Dolby

Dolby Atmos Game Studio

Technical Guidelines

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Notices

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Contents

1

Introduction to this documentation

This documentation provides technical guidelines for studios wishing to employ a 5.1.4 or greater Dolby Atmos monitoring setup for use in a Dolby Atmos game studio. These guidelines support the rapid deployment of the Dolby Atmos technology in key gaming markets.

1.1 Abbreviated speaker notations

Dolby documentation uses specific names and abbreviations to describe speakers or speaker channels. Dolby notation may differ from the names and abbreviations used by other organizations and companies.

Note: This information is provided for reference only. Not all speaker outputs identified in the table are supported by your product.

Table 1: Dolby speaker notation correspondences

Dolby notation		CTA-861	ITU-R BS.2159-5 (Type B 10.2 channel)	SMPTE 2036-2 (22.2 channel)	IEC 62574 (30.2 channel)
L	Left	FL	L	FL	FL
R	Right	FR	R	FR	FR
C	Center	FC	C	FC	FC
Ls	Left surround	RL	LS	—	LS, LSd
Rs	Right surround	RR	RS	—	RS, RSd
Lrs	Left rear surround Left back	RLC	LB	BL	BL
Rrs	Right rear surround Right back	RRC	RB	BR	BR
Cs S	Center surround	RC	—	BC	BC
Lw	Left wide	FLW	—	—	FLW
Rw	Right wide	FRW	—	—	FRW
Lc	Left center	FLC	—	FLC	FLC
Rc	Right center	FRC	—	FRC	FRC
Ls1	Left surround 1	—	—	SiL	SiL
Rs1	Right surround 1	—	—	SiR	SiR
Lfh Lvh	Left front height	FLH	LH	TpFL	TpFL
Rfh Rvh	Right front height	FRH	RH	TpFR	TpFR
Ltm Lts	Left top middle Left top surround	—	—	TpSiL	TpSiL
Rtm Rts	Right top middle Right top surround	—	—	TpSiR	TpSiR
Ltf	Left top front	—	—	—	—
Rtf	Right top front	—	—	—	—
Ltr	Left top rear	—	—	—	TpLS
Rtr	Right top rear	—	—	—	TpRS
Lrh	Left rear height	—	—	TpBL	TpBL

Table 1: Dolby speaker notation correspondences (continued)

Dolby notation		CTA-861	ITU-R BS.2159-5 (Type B 10.2 channel)	SMPTE 2036-2 (22.2 channel)	IEC 62574 (30.2 channel)
Rrh	Right rear height	—	—	TpBR	TpBR
LFE LFE1	Low-frequency effects 1	LFE	LFE1	LFE1	LFE1
LFE2	Low-frequency effects 2	—	LFE2	LFE2	LFE2
Lsc	Left screen	—	—	—	—
Rsc	Right screen	—	—	—	—
Ls2	Left surround 2	—	—	—	—
Rs2	Right surround 2	—	—	—	—
Lcs	Left center surround	—	—	—	—
Rcs	Right center surround	—	—	—	—
Ch Cvh	Center height	FCH	—	TpFC	TpFC
Ts	Top surround	TC	—	TpC	TpC
Lbin	Left binaural	—	—	—	—
Rbin	Right binaural	—	—	—	—
Lo	Left only	—	—	—	—
Ro	Right only	—	—	—	—
Lsd	Left surround direct	—	—	—	—
Rsd	Right surround direct	—	—	—	—
Le	Left Dolby Atmos enabled	—	—	—	—
Re	Right Dolby Atmos enabled	—	—	—	—
Lse	Left surround Dolby Atmos enabled	—	—	—	—
Rse	Right surround Dolby Atmos enabled	—	—	—	—
Lrse	Left rear surround Dolby Atmos enabled	—	—	—	—
Rrse	Right rear surround Dolby Atmos enabled	—	—	—	—
Lrs1	Left rear surround 1	—	—	—	—
Rrs1	Right rear surround 1	—	—	—	—
Lrs2	Left rear surround 2	—	—	—	—
Rrs2	Right rear surround 2	—	—	—	—
Sh	Single height	—	—	—	—

1.2 Contacting Dolby

You can contact Dolby regarding game studio setups and supporting documentation.

To talk to Dolby concerning your studio, contact your local Dolby representative or email games@dolby.com.

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

2

Technical guidelines for game studios

These technical guidelines cover room geometry, room acoustics, speaker positioning and electroacoustic performance, mix equipment, and applicable Dolby Atmos rendering solutions.

2.1 About game studio technical guidelines

Game studio technical guidelines are founded on the algorithms and function of the Dolby Atmos Renderer engine. They detail the best practices for accurate mix and replay capability.

We recommend that you contact Dolby before purchasing or installing any mixing or monitoring equipment.

In addition, we recommend that you consult the ITU-R Rec. BS.2051 standard publication for immersive audio.

2.2 Room design dimensions, terminology, and fundamentals

The Dolby Atmos room geometry and speaker layout specification for a studio takes into account several factors to provide a commercial facility with an optimum space for mixing. These include speaker positions used by the Dolby Atmos Renderer, 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 planning for a Dolby Atmos studio setup, the key dimensions to consider should be those 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 lowest top surround speaker baffle.
- Speaker layout width: This is the maximum width between side wall speaker pairs as measured between speaker baffles. For circular layouts, use the circle diameter.
- Speaker layout length: This is the maximum length between screen and rear speakers as measured between speaker baffles. For circular layouts, use the circle diameter.

To ensure an accurate mix environment for Dolby Atmos, we recommend these layout dimensions and acoustic criteria.

Table 2: Recommended minimum and maximum layout dimensions

Dimension	Specification
Minimum layout height	2.2 m
Minimum layout width	3 m
Minimum layout length	3.5 m
Recommended room volume	>50 m^3
Speaker distance to mix position	≤5 m (<4 m recommended)

Additional room design terminology and fundamentals

Your layout plan is subject to certain basic guidelines.

- 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.
- The preferred speaker layout for a Dolby Atmos game studio is 7.1.4.
- A 5.1.4 layout is acceptable; however, the absence of rear surrounds will lead to a difference in spatial resolution. Refer to *Speaker configuration design guidance for 5.1.4 speaker layouts in a Dolby Atmos Game Studio* for 5.1.4 layout design guidance.
- The mix position is the reference point from which all speakers are placed in a Dolby Atmos game studio speaker layout. The ideal location for the mix position is 1.2 m in height, directly above the rear edge of the console arm rest, and in line with the center speaker.

- Ideally, all speakers should 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 are applied, to a recommended maximum of 10 ms.
- All speakers should be angled both vertically and horizontally toward the mix position, where possible. Where this is not possible, the mix position should be well within the dispersion angle of the speaker.
- The standard plane speakers are defined as L, R, C, Ls, Rs, Lrs, and Rrs. The overhead plane speakers are defined as Ltf, Rtf, Ltr, and Rtr.
- All measurements should be taken at the acoustic center of the speaker. This is typically at the mid-point of the low-frequency and high-frequency driver or waveguide, or the mid-frequency and high-frequency driver or waveguide.
- We use these geometric terms:

  Longitudinal plane
  A plane running from the front of the room to the rear, used to differentiate between references to in front of or behind the mixer, as opposed to on the sides.

  Longitudinal position
  The position of a speaker or mixer between the rear and front of the room.

  Longitudinal angle
  An angle between two positions on the longitudinal plane with reference to the mixer. For example, the longitudinal angle between the center speaker and the front top surround speaker could be 45°.

  Lateral plane
  A plane running from one side of the room to the other, used to differentiate references to the sides of the mix position, as opposed to in front of or behind it.

  Lateral position
  The position of an item between one side of the room and the other.

  Lateral angle
  An angle between two positions on the lateral plane with reference to the mix position. For example, the lateral angle between the left side surround speaker and the left top front surround speaker could be 60°.

  Horizontal plane
  This is the plane extending from the mix position at head height in a flat manner.

  Horizontal angle
  In Dolby Atmos room design, this is the angle from the center speaker to another speaker in the horizontal plane, with reference to the mix position.

  Horizontal angular placement
  The reference to the method used to determine the placement of a speaker using an angle.

  Vertical plane
  A plane running from the floor of a room to the ceiling.

Related information

Sample reference 7.1.4 layout diagrams on page 27

Speaker configuration design guidance for 5.1.4 speaker layouts in a Dolby Atmos Game Studio on page 21

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 usually has greater length than width, and the 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. 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

Proper acoustic treatment is recommended to avoid significant early reflections and slap delays.

The room should be quiet, even with all noise sources active (such as local air conditioning units). Reverberation decay times (RT60) should be appropriate for the room volume, and decay with frequency should show a smooth transition from one octave band to the next.

To ensure an accurate mix environment for a Dolby Atmos game studio, we recommend following these 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 for Home Entertainment, Expanded (DARDT_HE_EXP) `.xlsb` Excel file. Locate and download the tool at https://games.dolby.com. Alternatively, you can request the tool by contacting your local Dolby representative, or emailing games@dolby.com.

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.

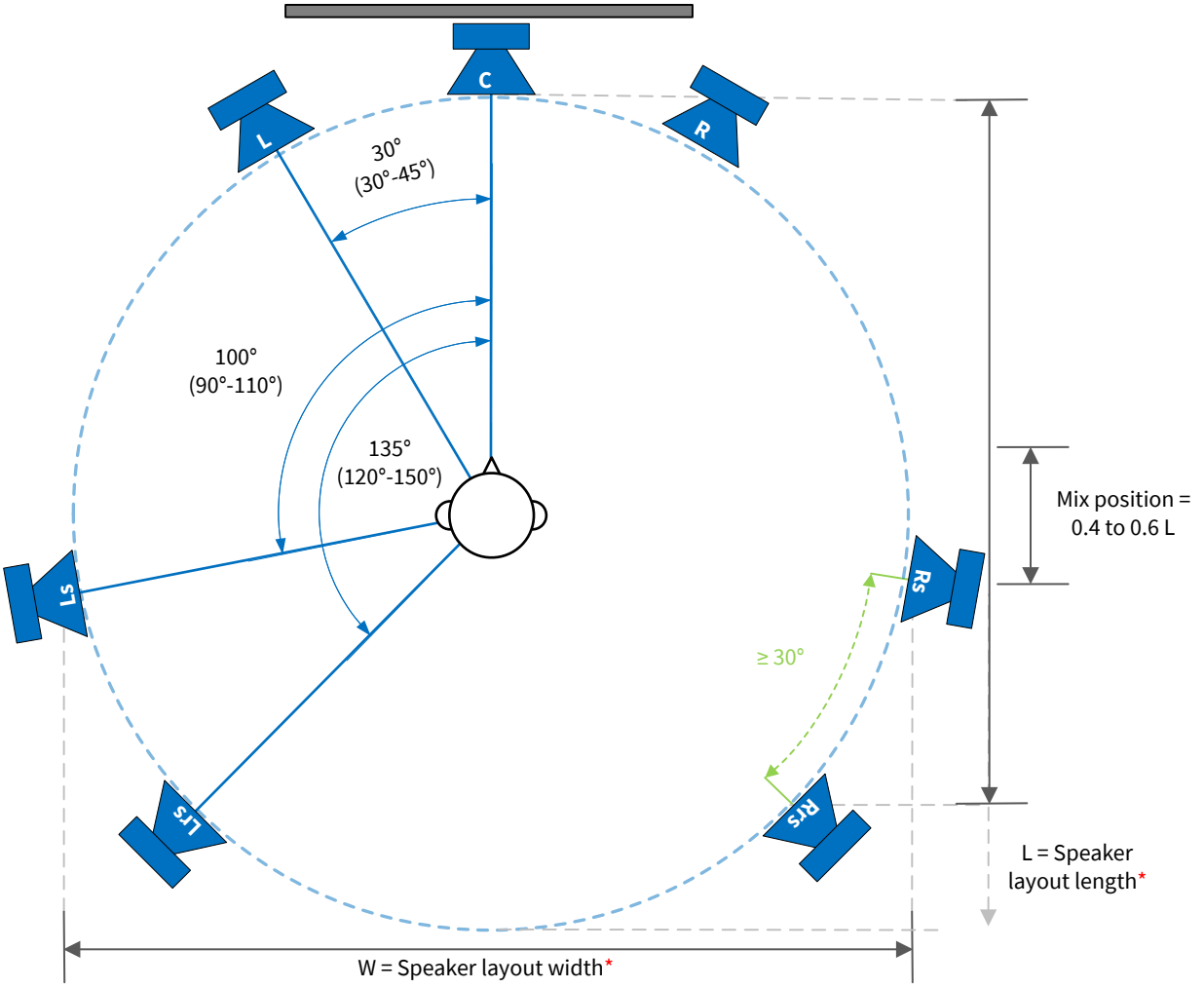
- Horizontal angular placement and angular separation from each other
- The desired elevation of the screen speakers, measured as an angle from the mix position
- The position and type of the display used

Screen speaker horizontal angles

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

Refer to the drawing for your layout type.

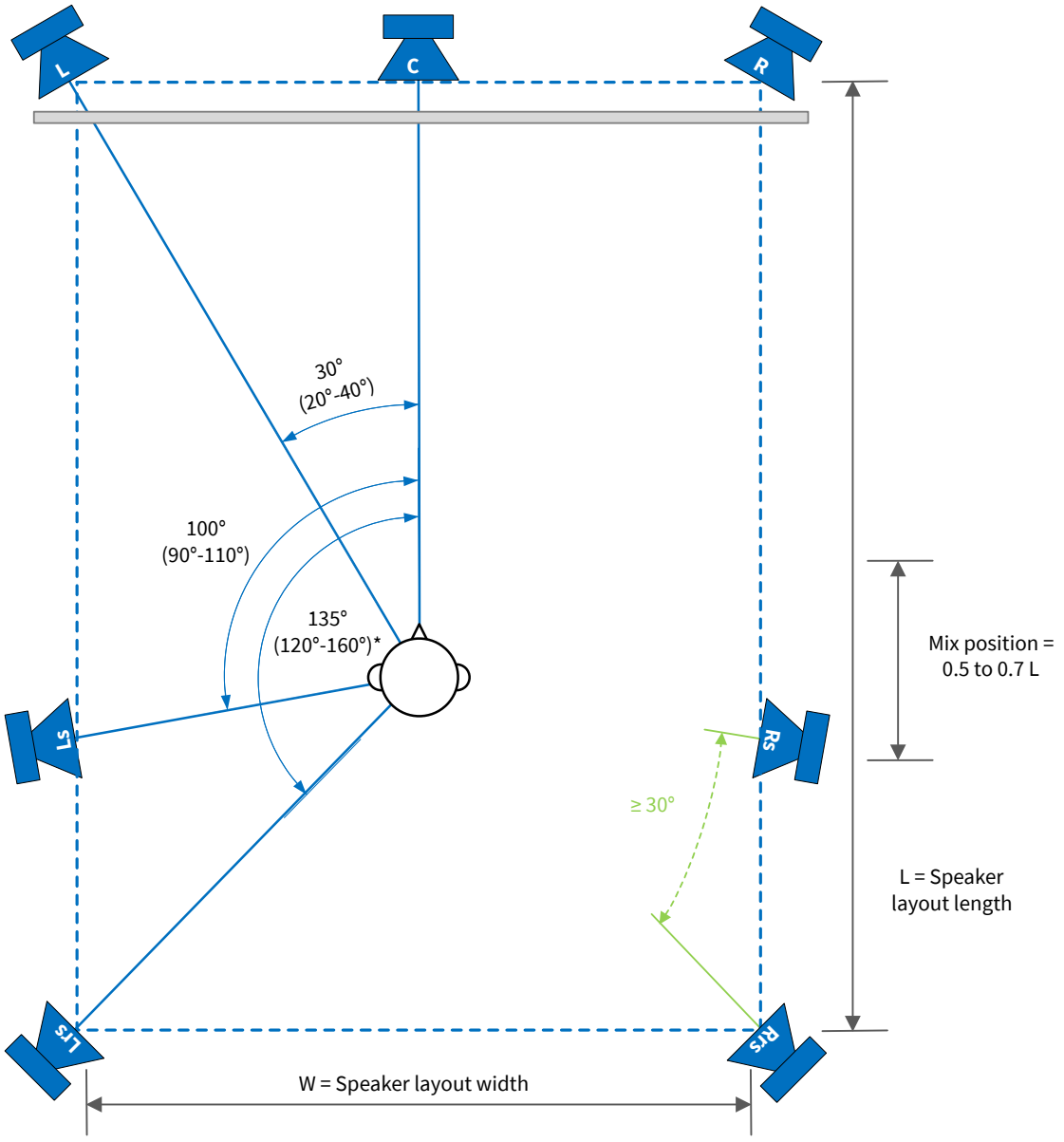
Figure 1: Equidistant layout plan view showing screen and surround speaker positions



Key

Ls/Rs = Left and right side surround
Lrs/Rrs = Left and right rear surround
n° = Recommended angle
(n°-n°) = Angle limits
W = Speaker layout width
L = Speaker layout length
≥ n° = Minimum separation angle
* = Layout width and length: For circular layouts, use the circle diameter. For other configurations, use the width and length between speakers.

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



Key

Ls/Rs = Left and right side surround
Lrs/Rrs = Left and right rear surround
n° = Recommended angle
(n°-n°) = 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 be positioned at seated ear height, at approximately 1.2 m. It may be necessary, however, to elevate them due to image displays, sight lines, and room use and geometry.

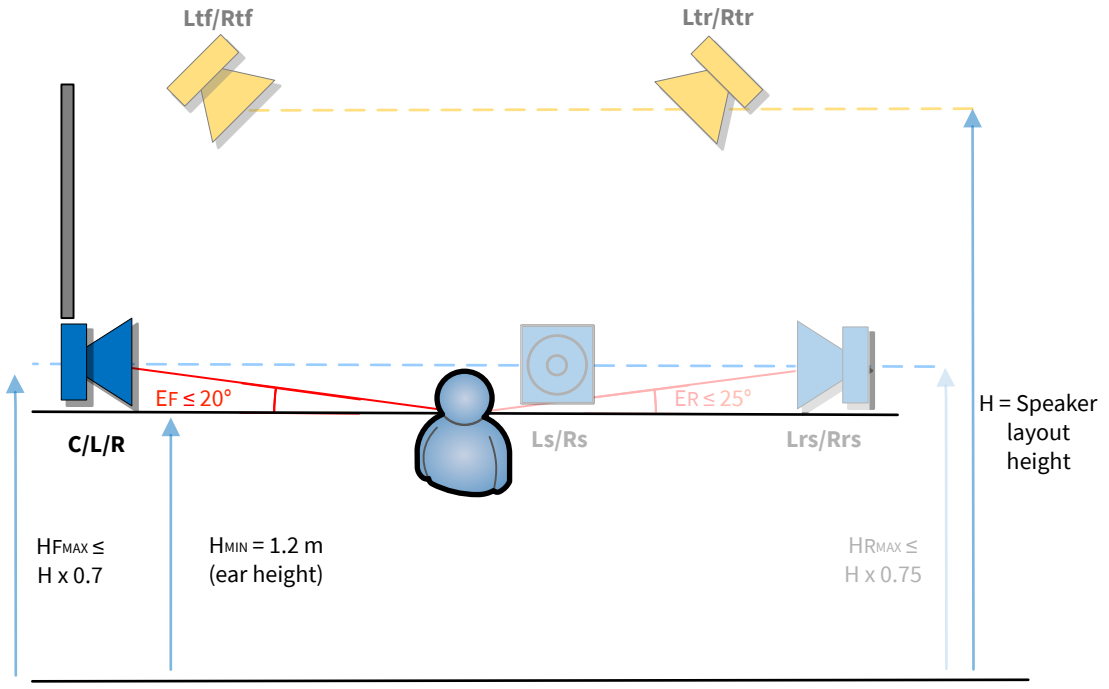
To minimize the sense of height when screen speakers are slightly elevated and to ensure adequate separation to the overhead speakers, these guidelines apply:

- The angle of elevation of the screen speaker should be no greater than 20°.

- 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 3 m, 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



Key

Ltf/Rtf = Left and right top front speakers
Ltr/Rtr = Left and right top rear speakers
EF = Angle from horizontal to C, L, and R
ER = Angle from horizontal to Lrs and Rrs
H = Speaker layout height
HMIN = Minimum speaker height
HFMAX = Maximum screen, wide, and side speaker height
HRMAX = Maximum rear surround height

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 speakers just within the width of, or slightly outside of, the screen. Ideally, the acoustic center of the screen speakers should be one-third to two-thirds the height of the screen.

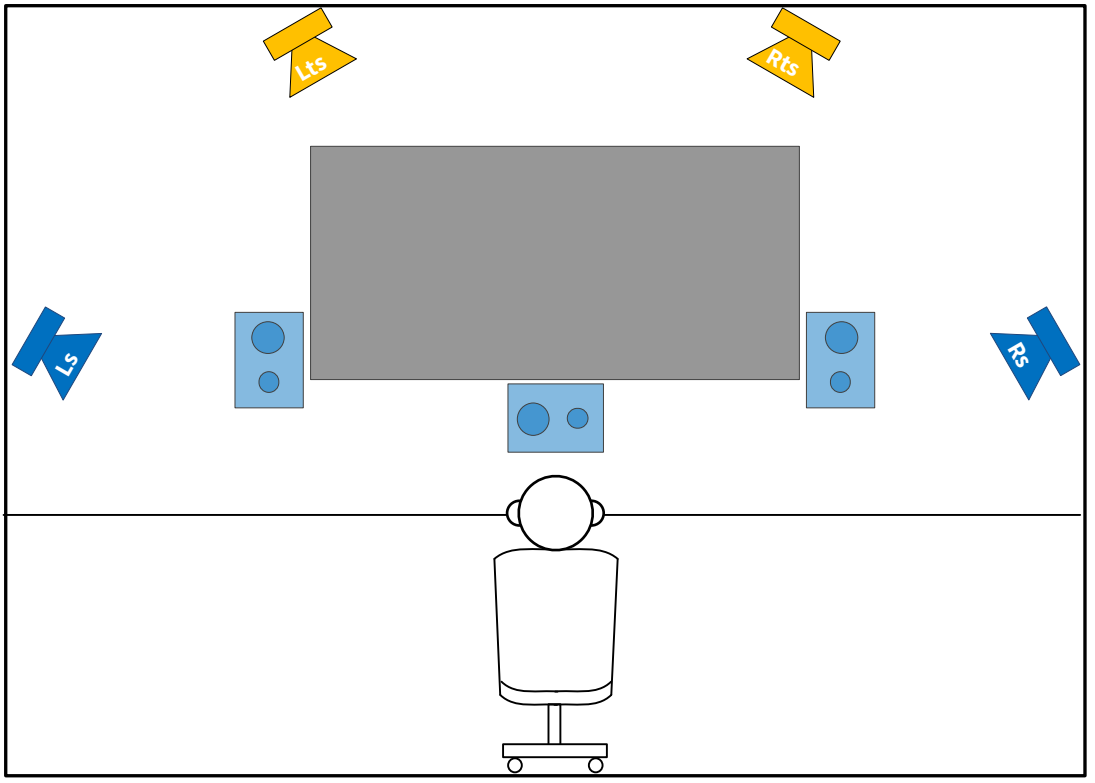
Flat-panel monitor

When a flat-panel monitor is used, the left and right speakers should be placed at the corresponding monitor edges, 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 speakers as possible. Ideally, the left and right speakers should be no higher than midscreen.

Figure 4: Front elevation diagram showing screen speaker positions



2.3.2 Subwoofer placement

Place subwoofers off-center on the lateral plane, ideally on the floor, to avoid modal build up. Multiple cabinets, all fed from the Low-Frequency Effects (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).

Positioning of the standard-plane surround speakers is dictated by two main design aspects:

- Horizontal angular placement and angular separation from each other
- The desired elevation of the surround speakers, measured as an angle from the mix position

Standard-plane surrounds horizontal angles

The recommended ranges and the ideal horizontal angles for the side and rear surrounds are dependent on the layout type. For both types, we suggest 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 11

Standard-plane surrounds elevation

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

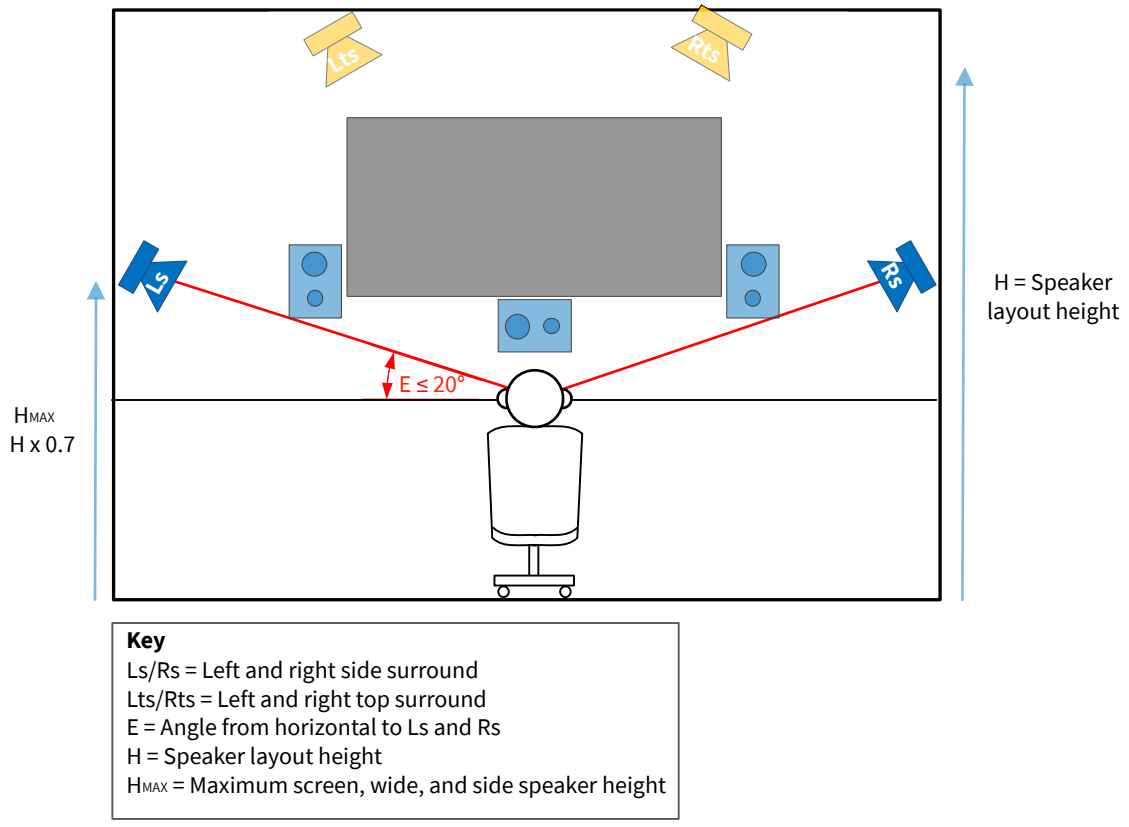
To minimize the sense of height when surround speakers are elevated, and to ensure adequate separation from the overhead speakers, follow the guidelines for side and rear surround elevation.

Side surround elevation guidelines

- The angle of elevation of the side surround speakers should be no greater than 20°.
- 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 the acoustic center of the surround speakers.

Figure 5: Front elevation diagram showing side surround speaker positions



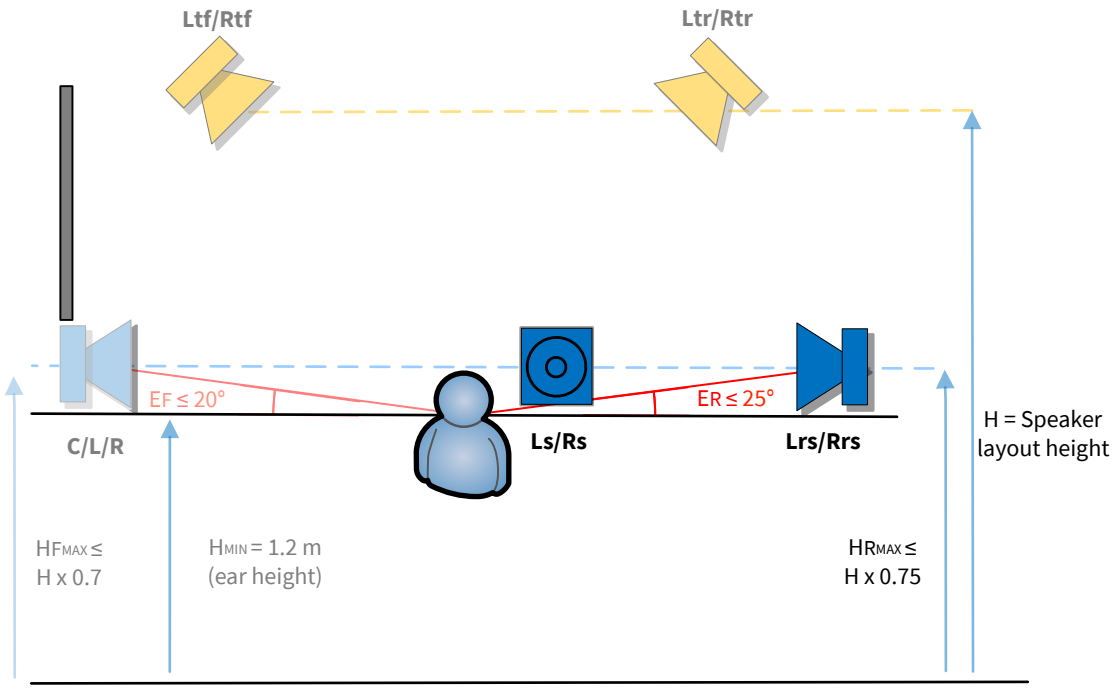
Key
Ls/Rs = Left and right side surround
Lts/Rts = Left and right top surround
E = Angle from horizontal to Ls and Rs
H = Speaker layout height
HMAX = Maximum screen, wide, and side speaker height

Rear surround elevation guidelines

- The angle of elevation to the rear surround speakers should be no greater than 25°.
- 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 speakers through the acoustic center of the surround speakers.

Figure 6: Side elevation diagram showing rear surround speaker positions



Key

Ltf/Rtf = Left and right top front speakers
Ltr/Rtr = Left and right top rear speakers
EF = Angle from horizontal to C, L, and R
ER = Angle from horizontal to Lrs and Rrs
H = Speaker layout height
HMIN = Minimum speaker height
HFMAX = Maximum screen, wide, and side speaker height
HRMAX = Maximum rear surround height

2.3.4 Top surround speakers

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

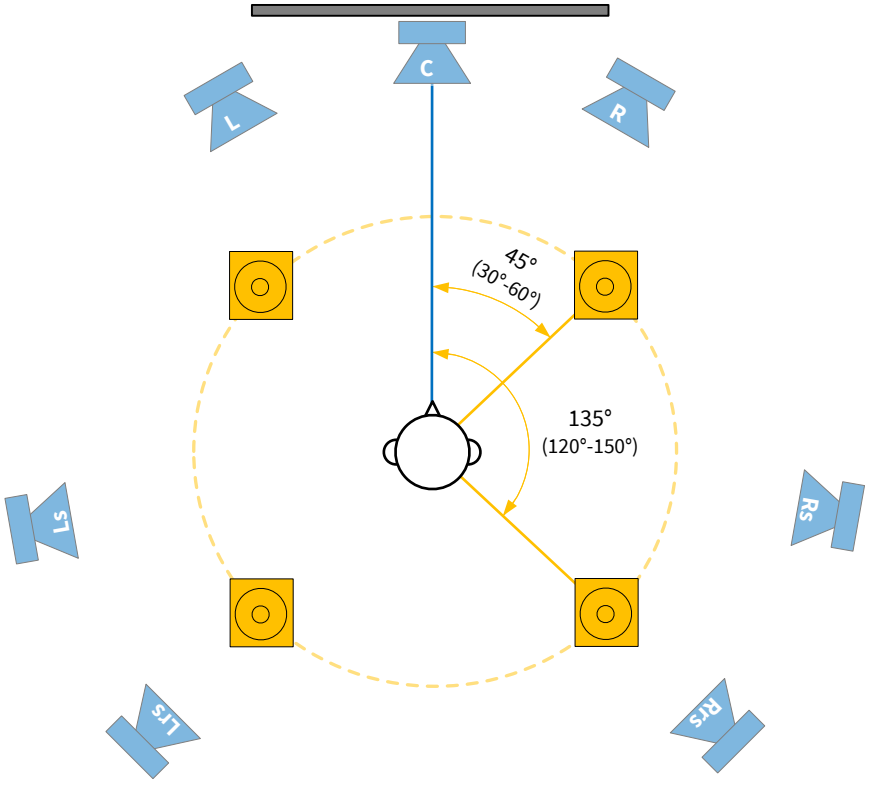
When referring to left or right top surrounds, the abbreviation Lts or Rts can be used.

Positioning of all top surround speakers is dictated by these design aspects:

- Achievable height of the top surround speaker
- Horizontal angular placement
- Lateral angle to the top surround speaker from horizontal at the mix position
- Longitudinal angle to the top surround speaker from horizontal at the mix position

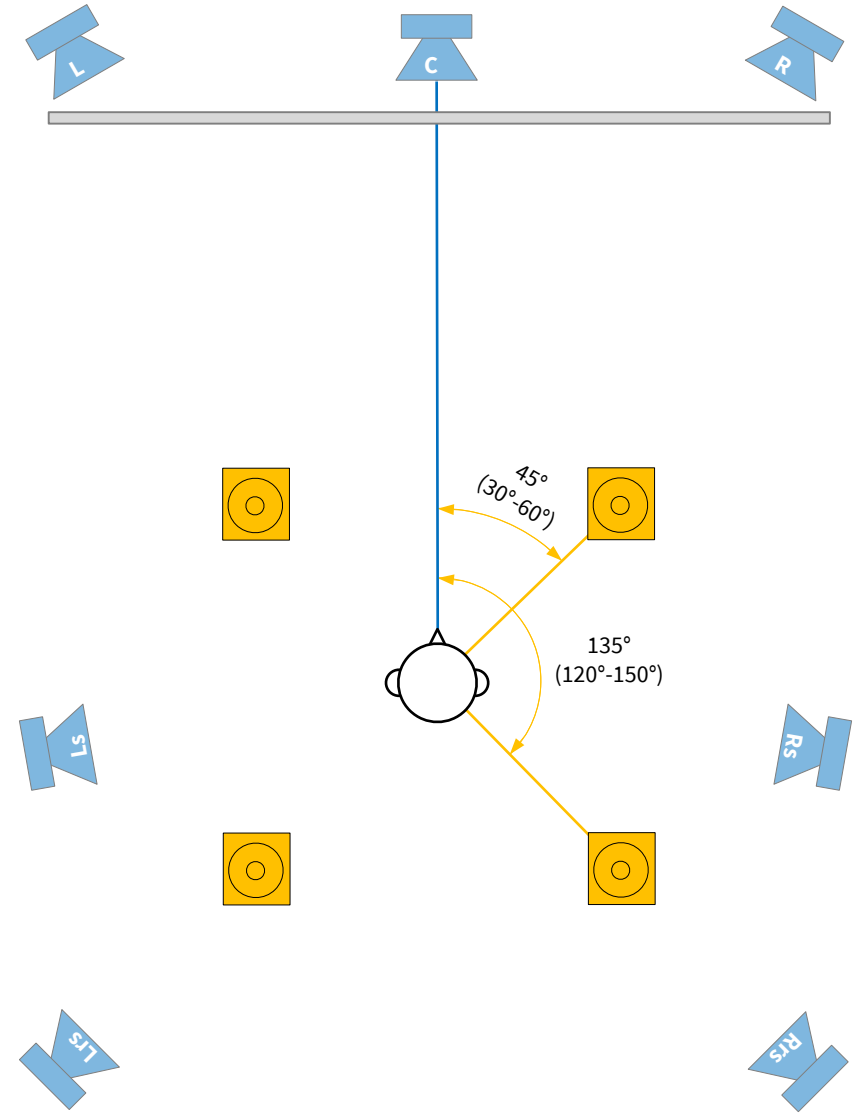
The result of these guidelines is a quad of overhead speakers placed centrally over the mixer, as shown in these figures.

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



Key
Ls/Rs = Left and right side surround
Lrs/Rrs = Left and right rear surround
n° = Recommended angle
(n°-n°) = Angle limits

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



Key
Ls/Rs = Left and right side surround
Lrs/Rrs = Left and right rear surround
n° = Recommended angle
(n°-n°) = Angle limits

Top surround speaker height

The top surround speakers are normally placed adjacent to the ceiling, with a minimum height of 2.2 m from the floor level at mix position.

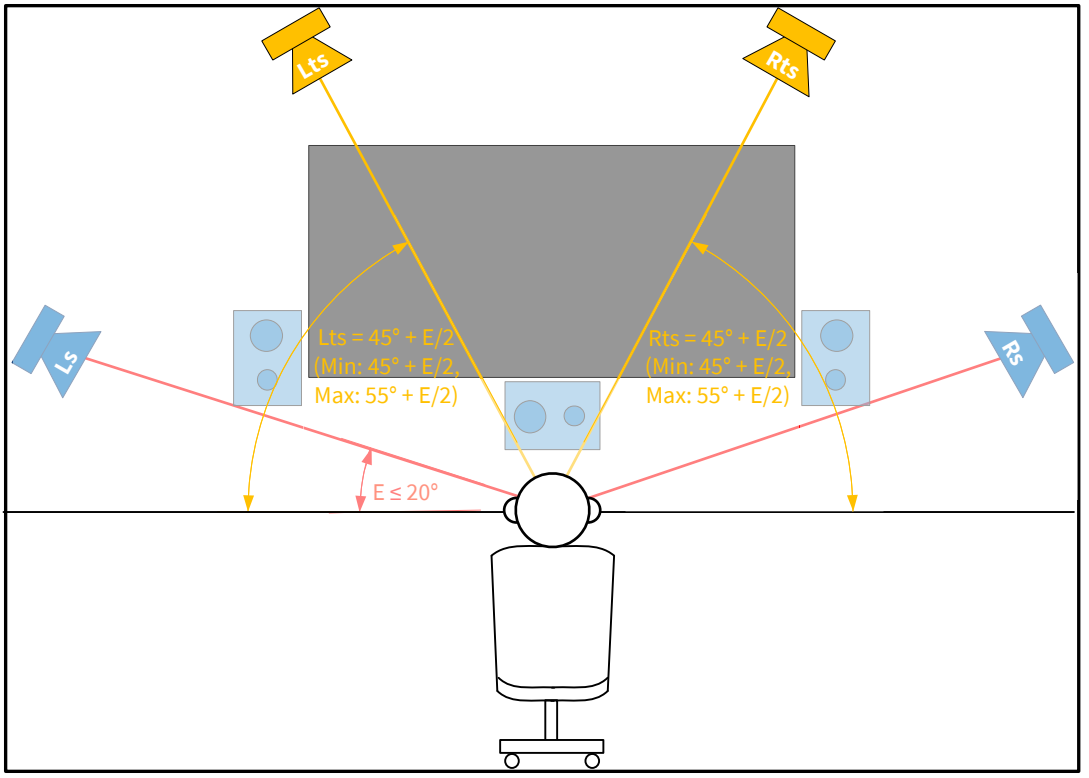
Top surround speaker lateral position

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



Key

Ls/Rs = Left and right side surround
Lts/Rts = Left and right top surround recommended angle
(Min: Max): = Top surround angle limits
E = Angle from horizontal to Ls and Rs

Top surround speaker longitudinal position

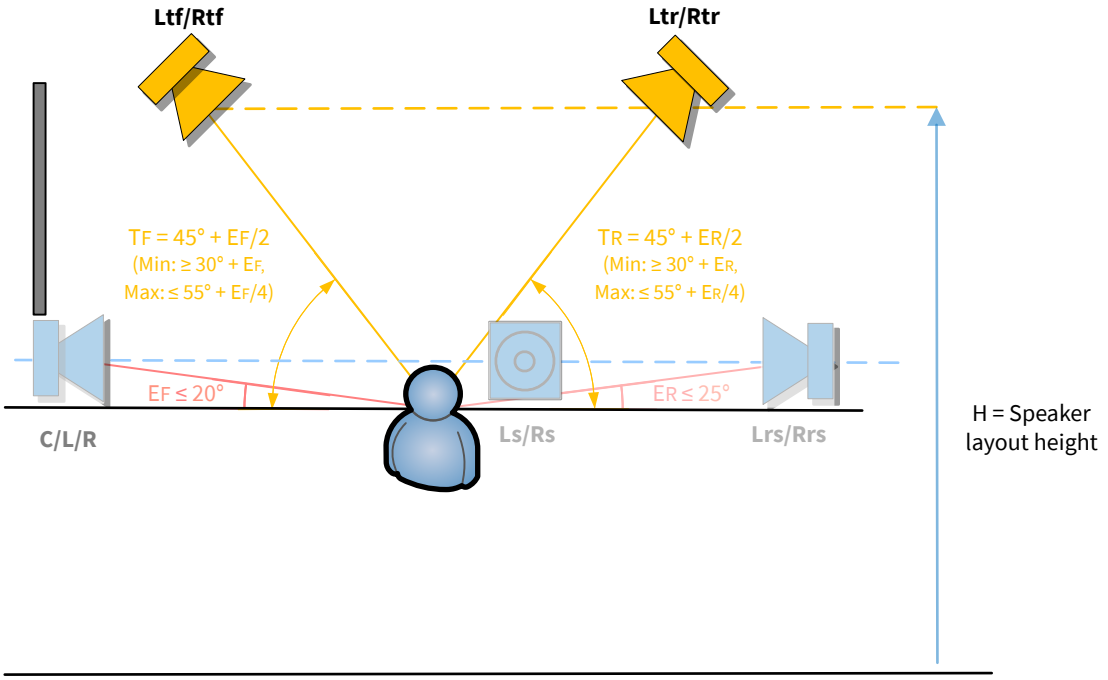
The ideal angle of the front top surrounds from horizontal is 45˚ + (EF ÷ 2), where EF is the elevation angle of the screen speakers from horizontal.

Speakers should be placed as close to the ideal as possible; however, the recommended 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



Key
TF/TR = Recommended top surround angle
(Min: Max:) = Top surround angle limits
EF = Angle from horizontal to C, L, and R
ER = Angle from horizontal to Lrs and Rrs
H = Speaker layout height

2.3.5 Speaker configuration design guidance for 5.1.4 speaker layouts in a Dolby Atmos Game Studio

Although 7.1.4 is the preferred layout for a Dolby Atmos game studio, you can alternatively use a 5.1.4 layout. However, with a 5.1.4 layout, the absence of rear surround speakers will lead to a difference in spatial resolution.

Dolby Atmos 5.1.4 speaker layout sizes are often smaller than typical 7.1.4 layouts, but overall size guidance remains the same as described in *Room layout design*.

Related information

Room layout design on page 9

Screen speakers and subwoofer placement

Screen speaker and subwoofer placement guidance is the same.

Refer to the *Screen speakers* section for more information on this topic.

Related information

Screen speakers on page 11

Side surround speaker placement

The angles of the side surround speakers from the center speaker in the horizontal plane are adjusted to match typical 5.1 positions.

As detailed in the figure titled *Equidistant layout plan view showing screen and surround speaker positions*, the ideal horizontal plane angle for Ls and Rs speakers is increased to 110° from the Center speaker. The recommended guidance range for side surrounds extends from 90° to 120°.

Side surrounds should be positioned away from the rear corners of the room. There must be additional room length beyond the side surround positions to allow for the correct placement of Ltr/Rtr rearmost top surround speakers.

Related information

Calculating the layout length parameter on page 22

Calculating the layout length parameter

Before the positions of the top surrounds can be calculated, the layout length parameter must be calculated.

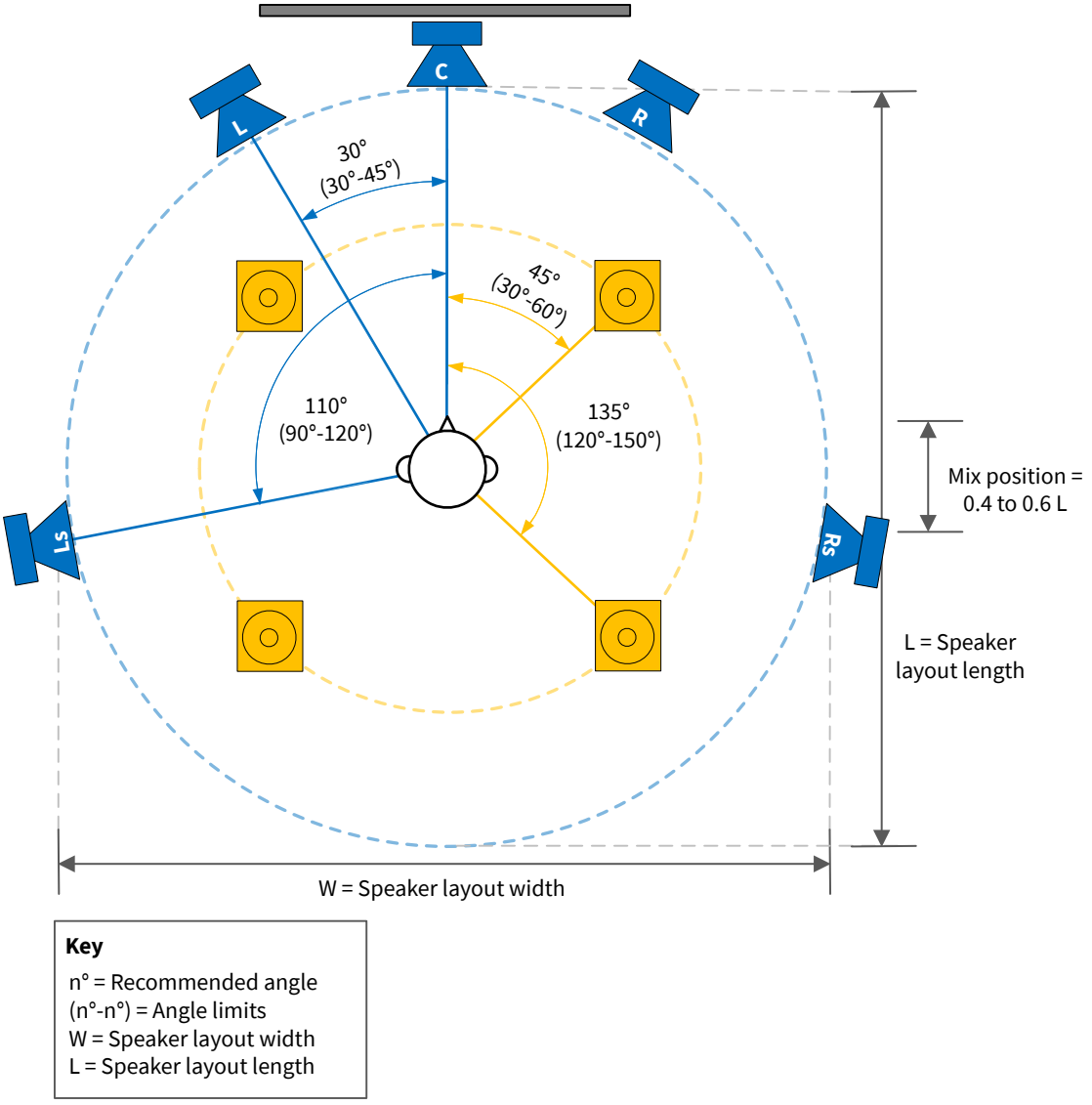
In a 7.1.4 speaker configuration, the longitudinal distance from the center speaker to the rear surrounds is defined as the layout length. However, due to the omission of the rear surround speaker positions in a 5.1.4 system, a virtual configuration length needs to be calculated using notional rear surround positions.

A circular arc is traced from one side surround to the other, forming an equidistant arc behind the mix position. The notional rear surround positions are at an angle of 135° from the Center speaker, but the positions also need to maintain a minimum 30° separation from side surrounds. The range for notional rear surrounds therefore extends from 135° to 150°. The elevation of the notional rear surround positions is presumed to match that of the side surrounds.

The layout length is defined as the longitudinal distance from the center speaker to the notional rear surround positions. When using the Dolby Audio Room Design Tool for Home Entertainment, Expanded (DARDT_HE_EXP), this calculation is automated.

Note: In the tool, when in 5.1.4 mode, the configuration (or layout) length parameter becomes a room length parameter. To engage 5.1.4 mode in the tool, disengage the rear surround line item check box.

Figure 11: Equidistant layout plan view showing screen and surround speaker positions



Key

n° = Recommended angle
(n°-n°) = Angle limits
W = Speaker layout width
L = Speaker layout length

Top surround speaker placement

Once the notional position of the rear surrounds has been established, it can then be used to help define Ltr/Rtr top surround positions.

Refer to *Top surround speakers* section for more information on this topic.

Note:

If required, the Rtr/Ltr speakers can be mounted high up on the rear wall, as long as the subsequent layout height and angular positions fit within the guidelines.

Related information

Top surround speakers on page 17

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. A calibration level of 79 dBC is recommended for a Dolby Atmos game studio, but an acceptable range would be from 79 to 85 dBC.

The ideal design requirement of the amplifier and speaker equipment reproduces the content, as recorded within the digital audio workstation (DAW), such that it does not add distortion. Each speaker would ideally be capable of producing 20 dB above reference level for content peaks, but this can sometimes be financially prohibitive. Lower, more achievable minimum thresholds are set out in this technical guide.

Each screen speaker should be capable of producing 17 dB above reference level, and each surround speaker should be capable of producing 14 dB above reference level. The subwoofer is aligned at +10 dB when compared to the center speaker, as per the SMPTE 202 specification, It should ideally be capable of producing at least 20 dB above reference level (which equates to a total of 30 dB above alignment level), but an acceptable lower minimum headroom threshold would be 17 dB above reference level.

To check the suitability of speakers and amplifiers, use the Dolby Audio Room Design Tool for Home Entertainment, Expanded (DARDT_HE_EXP) `.xlsb` Excel file. This tool helps you to evaluate the correct headroom at mix position. Minimum and recommended headroom thresholds are clearly shown in the tool. Locate and download the tool at https://games.dolby.com. Alternatively, you can request the tool by contacting your local Dolby representative, or emailing games@dolby.com.

2.4.1 Bass management

If using speakers with limited low-frequency response, you should use bass management to redirect low-frequency sounds to the subwoofer.

When redirecting low-frequency sounds, we recommend using the LFE subwoofer, as this is common in most gaming environments; however, you can also consider using dedicated bass management subwoofers. Systems with dedicated bass management subwoofers in which not all speakers are bass managed need an external bass management processor. We recommend a crossover point of approximately 80 Hz or less to reduce the localization of the subwoofer.

Consult your local Dolby representative about these options, or email games@dolby.com.

2.4.2 Speaker frequency response

The frequency response guidelines are dependent on the speaker type.

The frequency response of all speakers other than the subwoofer should conform to the wide-range characteristic defined in International Organization for Standardization (ISO) 2969/SMPTE 202 standards, with or without bass management. The response should 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

Our recommendation for a Dolby Atmos game studio is to install 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 should be installed and correctly positioned.

2.4.4 Dispersion pattern

Surround speakers should have a wide directivity pattern of at least ±45° 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 for a game studio

After you install Dolby Atmos for gaming and follow the technical guidelines in this documentation, we recommend that you install specific hardware and software for mixing, monitoring, and mastering.

These include:

- Audio middleware, PC with HDMI port and Dolby Access software
- An audio/video receiver (AVR) (audio video receiver) with Dolby Atmos decoding and 7.1.4 pre-out
- Immersive-format monitoring controller, or audio interface/digital speaker system with immersive monitoring controller and with dedicated speaker calibration DSP features
- DAW with Dolby Atmos renderer solution (such as Dolby Atmos Mastering Suite or Dolby Atmos Production Suite) and output for monitoring signal to the speaker system. This is especially applicable for linear cinematic content or cutscenes.
- Xbox One or Xbox Series X|S

If mixing for a mobile game, you will also need a Dolby Atmos gaming supported Android and/or iPhone.

If mixing for a console game, you may also need an Xbox One or Xbox Series X|S development kit.

2.5.1 Picture size and resolution guidelines

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

The video device should display, and be set up to correctly reproduce, the specified video standards in use in the relevant market.

To provide for international content, we recommend the video device be capable of displaying these frame rates:

- 23.976 fps (progressive)
- 24 fps (progressive)
- 25 fps (interlaced)
- 25 fps (progressive)
- 29.97 fps (interlaced)
- 30.5 fps (progressive)
- 59.94 fps (progressive)
- 60 fps (progressive)

Additional recommendations:

- Minimum 50-inch screen
- Minimum resolution of 1920 × 1080
- 4K high dynamic range (HDR) capable
- Processing delay that is known and compensated for by a suitable offset in the video replay device.

2.6 Sample studio block diagrams

The sample studio block diagrams include the basic system components. The examples are provided for integration guidance.

Figure 12: Diagram for studios using a monitor controller or similar hardware for routing to speakers

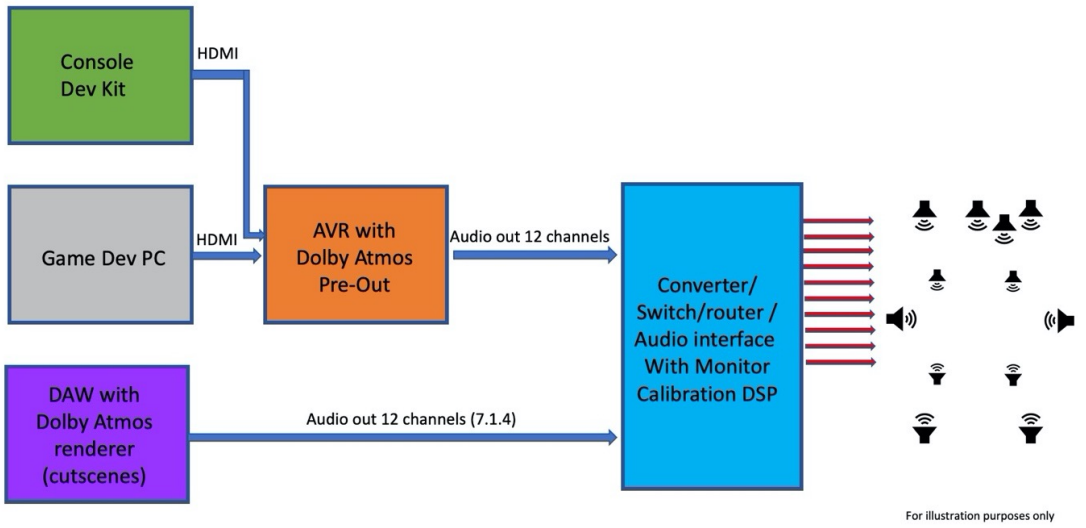
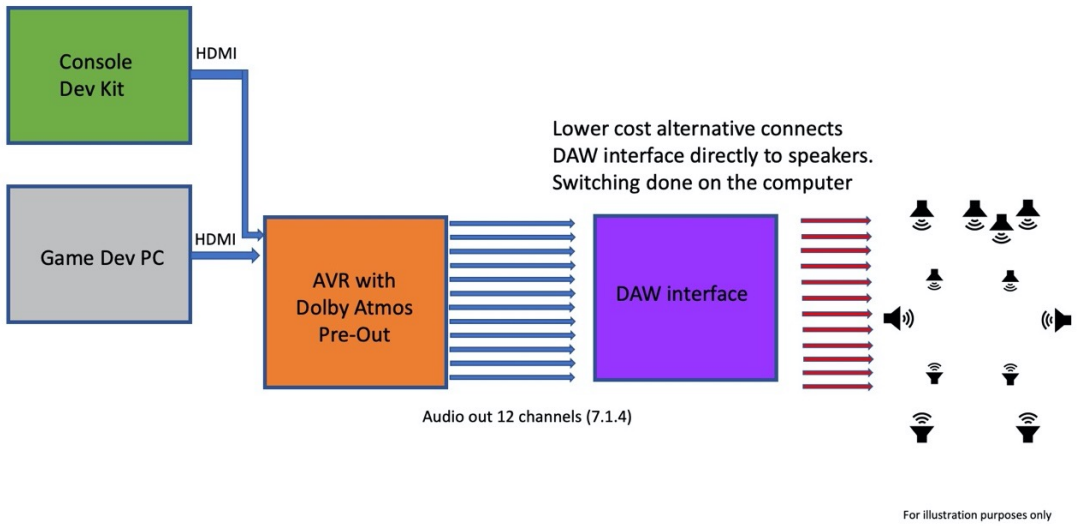


Figure 13: Diagram for studios using a DAW interface in place of a monitor controller



2.7 Speaker calibration

Speaker calibration includes setting monitor reference levels and speaker equalization (EQ).

2.7.1 Monitor reference levels

The monitor reference levels should be set at the preferred level of the studio but must be 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. Reference levels lower than the preferred studio level are also acceptable in smaller room environments.

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 EQ

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

For rooms with volume exceeding 125 m^3 (approximately 4,400 cu ft), 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 7.1.4 layout diagrams

Example diagrams provide context on angle and distance measurements.

These example diagrams show the detail considerations needed as part of a studio speaker layout. The letters refer to angle and distance measurements that should be replaced with actual values and included in these diagrams.

Figure 14: Plan view diagram sample

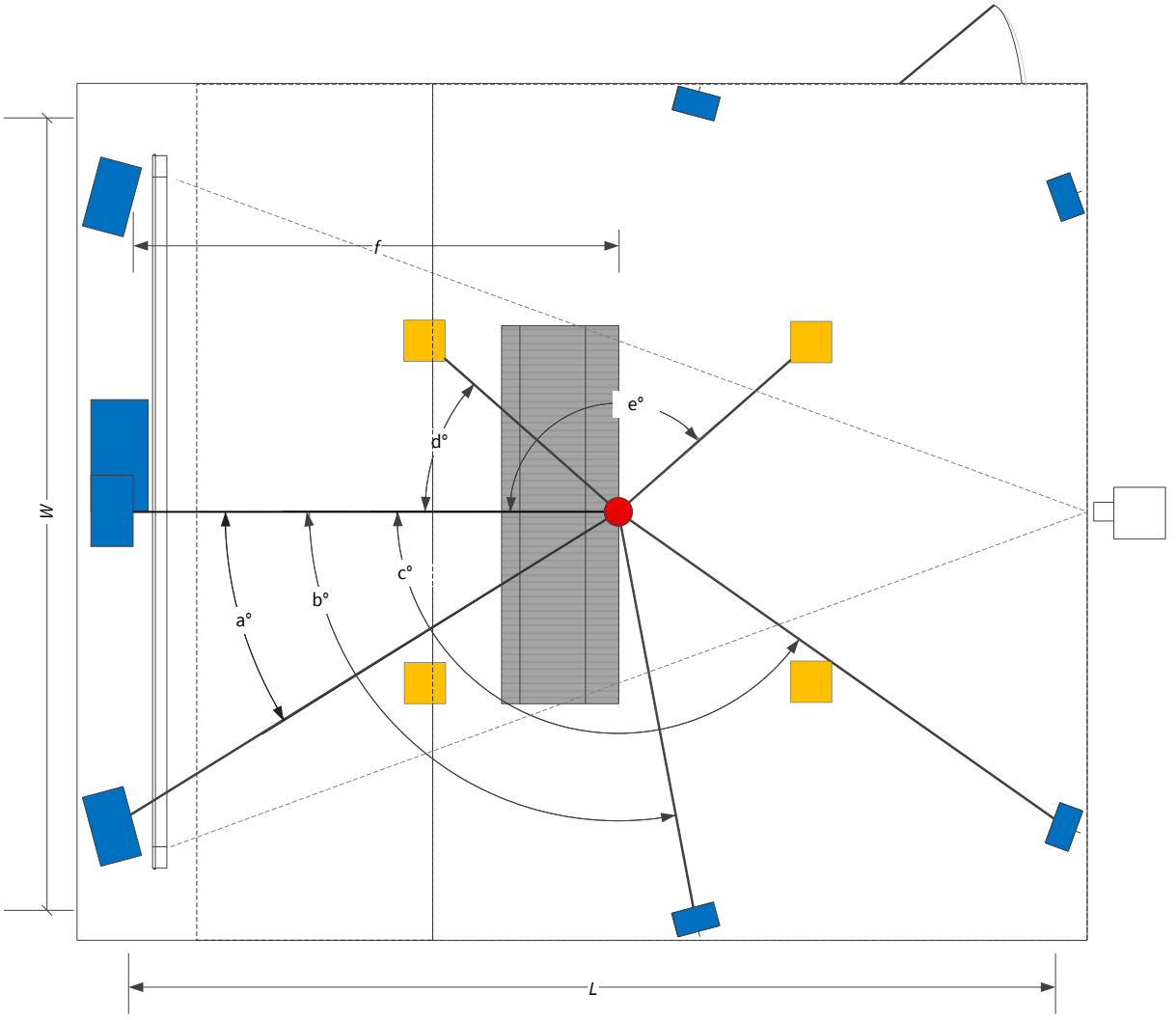


Figure 15: Side elevation diagram sample

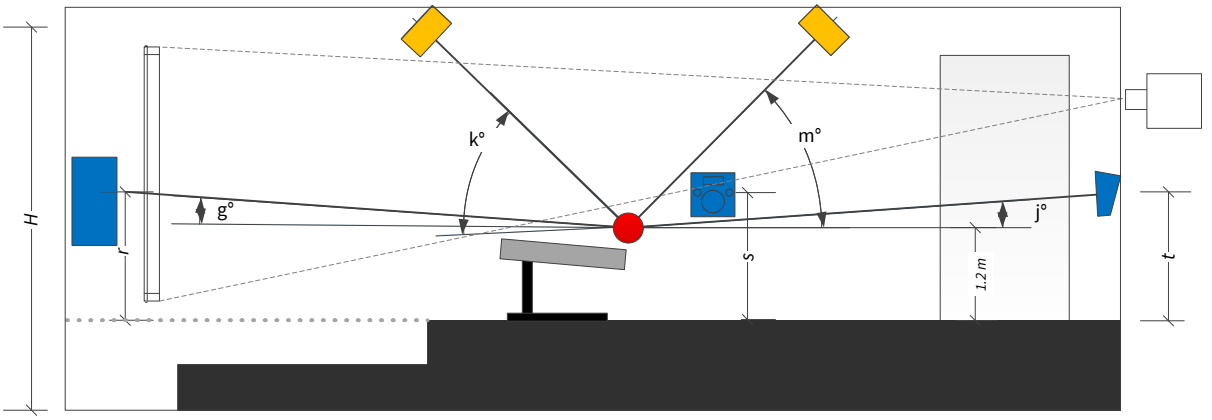


Figure 16: Front screen elevation diagram samples

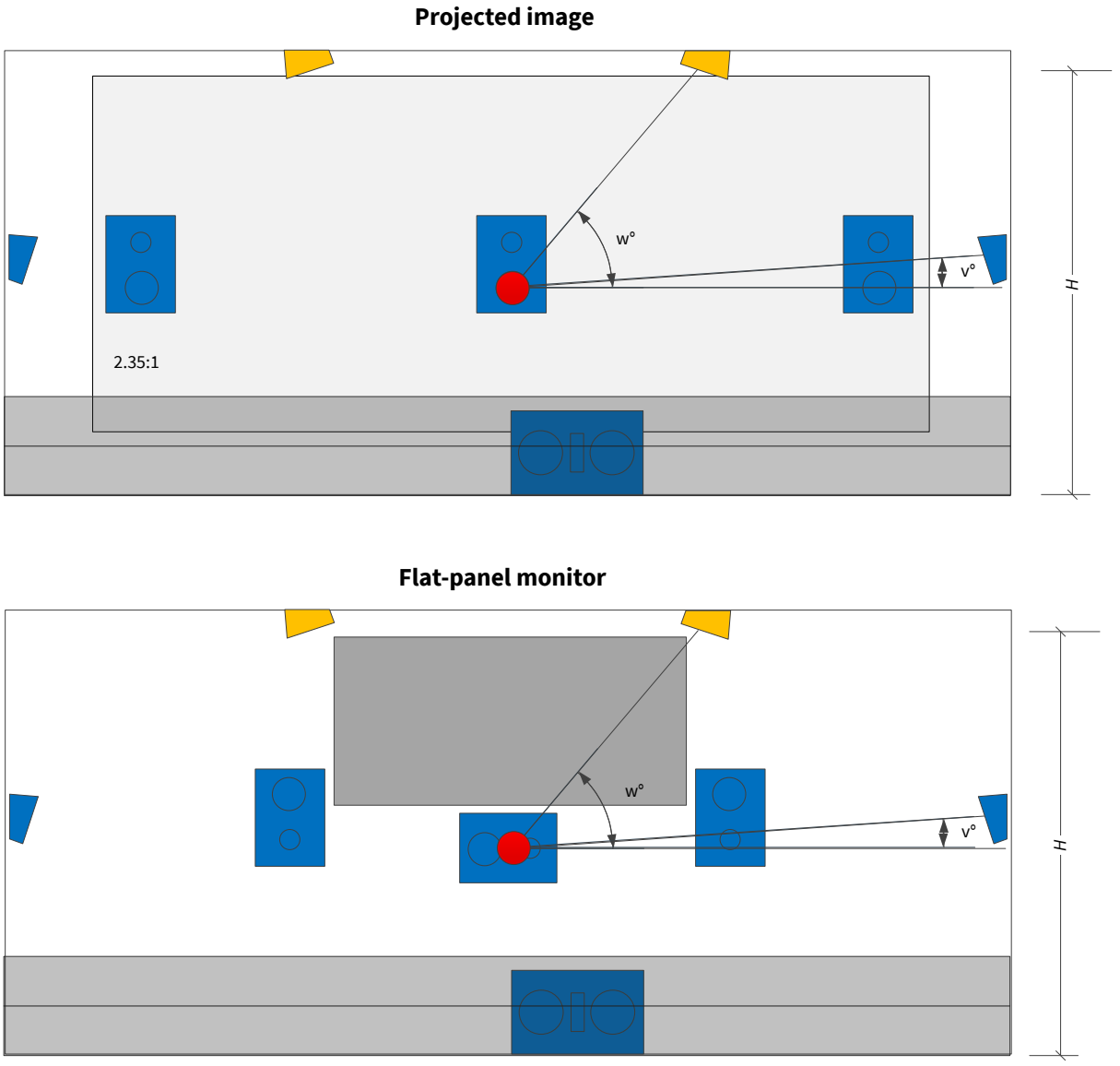
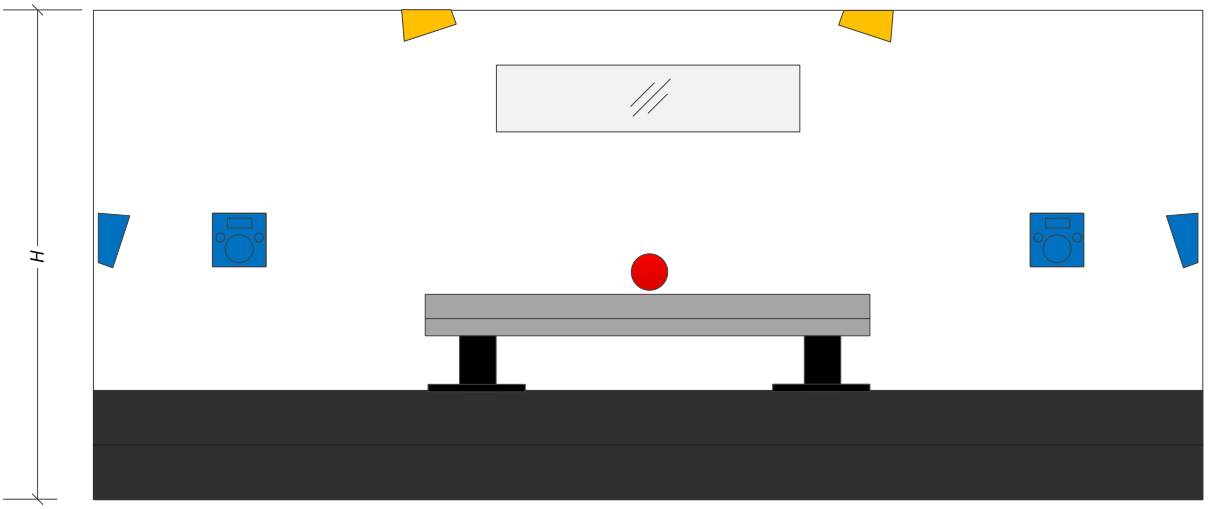


Figure 17: Rear elevation diagram sample



2.8.1 Estimating speaker output guidelines

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

About this task

The performance guidelines for sound pressure level (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 EQ, 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 SPL_{max} is not stated, compute it using the rated sensitivity (1 W at 1 m) and power handling (International Electrotechnical Commission (IEC) noise, with Audio Engineering Society (AES) duration of two hours) of the speaker, as follows:

   SPL_{max} = sensitivity + 10 × log10(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 attenuation of sound pressure from the speaker to the reference position, as follows:

   Distance attenuation = 20 × log10(D1/D2)

   In this equation, 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 evaluate the manufacturer equipment specification in relation to our technical guidelines, as written, when considering the approval of any amplifier or speaker. Dolby cannot be held liable for poor performance of speakers and amplifiers upon installation if the equipment does not meet the performance requirements. Discuss the equipment choice with the relevant manufacturer if any information beyond the published data is desired.

2.8.2 Notes on SPL

Achieving sufficient sound pressure levels (SPL s) 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 s are 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 challenging, 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 (half-space 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: 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 compensation with EQ 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.

Glossary

acoustic center
The point at which sound waves seem to originate from a speaker driver.

AES
Audio Engineering Society. An international organization that promotes advances in audio and disseminates new knowledge and research.

AVR
Audio/video receiver. An audio amplifier and audio/video (A/V) switching combination device for a home theater. It contains inputs for all of the audio and video sources and outputs to one or more sets of speakers and one or more monitors or TVs.

baffle
A surface or structure on which a speaker driver is mounted to prevent the front and rear sound waves from interfering with each other, thereby causing cancellation.

DAW
Digital audio workstation. An electronic device or computer software application used to record, edit, and produce audio files.

directivity
The extent to which a speaker driver emits sound in different directions.

Dolby RMU
Dolby Rendering and Mastering Unit.

DSP
Digital signal processor. A specialized microprocessor optimized for digital signal processing.

EQ
Equalization. The adjustment of audio frequency responses for practical or aesthetic reasons.

frequency response
The range of frequencies that a speaker or headphones can reproduce.

HDMI
High-Definition Multimedia Interface. A high-speed, high-capacity format for transferring digital information and the specific hardware interface for the format.

IEC
International Electrotechnical Commission.

ISO
International Organization for Standardization.

ITU
International Telecommunication Union.

LFE
Low-Frequency Effects. A band-limited channel specifically intended for deep, low-pitched sounds.

MADI
Multichannel Audio Digital Interface. A communications protocol for an interface that carries multiple channels of digital audio, defined by the Audio Engineering Society. Also known as AES10.

PC
Personal computer.

SMPTE
Society of Motion Picture and Television Engineers.

SPL
Sound pressure level. A logarithmic measure of the force of sound on a surface area perpendicular to the direction of the sound.

up-firing
A speaker driver orientation whose output is directed upward to a ceiling.

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