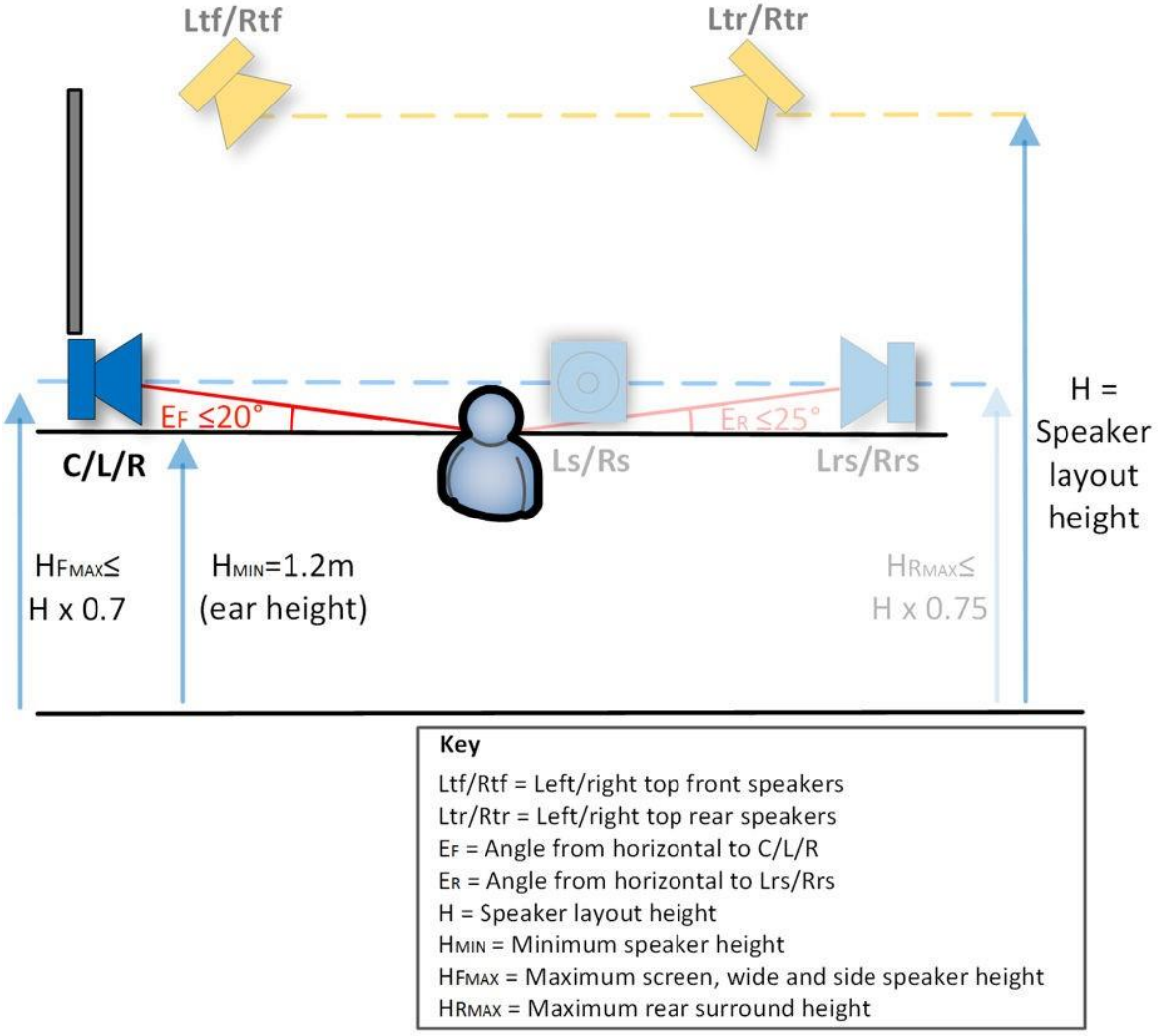
We recommend that the screen speakers are positioned at seated ear height at approximately 1.2 meters. However, it may be necessary to elevate them due to image displays, sight lines, and room use and geometry.

To minimize the sense of height when screen speakers are slightly elevated and ensure adequate separation to the overhead speakers, employ these rules:

- The angle of elevation of the screen speaker should be no greater than 20 degrees.
- The screen speaker height should be no greater than 0.7 multiplied by the layout height. For example, if the measured distance from the floor to the overhead speaker acoustic center is three meters, the maximum screen speaker acoustic center height should be 2.1 m.

This diagram shows the recommended screen and front surround speaker positions for side elevation.

Figure 3: Side elevation diagram showing screen speaker positions



Display type and position of screen speakers

The position of the screen speaker is dependent on the display type: projected image or flat-panel monitor.

Projected image

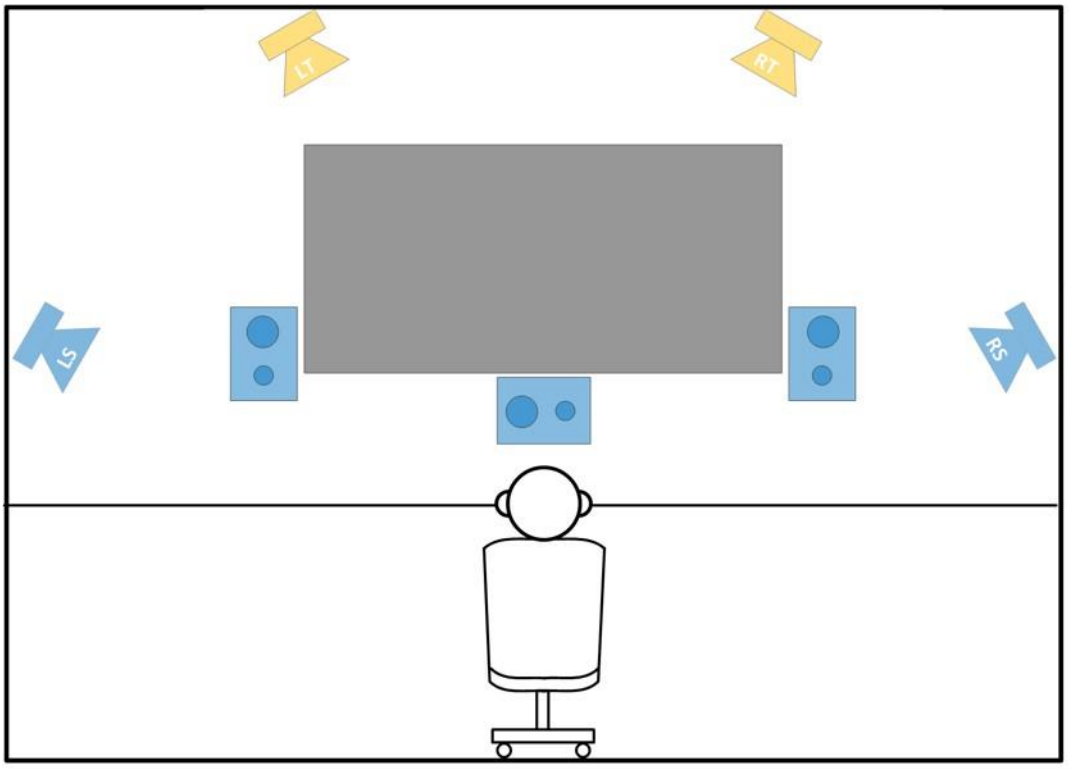
When a projected image is used, the screen speakers should be behind an acoustically transparent screen, at equal height, and equally spaced, with the left and right speaker just within the width of, or slightly outside of, the screen. Ideally, the screen speakers acoustic center should be a third to two thirds the height of the screen.

Flat-panel monitor

When a flat-panel monitor is used, the left and right speakers should be placed at the corresponding monitor edge, as long as this does not narrow the angle below the specification minimum. Where the angle is narrower than the specification minimum, place left and right speakers at the minimum angle, rather than the screen edge.

The center speaker should ideally be below the screen, and where possible, the left, center, and right speakers should be of equal height. If this is not possible, the acoustic center of the center speaker should be vertically as close to the left and right as possible. Left and right should be no higher than midscreen.

Figure 4: Front elevation diagram showing screen speaker positions



2.3.2 Subwoofer placement

Subwoofers should be placed off center on the LCR plane, to avoid modal build up, and ideally on the floor. Multiple cabinets, all fed from the LFE channel, can produce improved results.

2.3.3 Standard plane surrounds

In a 7.1.4 Dolby Atmos setup, there are four standard plane surround speakers. These are labeled Left Surround (Ls), Right Surround (Rs), Left Rear Surround (Lrs), and Right Rear Surround (Rrs).

The position of the standard plane surround speakers is dictated by two main design aspects:

- Horizontal angular placement and angular separation from each other
- The desired angular elevation of the surround speakers to suit the needs of the studio

Standard plane surrounds horizontal angles

The allowable ranges and the ideal horizontal angles for the side and rear surrounds are dependent on the layout type. For both types, ensure a separation of at least 30° between Ls, Lrs, Rrs, and Rs.

For the equidistant and orthogonal layouts, see the respective figures in *Screen speaker horizontal angles.*

Related information

Screen speaker horizontal angles on page 4

Standard plane surrounds elevation

We recommend that the standard plane surround speakers are positioned at seated ear height, around 1.2 meters, matching the ideal height of the screen speakers. However, it might be necessary to elevate them due to room use, geometry, and architectural features.

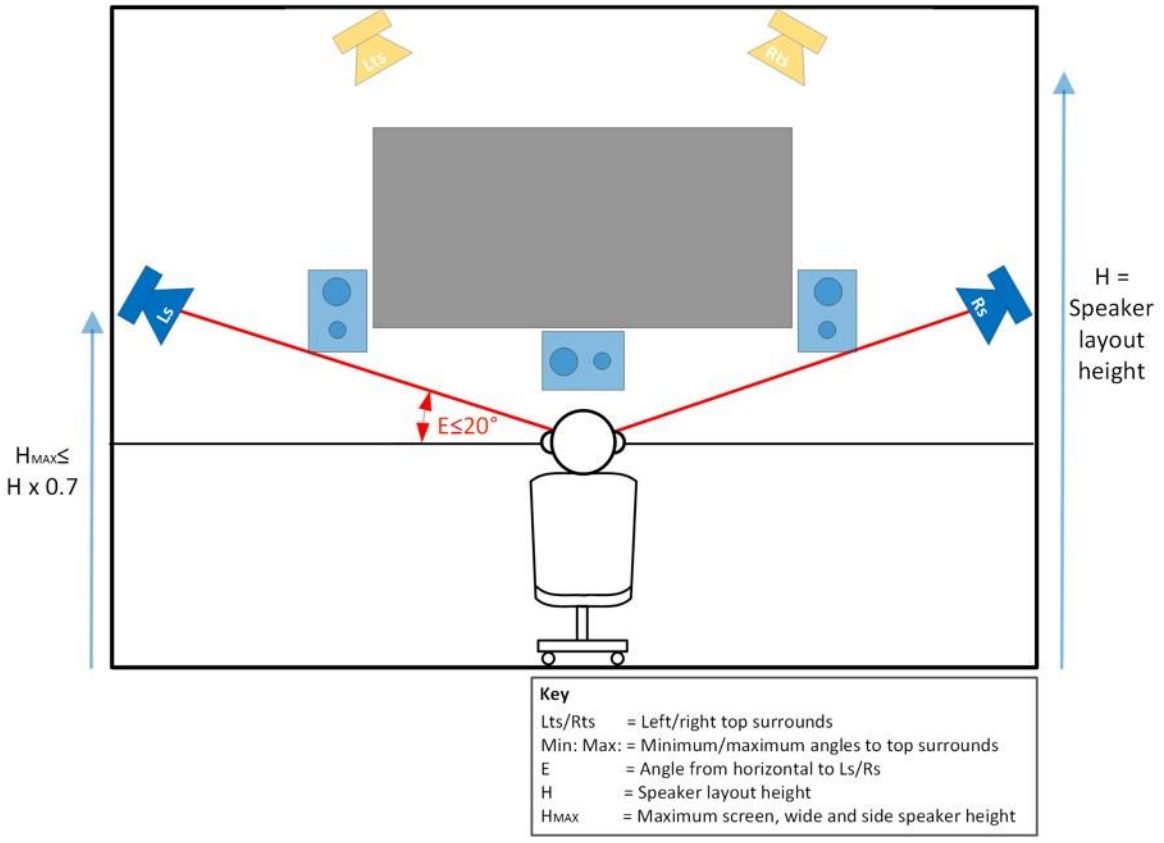
To minimize the sense of height when surround speakers are elevated, and ensure adequate separation to the overhead speakers, employ the rules for side and rear surround elevation.

Side surround elevation rules

- The angle of elevation of the side surround speakers should be no greater than 20 degrees.
- The side surround height should be no greater than 0.7 multiplied by the layout height. This provides vertical separation between top surrounds and the other speakers.

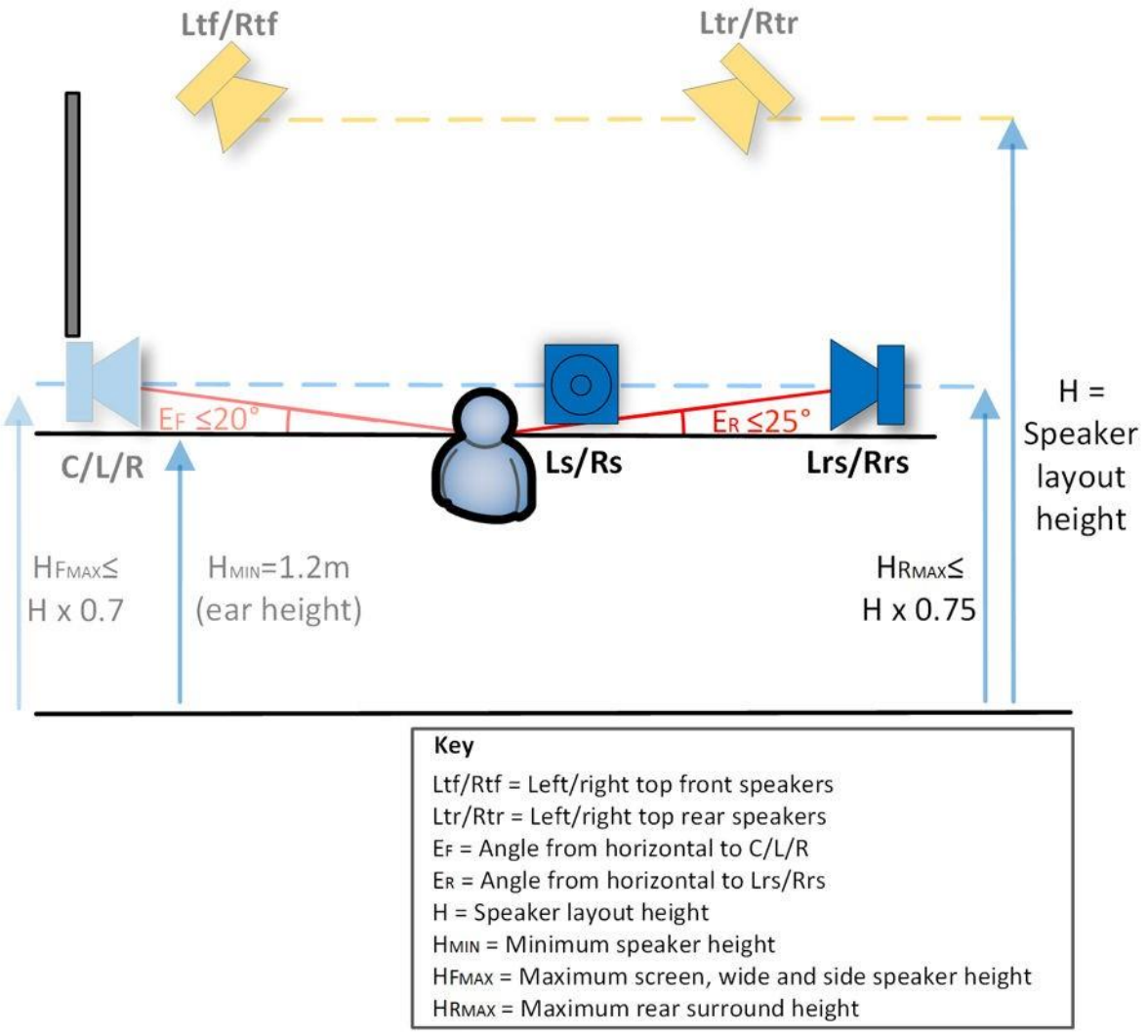
Note: Surround speakers of differing heights should follow a smooth line from the screen speakers through their acoustic center.

Figure 5: Front elevation diagram showing side surround speaker positions



Rear surround elevation rules

- The angle of elevation to the rear surround speakers should be no greater than 25 degrees.
- The rear surround height should be no greater than 0.75 multiplied by the layout height.



Note: Surround speakers of differing heights should follow a smooth line from the screen through their acoustic center.

Figure 6: Side elevation diagram showing rear surround speaker positions speakers

2.3.4 Top surround speakers

In a 7.1.4 Dolby Atmos setup, there are four top surrounds speakers. These are labeled left top front (Ltf), right top front (Rtf), left top rear (LTR), and right top rear (RTR).

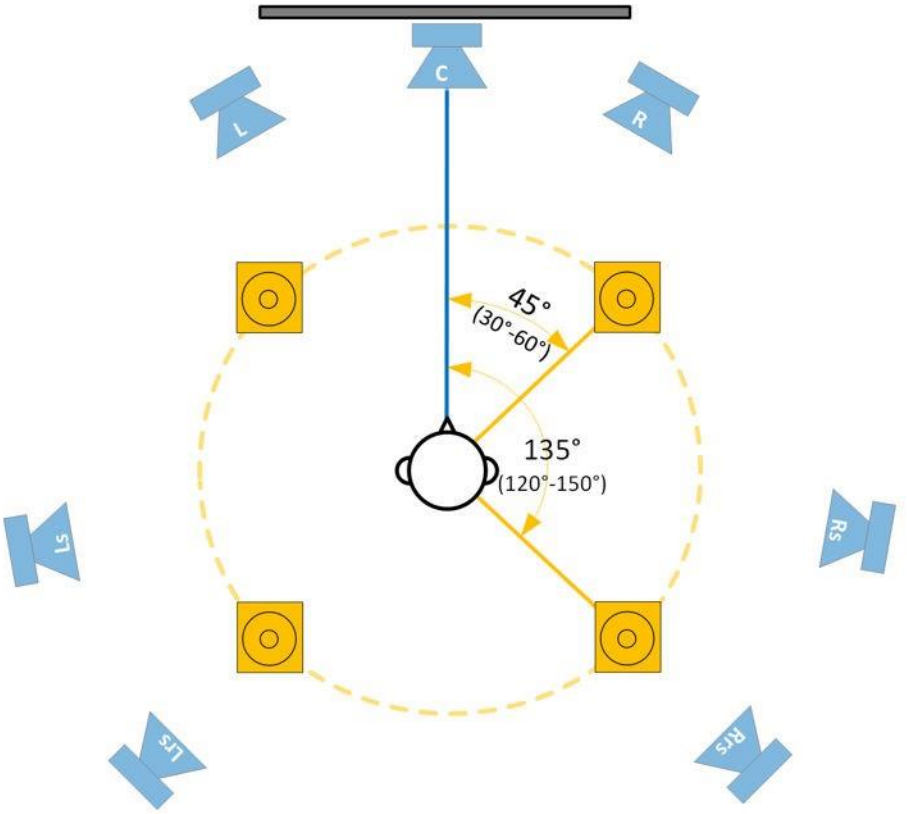
When referring to both left or right top surrounds, the abbreviation Ltr or Rtr can be used.

The position of the top surround speakers is dictated by three main design aspects:

- Height of the top surround and ceiling height
- Vertical elevation angle of the top surrounds in the lateral plane
- Vertical elevation angle of the top surrounds in the longitudinal plane

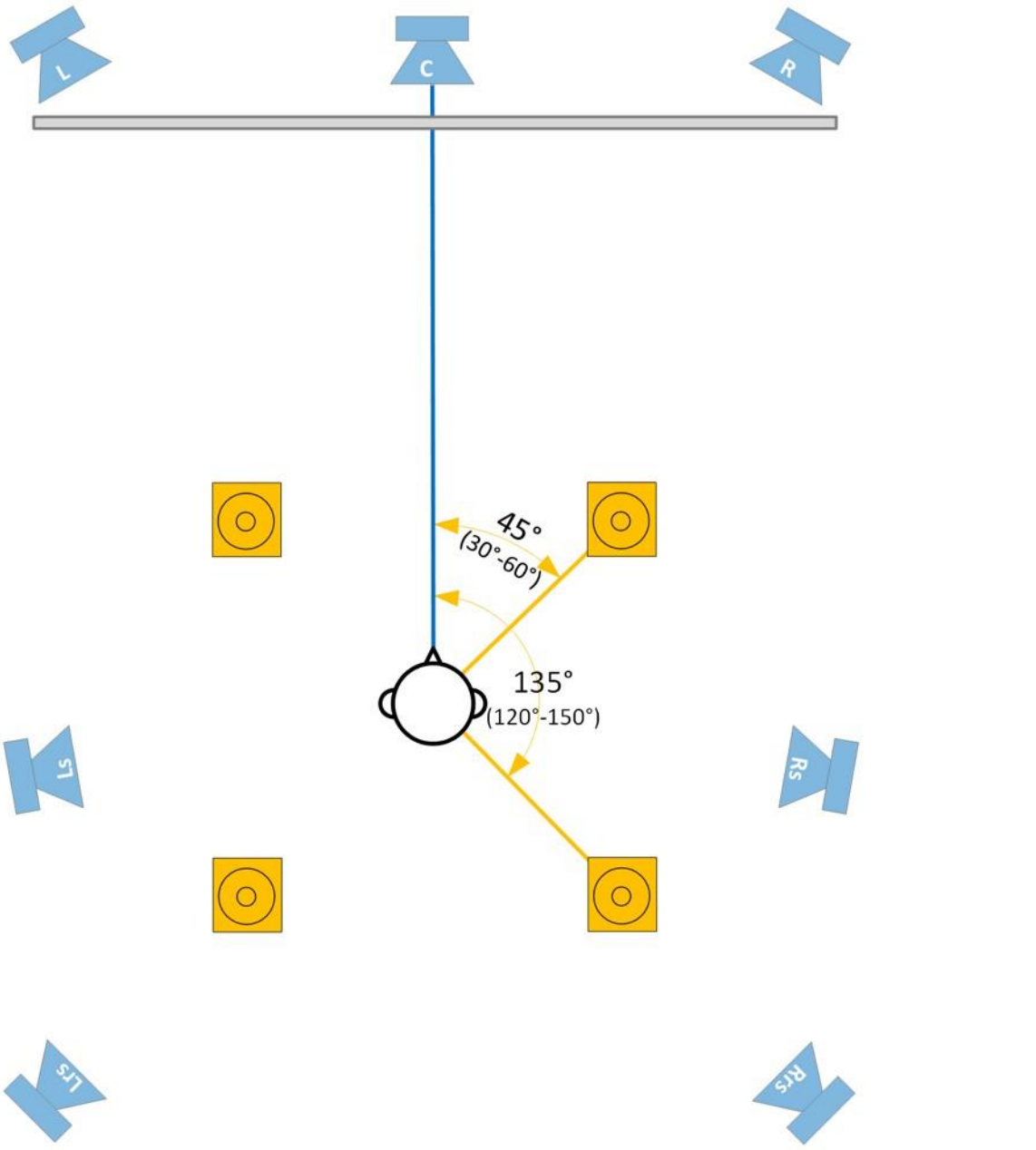
The result of these rules is a quad of overhead speakers placed centrally over the mixer, as shown in these figures.

Figure 7: Equidistant layout plan view showing top surround speaker positions



Key		
	Ls/Rs	Left/right side surround
	Lrs/Rrs	Left/right rear surround
	100°	The larger top number shows recommended angle
	(95°-120°)	The smaller bottom number shows angle limits

Figure 8: Orthogonal layout plan view showing top surround speaker positions



Key		
	Ls/Rs	Left/right side surround
	Lrs/Rrs	Left/right rear surround
	100°	The larger top number shows recommended angle
	(95°-120°)	The smaller bottom number shows angle limits

Top surround speaker height

The top surround speakers are normally placed adjacent to the ceiling, with a minimum height of 2.4 m from the floor level at mix position.

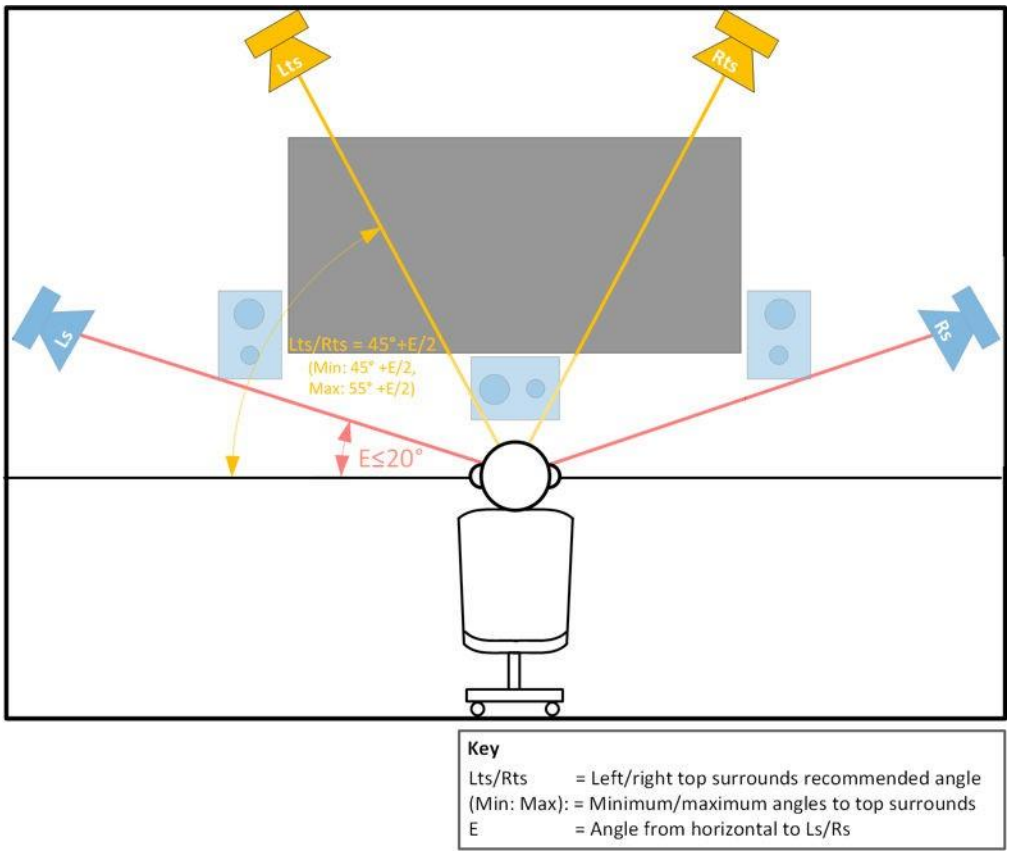
Top surround speaker lateral elevation angles

The placement of the top surrounds should be such that there is symmetry between the right and left halves of the room, on each side of the mixer (so that the lateral angle to each overhead surround is the same).

The minimum top surround elevation angle as viewed on a front elevation diagram is 45˚ + (E ÷ 2), where E is the elevation angle of the side surround loudspeaker from horizontal. This is also the ideal angle.

The maximum top surround elevation angle is 55˚ + (E ÷ 2), as shown in this figure.

Figure 9: Front elevation diagram showing top surround speaker positions



Top surround speakers longitudinal elevation angles

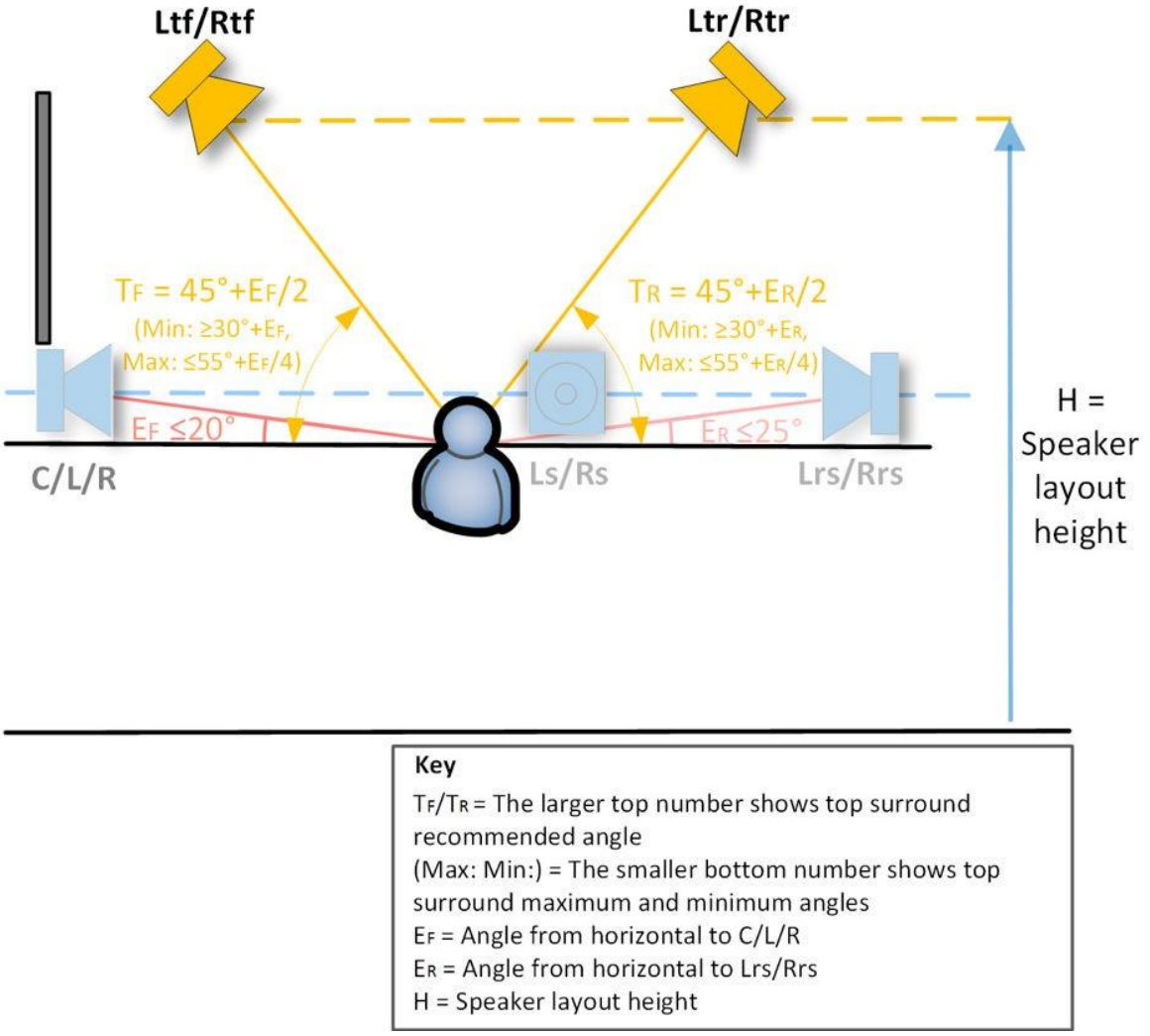
The ideal angle of the front top surrounds from horizontal is 45˚ + (EF ÷ 2), where EF is the elevation angle of the screen speakers from horizontal.

Speakers should be placed as close to the ideal as possible; however, an allowable range of subtended angles to the front top surround speakers is:

- Minimum: 30˚ + EF
- Maximum: 55˚ + (EF ÷ 4)

The ideal and limits for the placement of the rear surrounds are the same, except that the angle to the rear surrounds is known as ER.

Figure 10: Side elevation diagram showing top surround speaker positions



2.4 Speaker and amplification specification

The suitable sound pressure reference level for a studio will be dependent upon the content type being produced and precise delivery requirements. Allowable ranges for Dolby Atmos home entertainment studio certification range from 79 to 85 dBC.

The requirement of the amplifier and speaker equipment is to reproduce the content, as recorded within the digital workstation, such that it does not add distortion. Each screen speaker shall be capable of producing 20 dB above reference level, and each surround speaker shall be capable of producing 17 dB above reference level. The subwoofer is aligned at +10 dB when compared to the center speaker and should also be capable of producing at least 20 dB above reference level.

To check the suitability of speakers and amplifiers, use the Dolby Audio Room Design Tool .xlsb Excel file to help evaluate the correct headroom at mix position.

2.4.1 Bass management

If using speakers with limited low-frequency response, it is necessary to employ bass management to redirect low-frequency sounds to the subwoofer. A crossover point of around 80 Hz or below is recommended to reduce the localization of the subwoofer.

2.4.2 Speaker frequency response

The frequency response requirements are dependent on the speaker type.

The frequency response of all speakers other than the subwoofer must conform to the wide-range characteristic defined in ISO 2969/SMPTE 202 standards, with or without bass management. The response must extend from 40 Hz at the low frequencies and ideally up to 18 kHz with no variation greater than ±3 dB.

The subwoofer should have a frequency response of at least 31.5 to 150 Hz.

All speakers should have a similar frequency response. Therefore, it is recommended that they are all made by the same manufacturer and correctly aligned. Speakers in pairs (screen channels, side surrounds, rear surrounds, top surrounds) should also be of the same model.

2.4.3 Top surround speaker type

Certified Dolby Atmos home entertainment studios should have physical top surround speakers. If Dolby enabled speakers (upward firing) are desired for consumer up-firing simulation, these should be in addition to the top surround speakers, and the appropriate reflective surface must be installed and correctly positioned.

2.4.4 Dispersion pattern

Surround speakers should have a wide directivity pattern of at least ±45 degrees from 100 Hz to 10 kHz. The mix position should be well within the dispersion of the speaker, and speaker tilt applied if this is not the case.

Ideally, all speakers should be aimed directly at mix position.

2.5 Mixing, monitoring, and mastering equipment

Room certification requires specific hardware for mixing, monitoring, and mastering.

These include:

- Dolby qualified computer hardware with Dolby Atmos Mastering Suite software. (Contact your authorized Dolby professional equipment distributor for details.)
- DAW/mixing console that can generate Dolby Atmos panning metadata with a minimum of 128 dedicated outputs.
- Medium format mixing console or control surface (recommended).
- Immersive format monitoring controller, with input from the rendering and mastering workstation and overall level control (recommended).
- A separate 5.1/7.1 monitor path, which bypasses the rendering and mastering workstation (recommended).
- Industry-standard timecode and synchronization interface.

2.5.1 Picture size and resolution requirements and recommendations

Projected image on screen or flat-panel monitors are both acceptable. The requirements and recommendations are the same for both picture types.

Requirements

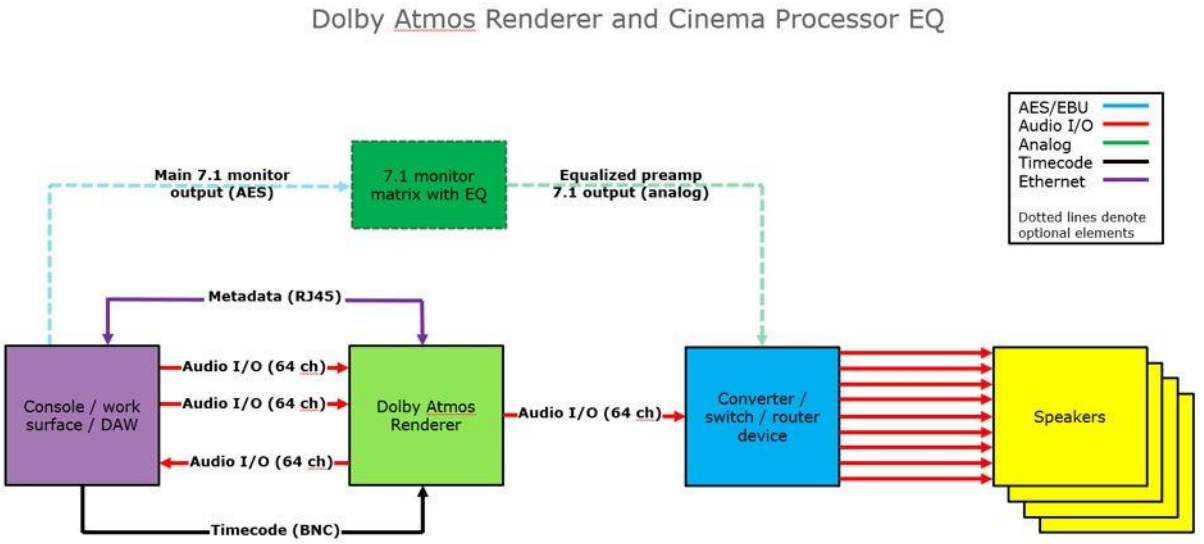
- The video device must display, and be set up to correctly reproduce, the specified video standards:
- Capable of displaying these frame rates:
- 23.976 fps (progressive)
- 24 fps (progressive) • 25 fps (interlace)
- 25 fps (progressive)
- 29.97 fps (interlaced)
- 30.5 fps (progressive)
- 59.94 fps (progressive)
- 60 fps (progressive)
- Minimum resolution of 1920×1080.
- Processing delay must be known and compensated for by a suitable offset in the video replay device.

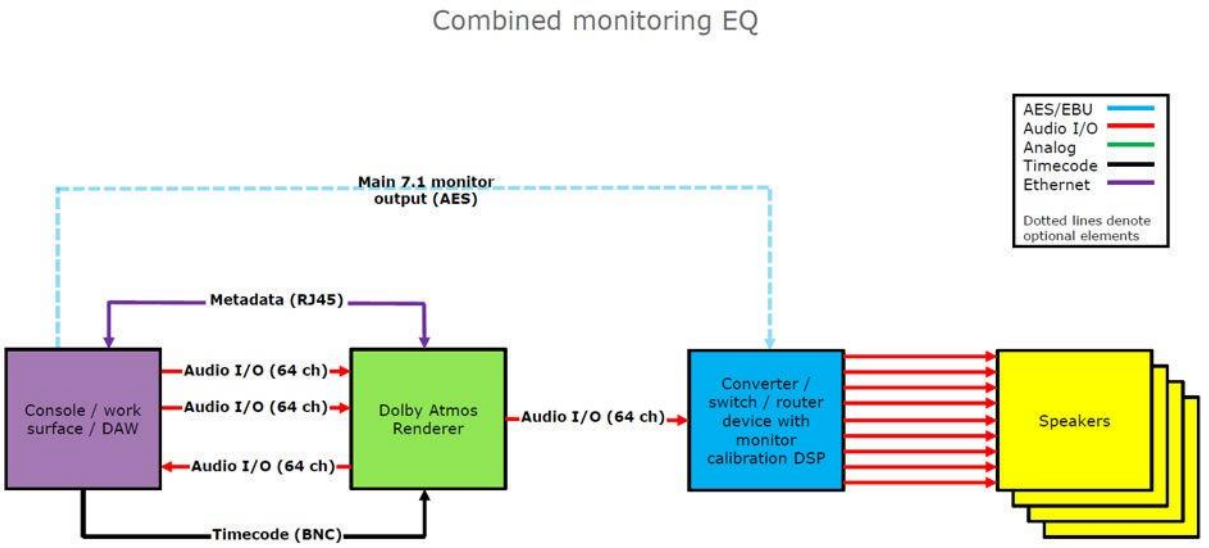
Recommended

- Minimum 50-inch screen
- 4K HDR capable

2.6 Sample studio block diagrams

The studio block diagram for the certification process should include the basic system components. Refer to the provided studio block diagram examples for guidance.





2.7 Speaker calibration

Speaker calibration includes setting monitor references levels and speaker equalization.

2.7.1 Monitor reference levels

The monitor reference level should be set at the preferred level of the studio, but between 79 and 85 dBC. Dolby pink noise should be used to align all speakers to required values, with measurements taken on the slow setting.

All speakers should be set to the same level, except for the LFE subwoofer. The subwoofer should have an additional 10 dB of in-band gain for the frequency range covered by the LFE, as compared to the center speaker.

2.7.2 Speaker equalization

Acoustic room treatment should be installed to address any acoustical problems. Corrective speaker equalization should also be applied if room coloration remains. Target curves should be applied as relevant.

For rooms with volume exceeding 125 m^3 (approximately 4400 cf), we recommend applying the modified X-curve standard. Refer to SMPTE 222:1994.

Use reference material to gauge the timbre and consistency of the aligned speakers and, where possible, compare the mix translation in other replay environments.

2.8 Sample reference diagrams

Example diagrams provide context on angle and distance measurements.

Following are example diagrams showing the details needed in plans that are submitted as Dolby Atmos home entertainment studio certification drawings. The letters refer to angle and distance measurements that should be replaced with actual values and included in these diagrams.

Figure 11: Plan view diagram sample

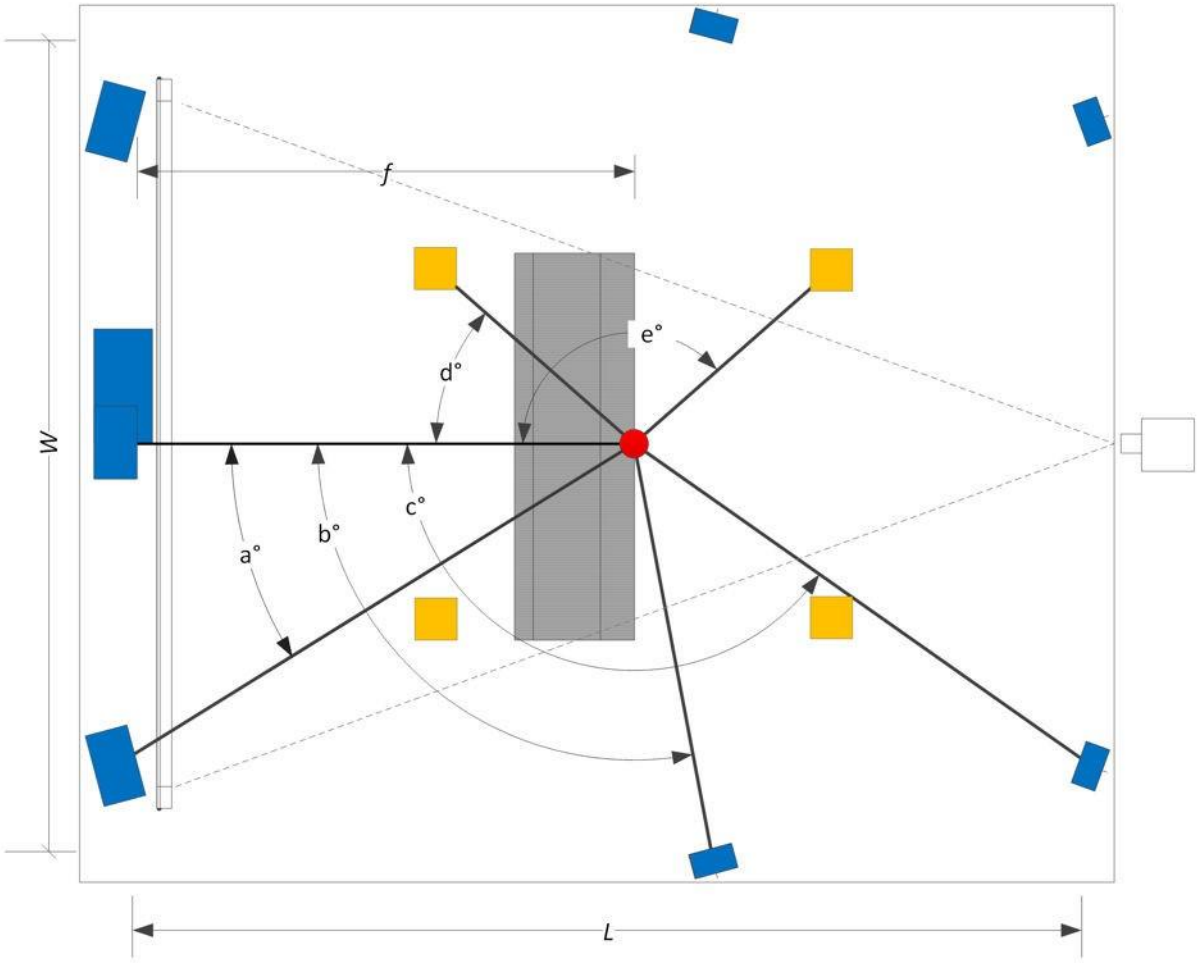


Figure 12: Side elevation diagram sample

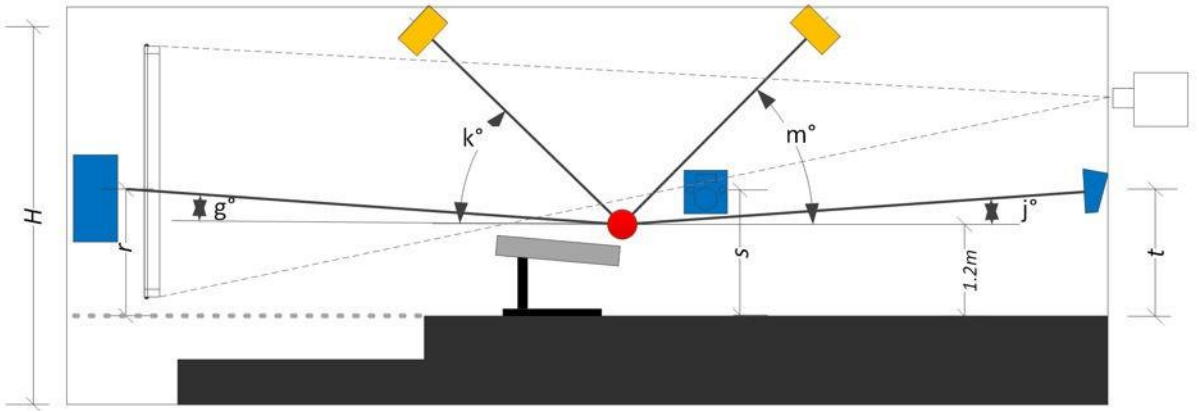


Figure 13: Front screen elevation diagram samples

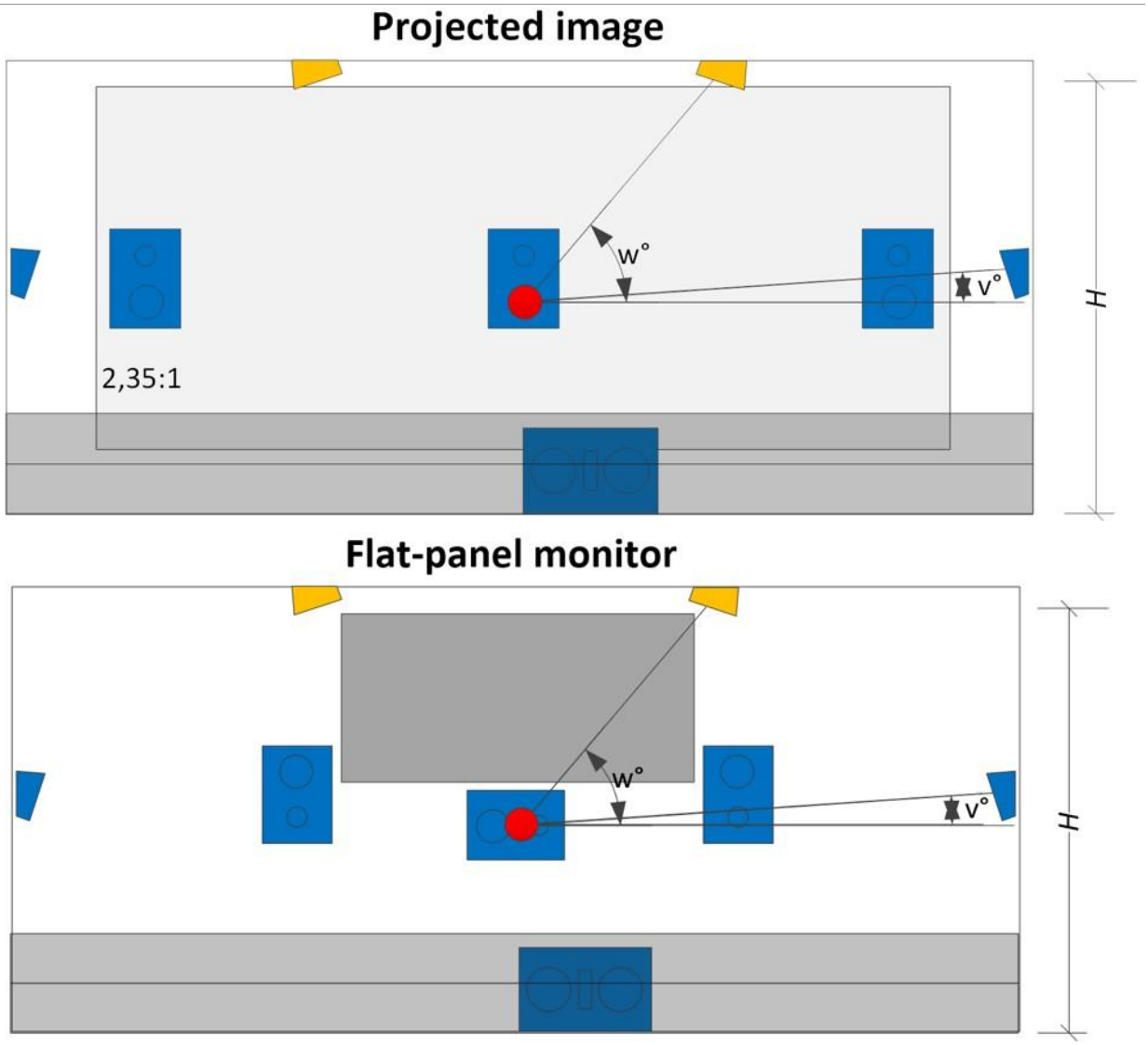
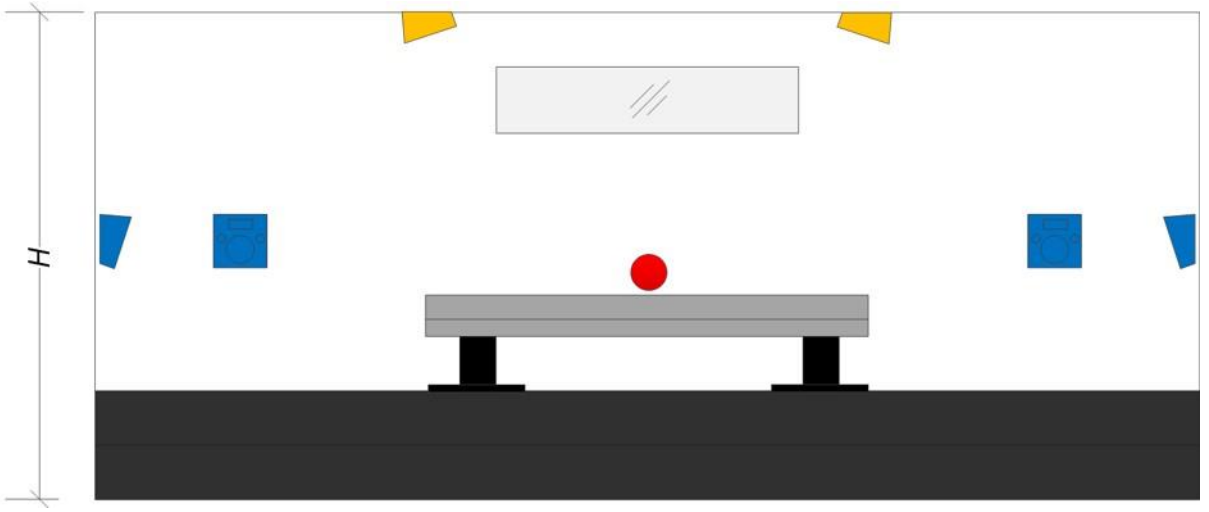


Figure 14: Rear elevation diagram sample



2.8.1 Estimating speaker output requirements

To assist you in determining the speaker output capability required, Dolby provides recommended steps.

About this task

The performance guidelines for SPL in this documentation are given with respect to the mix position and are based on the capabilities and demands of a calibrated studio. Many variables affect playback levels, including B-chain processing, amplifier and speaker capabilities, and the room itself. Existing standards for the specification of speakers and amplifier performance cannot take into account the unique characteristics of each studio (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 certainty the speaker performance requirements to achieve standard levels in all cases; one can only estimate.

Procedure

1. Determine the maximum continuous output SPL (SPL_{max}) of the speaker.

   This is often quoted in the speaker manufacturer literature. If SPLmax is not stated, compute it using the speaker rated sensitivity (1W at 1m) and power handling (IEC noise, with AES duration of two hours) as follows:

   SPL_{max} = Sensitivity + log10(Power Handling)

2. Measure the distance in meters (D2) from the speaker to the reference position, a point twothirds back in the auditorium in the middle of the seating area.
3. Using this distance information, calculate the attenuation of sound pressure from the speaker tothe reference position as follows: **Distance Attenuation = 20*log10(D1/D2)**

   where D1 is one meter, D2 is the distance from step 2, and Distance Attenuation is a negative number representing level change in decibels.
4. Add Distance Attenuation and SPL_{max}.

Results

Dolby will take the manufacturer equipment specification in relation to our technical guidelines as written, when considering the approval of any given amplifier or speaker. Dolby cannot be held liable for poor performance of speakers and amplifiers upon installation should equipment not meet the required performance. Please discuss the equipment choice with the relevant manufacturer should any information beyond the published data be desired.

2.8.2 Notes on sound pressure level

Achieving sufficient sound pressure levels (SPLs) from each speaker can be a challenge. This topic presents the critical factors in achieving the specified SPL at the mix position.

- Distance: The distance from the speaker to the mix position.
- Speaker power handling.
- Speaker sensitivity: This takes into account speaker directivity. Directivity can increase the SPL at the mix position, but only for higher frequencies. The low-frequency transducer should be specified to produce sufficient output without any gain assumed based on directivity.
- Speaker aiming: Quoted speaker sensitivity and maximum SPL is based on on-axis response. To achieve rated performance and uniform coverage, it is essential to aim each speaker toward the mix position.

- Bass management: Generating sufficient SPL at low frequencies is a particular challenge, so Dolby Atmos supports bass management of the screen and surround speakers.
- Room loading: Screen speaker sensitivity can be increased by mounting in a baffle wall (halfspace loading). Subwoofer sensitivity can be increased by clustering multiple subwoofers and by mounting at the junction of the wall and floor. Surround speakers should assume full space loading unless they are flush mounted to a wall or ceiling surface. Note that flush mounting of surrounds is not generally possible due to the need to properly aim each surround speaker through the listening area. See the manufacturer's guidelines for guidance on resulting gain.
- Speaker and room correction:
- The frequency response of the speaker and room requires compensating equalization to be applied. Large compensation gains will result in an additional load on the associated amplifier and speaker, limiting overall SPL capability.
- Application of EQ according to SMPTE 202 will decrease the output requirements above 2 kHz. This is a small effect for surround speakers, but it can significantly ease the requirements for the screen speakers, which must overcome screen losses.

These factors should not be assumed to contribute to increased SPL at the mix position:

- Loss of less than 6 dB per doubling of distance (inverse square law loss presumed).
- Room gain: Modern studios have low reverberation.

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