AUROMAX® FOR CINEMA THEATERS

Theatrical System Performance Specification

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1 INTRODUCTION

This document describes the definitions and requirements for Auro-3D® and AuroMax® compatible sound reproduction systems for cinema theaters, dubbing stages and screening rooms. The specifications defined in this document are meant as a guideline for acoustical engineers, architectural specialists and/or equipment manufacturers to follow or determine appropriate solutions necessary in the commercial marketplace to the support the Auro-3D®/AuroMax® formats.

From the start, the Auro 11.1, Auro 13.1 and AuroMax® systems were intended to provide the greatest compatibility with all existing standards and markets, including speaker setups for cinematic auditoriums. However, due to the addition of the Height channels and the use of zones in AuroMax®, some adaptations might be required to optimize the sonic and acoustical performance. As such, this document describes the ideal specifications that are most appropriate for new constructions or for auditoriums with the flexibility to reposition existing speaker channels.

The Auro-3D® concept and listening formats were conceived in 2005 by Wilfried Van Baelen (CEO Galaxy Studios & Auro Technologies) with the intention to create the most efficient 3-dimensional sound reproduction system without any concession on quality. Therefore a channel-based 5.1 system was chosen to guarantee the best audio reproduction quality with the addition of the minimum amount of channels to get a maximum 3-Dimensional sound reproduction. The Auro-3D® speaker configurations are designed to get a better compatibility between small and large rooms and between various media formats. For the technical solutions related to the Auro-3D Concept, please find the white papers on www.auro-technologies.com

In some cases the requirements for speaker placement may not be met. In such cases it may become necessary to supplement the existing speaker placements with new positions. E.g., if the existing screen channels are positioned too high to support the angular separation required for the addition of the Height screen channels, new positions for the lower speakers in an Auro-3D®/AuroMax® configuration may be installed directly below the existing screen channels. Alternatively, inverting the HF and LF positions of the existing 5.1 screen channels may be considered as well.

It is anticipated that many special circumstances will be discovered. *Auro Technologies* and *Barco* agree to accommodate requests for deviance and decisions will be made on a case-by-case basis.

In the course of this document, room sizes are divided into three categories:

- Small rooms: theaters up to 200 seats, smaller mixing and screening rooms
- Medium rooms: theaters from 200 to 500 seats
- Large rooms: theaters with more than 500 seats

2 PLAYBACK CONFIGURATIONS AND DEFINITIONS

The **Auro-3D** system knows two main channel configurations targeted towards the cinematic industry: **Auro 11.1** and **Auro 13.1**.

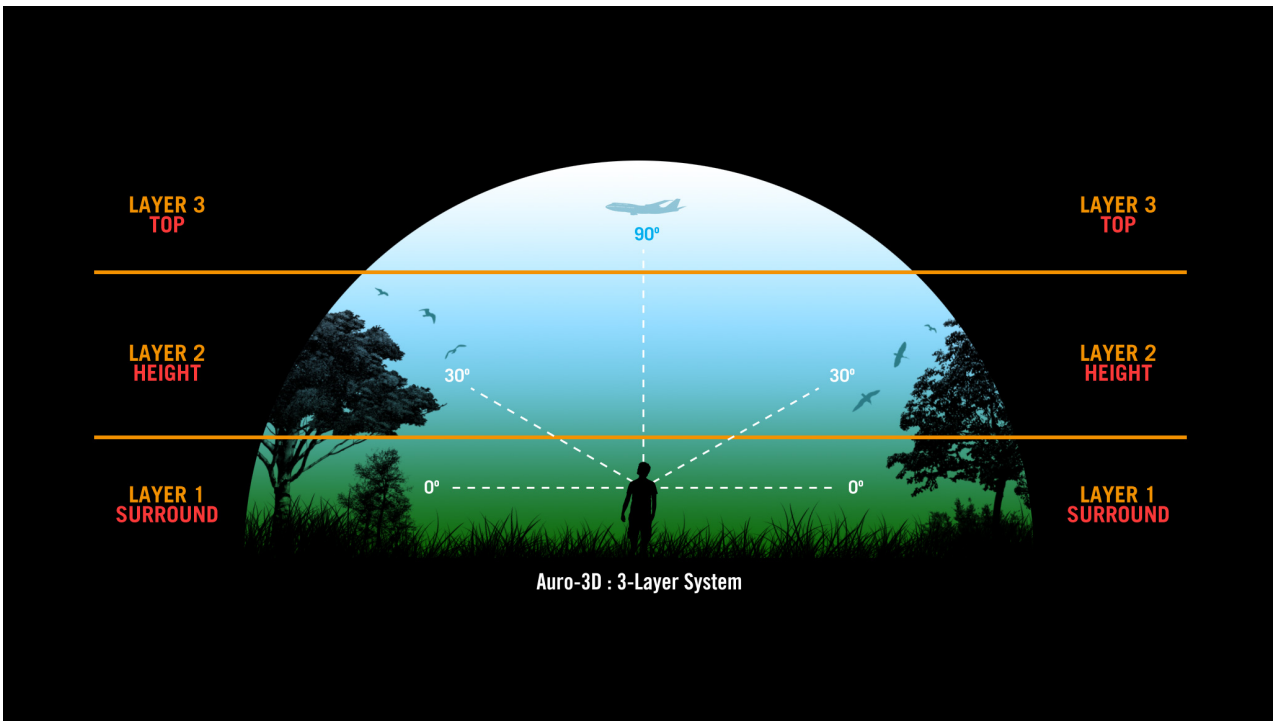
However, for reproduction of **AuroMax®**, three pre-defined playback configurations have been developed, allowing a more detailed reproduction of the object-based content while remaining fully compatible with the existing Auro-3D® installations: AuroMax 20.1, AuroMax 22.1 and AuroMax 26.1. Please keep in mind that these are NOT channel-based configurations in which content will be generated, but rather playback configurations for object-based audio, optimized for a maximum immersive experience at minimum additional expense.

2.1 Standard Auro-3D® Configurations

2.1.1 Auro 11.1 Configuration

The **Auro 11.1** speaker configuration is the default and preferred format for a theatrical 3-Dimensional sound system. It is based on the existing (2-dimensional) 5.1 surround sound configuration, augmented with Height channels (z-axis) above the existing 3 screen channels as well as above the 2 surround channels. The use of all Height Surround channels is key to achieve the true-to-life enveloping experience of sound in 3D. These Height Surround channels, placed around the listener, reproduce the essential acoustical information that our auditory system needs to achieve a natural 3-dimensional listening experience. With Front Height channels only, fly-over effects sound unnatural as they seem to 'land' behind the spectators in the lower surrounds instead of flying over.

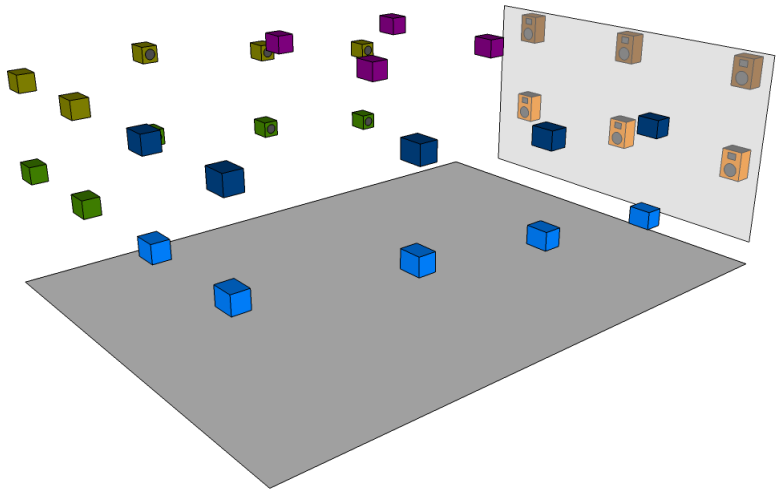
The Auro-3D system is built using three layers:



1) **Surround Layer** (horizontal plane): for sounds originating from around the listener
2) **Height Layer**: This layer reproduces sounds coming from a slightly higher angle (approx. 30°). It contains direct sounds such as bird, etc. as well as very important spatial

information (i.e. reflections) that define the correct acoustical properties of the space in a scene, and enhances the definition of sounds in the lower layer. The result is a much more natural sound quality (added harmonic information) as well as a better localization of the sounds reproduced in the horizontal plane.

3) **Top Layer**: The addition of another discrete channel (ceiling/Voice of God) for overhead fly-over or other special effects directly above the listener completes the layout for the 11.1 configuration. The combination of this Top layer and only a Surround layer is not sufficient to reproduce a natural 3-dimensional sound. For that, the Height layer is key, delivering the natural envelopment of a true 3-dimensional Listening Experience.



The following table summarizes the channel allocations for the Auro 11.1 Speaker setup.

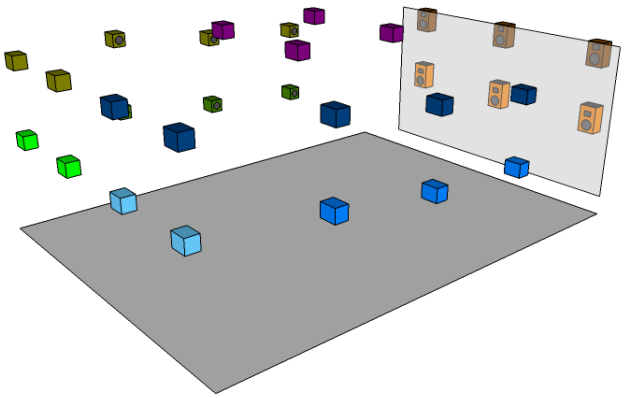
#	Abbr.		Channel	
1	2.1.1.1	L	2.1.1.2	Front Left Screen Channel
2	2.1.1.3	R	2.1.1.4	Front Right Screen Channel
3	2.1.1.5	C	2.1.1.6	Front Center Screen Channel
4	2.1.1.7	LFE	2.1.1.8	Low Frequency Effects
5	2.1.1.9	Ls	2.1.1.10	Left Surround
6	2.1.1.11	Rs	2.1.1.12	Right Surround
7	2.1.1.13	-	2.1.1.14	reserved
8	2.1.1.15	-	2.1.1.16	reserved
9	2.1.1.17	HL	2.1.1.18	Height Left Screen

				Channel
10	2.1.1.19	HR	2.1.1.20	Height Right Screen Channel
11	2.1.1.21	HC	2.1.1.22	Height Center
12	T		2.1.1.23	Height Top (VoG)
13	2.1.1.24	HLs	2.1.1.25	Height Left Surround
14	2.1.1.26	HRs	2.1.1.27	Height Right Surround
15	2.1.1.28	-	2.1.1.29	reserved
16	2.1.1.30	-	2.1.1.31	reserved

2.1.2 Auro 13.1 Configuration

The **Auro 13.1** speaker configuration is built from the Auro 11.1 system configuration, with the addition of the Back Surround channels, providing compatibility with 7.1 Surround without adding any extra speakers. This thus means that the same number of speakers is used for both the Auro 11.1 and Auro 13.1 configurations. The main difference is the addition of two channels of amplification channels. The cabling can then be executed in such a way that the processor can easily swap between the two different formats. This switch will be done as determined by the Barco Audio processor: if the movie is mixed in Auro 13.1, the processor will automatically change from the Auro 11.1 settings to the Auro 13.1 setup.

The 7.1 format distributed with certain titles is compatible with the Auro 11.1 and Auro 13.1 formats, but will be supported as a fold-down to 7.1..



The following table summarizes the channel allocations for the Auro 13.1 Speaker setup.

#	Abbr.	Channel		
1	2.1.2.1	L	2.1.2.2	Front Left Screen Channel
2	2.1.2.3	R	2.1.2.4	Front Right Screen Channel
3	2.1.2.5	C	2.1.2.6	Front Center Screen Channel
4	2.1.2.7	LFE	2.1.2.8	Low Frequency Effects
5	2.1.2.9	Lss	2.1.2.10	Left Side Surround
6	Rss		2.1.2.11	Right Side Surround
7	Lrs		2.1.2.12	Left Rear Surround
8	Rrs		2.1.2.13	Right Rear Surround
9	2.1.2.14	HL	2.1.2.15	Height Left Screen Channel

10	2.1.2.16	HR	2.1.2.17	Height Right Screen Channel
11	2.1.2.18	HC	2.1.2.19	Height Center
12	T	Top (VoG)		
13	2.1.2.20	HLs	2.1.2.21	Height Left Surround
14	2.1.2.22	HRs	2.1.2.23	Height Right Surround
15	-	Reserved		
16	-		2.1.2.23.1	Reserved

2.2 AuroMax® Playback Configurations

The AuroMax® Playback configurations build further on the Auro 11.1 and Auro 13.1 Speaker Configurations and introduce the concept of zones or multiple smaller speaker arrays where bigger speaker arrays were used, on the side and back walls as well as the ceiling. The zones are then not only used to reproduce the channel-based content (or beds) in the same way as the original Auro-3D® formats, but also for the object-based elements in the AuroMax® mix, providing increased accuracy in sound placement and movements. For more details, please see the 'AuroMax® White Paper'.

2.2.1 AuroMax® 26.1

The ideal configuration using the 'zones' approach, adds the so-called Wide or "Proscenium" speakers between the screen channels and the front-most surround speakers. These allow for smoother movements of sounds from the screen into the room, and are often used to bring the music slightly into the room, away from the screen.

The Surround speaker arrays are divided into two zones for each wall, while the Top layer (overhead) consists of four zones, arranged in a square.

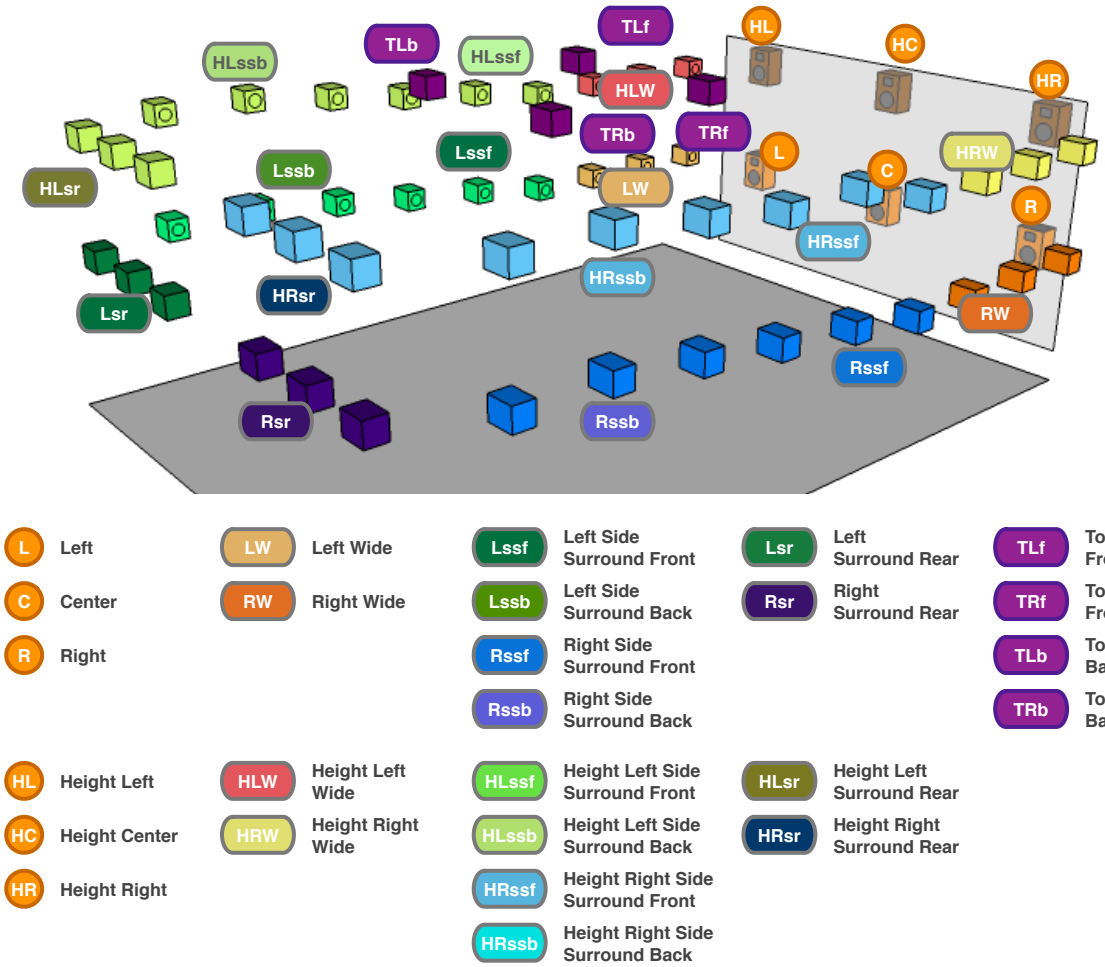


Figure 1 - AuroMax® 26.1 layout

This configuration is the recommended configuration for most rooms and provides the best immersive sound experience with the highest compatibility with standard Surround and Auro 11.1 productions and provides a large sweet spot.

2.3 AuroMax® 20.1

The smallest configuration for AuroMax® is based on the standard Auro 11.1 installation and splits the Surround and Top speaker arrays into two zones for each wall.

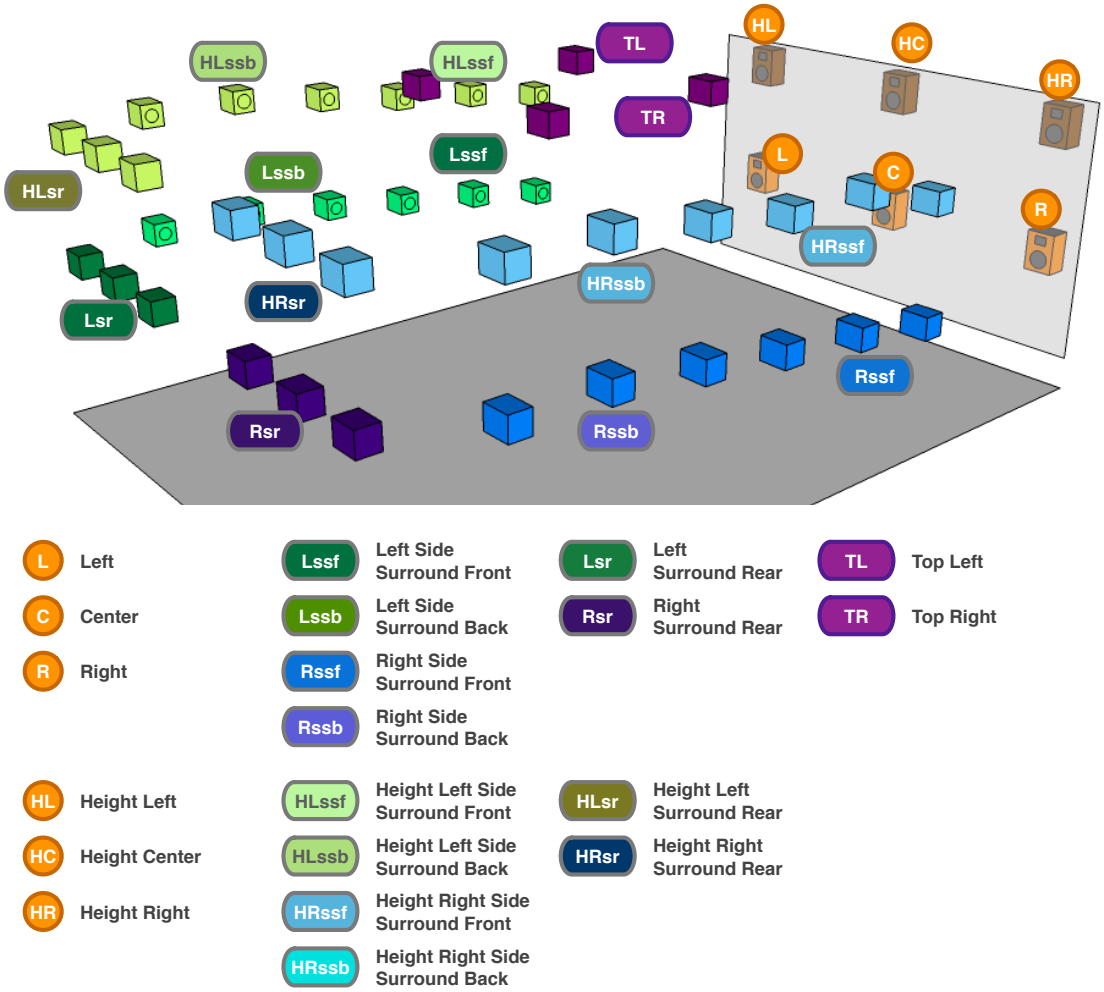


Figure 2 - AuroMax® 20.1 layout

2.4 AuroMax® 22.1

In a second configuration the Top layer is further divided into 4 distinct zones.

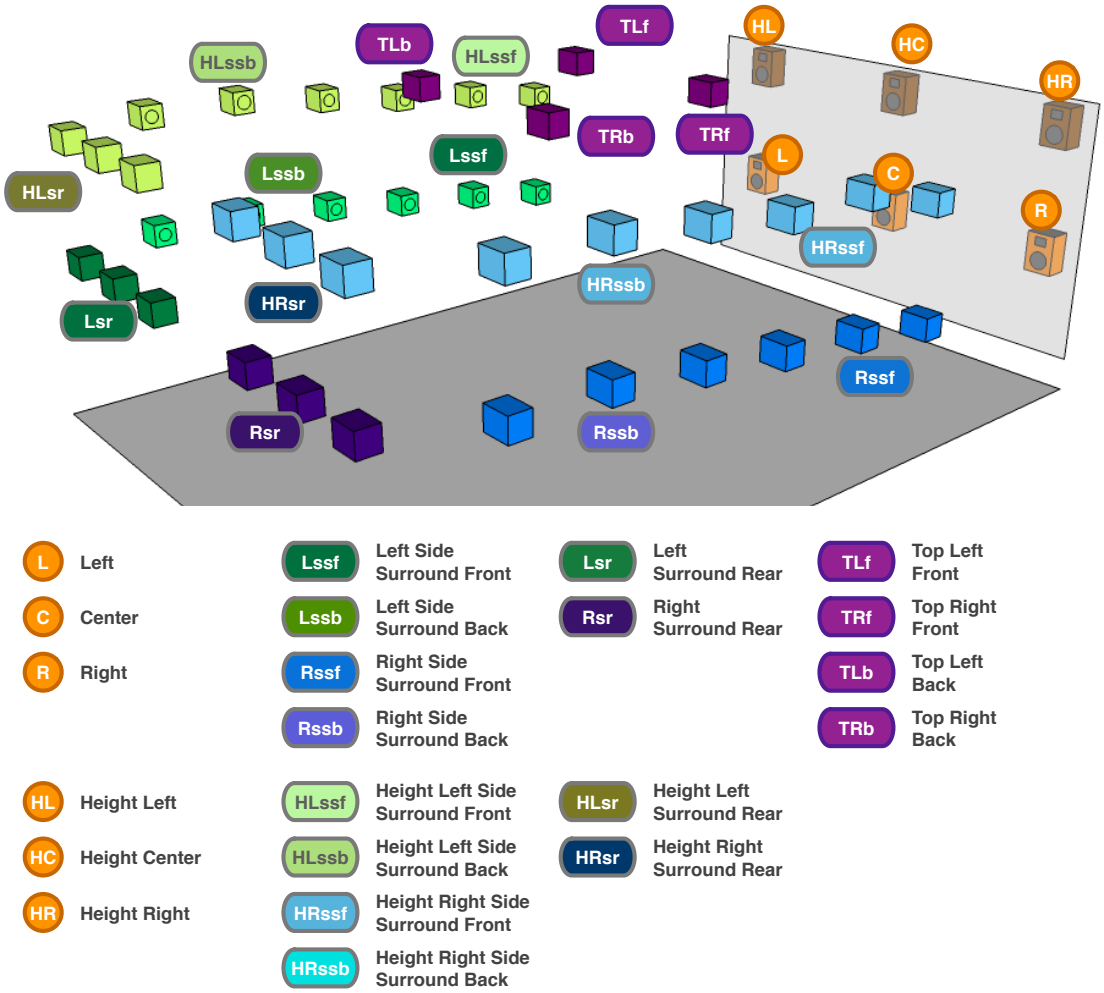


Figure 3 - AuroMax® 22.1 Layout

This configuration is recommended for theatres that want to convert an existing Auro 11.1 system without changing the speaker installation.

3 SPEAKER POSITIONS AND ANGLES

3.1 Screen Channels

All screen channels, including the Height channels, shall be spaced horizontally to match the widest picture format. The Height channels shall be placed vertically above the lower screen channel speakers.

There should be no interference to the dispersion of the speakers, regardless of the screen masking position.

The HF sections of the speaker systems (lower and height channels) shall be placed as close as possible to the screen and shall be time aligned to be in phase with the lower speakers..

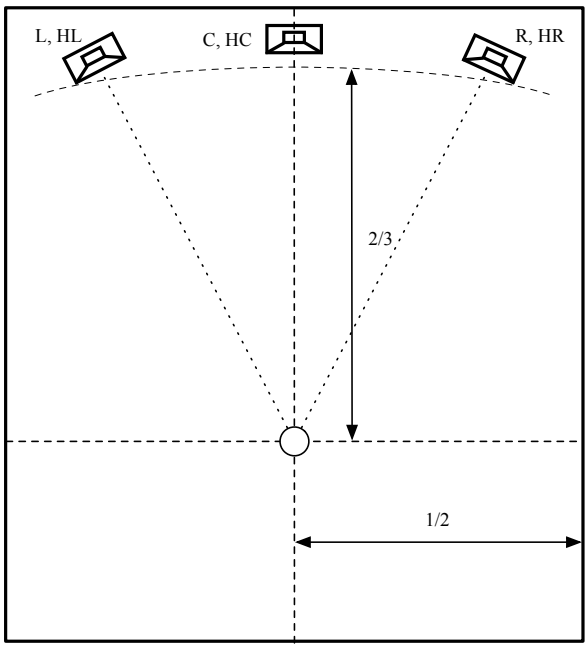


Figure 4 - Screen channel angles reference listening position

The outside loudspeakers shall be toed-in so that their on-axis extensions intersect at a point about 2/3 the distance from the screen to the back wall, regardless whether the screen is curved or not. This point in the room is called the Preferred Listening Position, or PLP. Care should be taken that the complete audience remains within the dispersion patterns of the HF speaker systems.

The lower screen channels, which are also used for standard 5.1 and 7.1 surround sound playback, shall be elevated so that their HF sections are preferably not higher than the middle of the screen. In those cases where the existing speakers are installed at 5/8-screen height, inverting the LF and HF components of the system will allow the separation requirements to be met without making structural modifications to the existing installation.

The Height screen channels shall then be elevated as high as possible to the top of the screen so their acoustical centers are 20° to 30° higher than the lower screen channels, seen from the reference listening position 2/3 in the back of the auditorium, with an absolute minimum of 15° above the screen channels. In case this minimum angle cannot be met, the lower screen channels should be lowered, remaining at a minimum of 1/3 screen height.

In situations where top masking is used, the Height screen channels need to remain unobstructed (acoustically transparent). Under certain circumstances it might thus be necessary to position the Height screen channels in front of the top masking to maintain the minimum angle of 15° with the lower screen channels, without creating visual interference to the screen. Therefore this action is allowed, but not preferred.

In case of a dub stage, the Height screen channels shall be at minimum 20° higher than the lower screen channels.

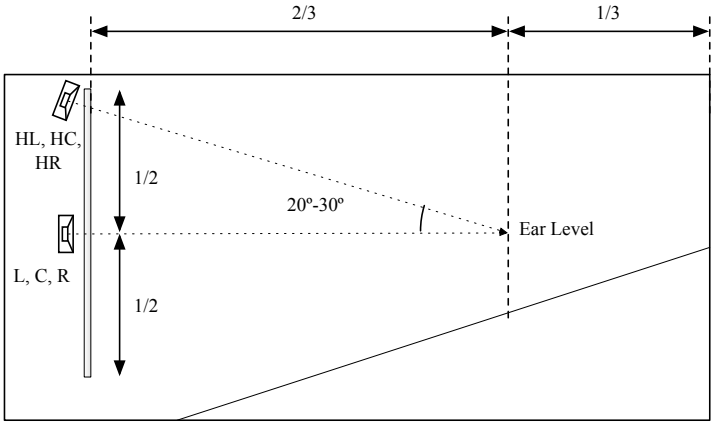


Figure 5 - Screen channels elevation and downward tilt

The HF elements of the screen channels shall be tilted downward so they point at ear level at a distance 2/3 toward to the back of the auditorium.

3.2 Side Surround channels

The front-most Surround channels shall be placed about 2/3 the distance from the back wall to the screen. The back-most sidewall surround channels shall be approximately 3m from the back wall to prevent acoustical corner loading. This distance may be 30% lower in small rooms, and up to 30% higher in large rooms.

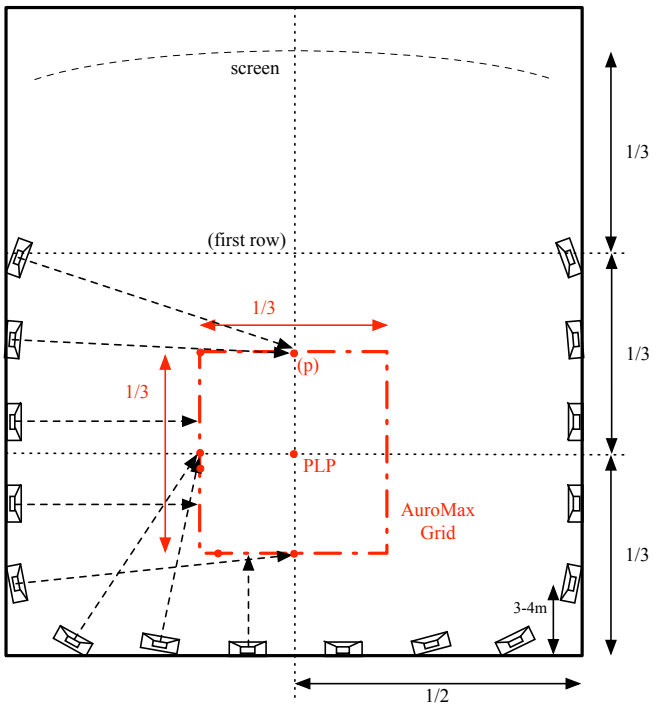


Figure 6 - Surround placement on side- and back walls

With the introduction of object-based audio capabilities, angling the speakers correctly is an important element to make sure that the placement and movement of the audio objects is consistent across the whole room. Thanks to the use of zones, the speakers do not need to be angled towards a single point, the so-called sweet spot, in the room. Instead, the concept of the AuroMax Grid is introduced. This is an imaginary rectangle with its centre in the PLP and which is 1/3 the room width wide and 1/3 of the room depth deep. The speakers shall then be angled so that they face the middle of the nearest side of the grid. In case the speakers can directly face the grid, they shall not be angled at all (see Figure 6).

While for optimum performance the lower Surround channels should theoretically be mounted at ear height, they shall be mounted at a minimum of 2.5m for safety reasons, but not exceeding an angle of 10° above ear level, seen from the middle of the auditorium. They should be positioned such that they are aiming at a position 2/3 from the opposite wall with a downwards tilt appropriate for the coverage capabilities of a given loudspeaker design.

For rooms up to 15m wide, the height H shall thus be 2.5m, and not having an angle bigger than 5°, above the floor and shall be appropriate so that equal power coverage of the audience can be attained. For rooms wider than 15m, the height shall be increased by 0.1m for each additional meter in width (e.g. H=3m for a 20m wide theater). When possible, follow the rake of the floor.

The Height Surround channels' elevation shall be 30° higher than ear level, i.e. at least 20° higher than the lower channels, as seen from the reference listening position in the middle of the auditorium. In case of stadium theaters, follow the rake of the floor until the speaker positions reach the ceiling corner, where they should be positioned as long a minimum angle of 15° is achieved. If the height of the wall is not sufficient to maintain the minimum 15° angle between Lower and Height Surround channels, e.g. in the back of the auditorium, the Height channels shall be mounted on the ceiling so that the minimum angle, seen from the reference listening position, can be maintained. However, the Height Surround channels shall not be mounted further than 1/6 of the auditorium width from the closest wall.

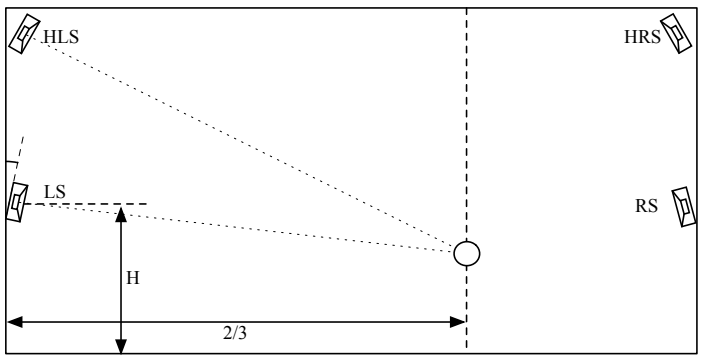


Figure 7 – Side Surround Channel ELEVATION and TILT when sufficient height is available

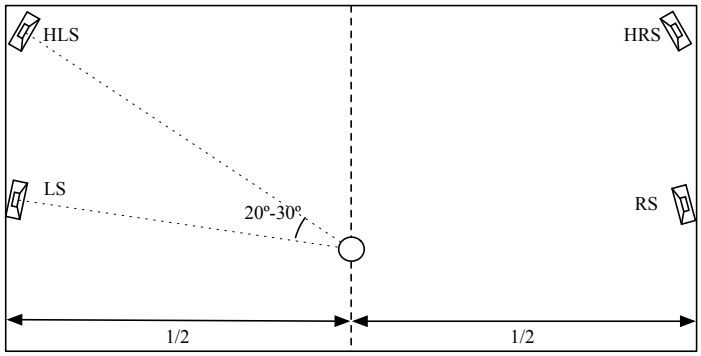


Figure 8 –Side Surround elevation: ANGLE between lower and Height surround channels

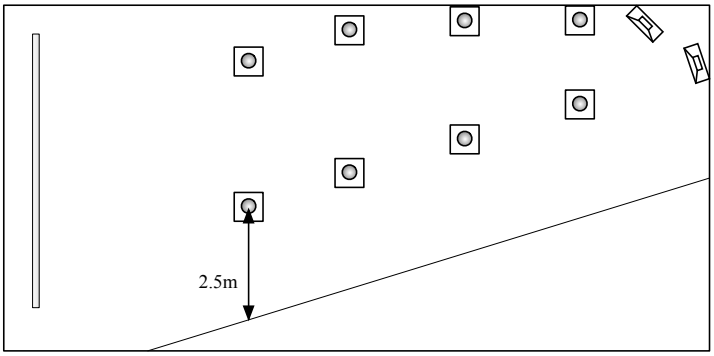


Figure 9 - Side surround elevation versus ceiling height

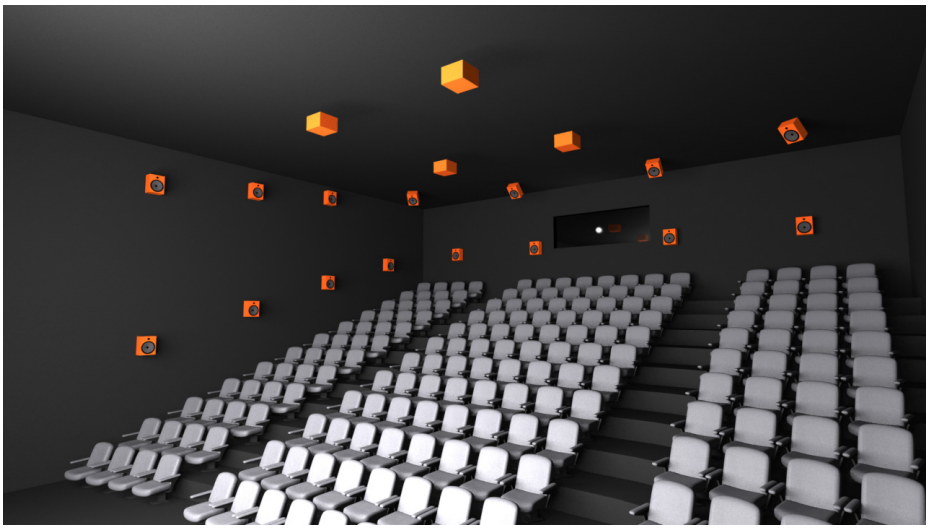


Figure 10 - An example of speaker placement

The acoustical center of the Surround and Height Surround speakers shall be aimed at 2/3 the width of the auditorium.

The Surround channels shall be evenly distributed according to the coverage and power handling capabilities of the speakers utilized.

The tilt of the ceiling-mounted Height Surround channels should be adjusted so that in the extreme condition of placement at 1/6 of the wall, the speakers are aimed at the same reference listening position as the other surrounds, to ensure an even acoustical dispersion of the sound in the auditorium. (This is either the 2/3-reference position in the case of the rear surrounds or the 2/3-width position for the side surrounds.)

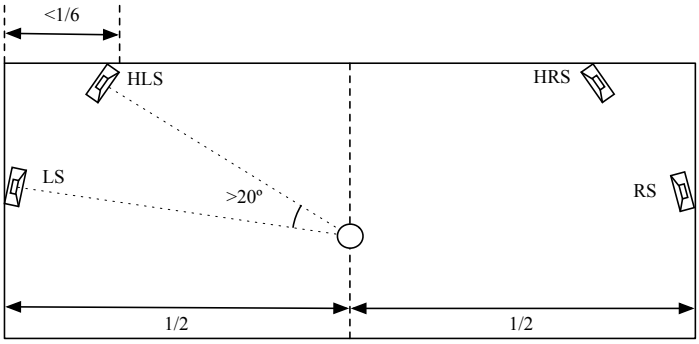


Figure 11 – Side Surround channel tilt

In case of a dub stage or small screening room, the lower Surround channels shall for practical reasons be mounted at 5° above ear height (maximum 10°), seen from the mixing position (although in theory they should be mounted at ear level). The Height Surround channels shall then be at 30°, i.e. at least 20°-25° higher than the lower Surround channels. For best performance of both the standard surround sound and Auro-3D formats, the lower Surround channels shall then also be positioned at the same level as the lower screen channels; the Height Surround channels should then be placed at the same height as the Height screen channels.

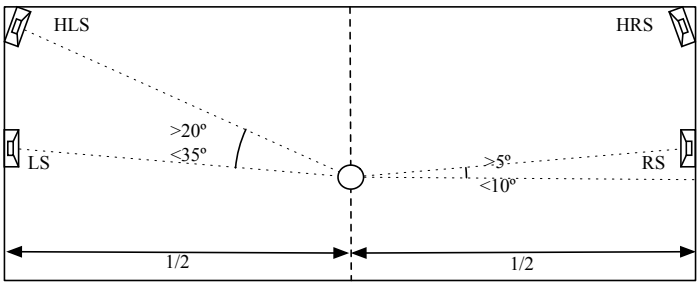


Figure 12 - Side Surround elevation at dubbing stages and in small screening rooms

3.3 Rear Surround Channels

The Rear Surround channels are used for the (Height) Rear Surround channels in case of an Auro 13.1 setup and for all AuroMax playback configurations, or used for the (Height) Surround channels in an Auro 11.1 configuration. In the latter case they shall then be divided into two sections (left and right).

The outer Rear Surround channels shall be no closer than 3m from the sidewall or as required to prevent acoustical corner loading. The other Rear Surround channels shall be evenly distributed according to the coverage and power handling capabilities of the loudspeaker design.

The rear speakers shall also be angled to the AuroMax Grid, as indicated in Figure 6. The speakers are angled so that they face the middle of the nearest side of the grid. In case the speakers can directly face the grid, they shall not be angled at all.

For optimum performance the lower Rear Surround channels should be mounted at the same height as the backmost Side Surround channels but for safety reasons they shall be elevated at about 2.5m in such manner that they are aiming at a position 2/3 from the opposite wall with a downwards tilt appropriate for the coverage capabilities of a given loudspeaker design. There shall be no objects or materials obstructing or interfering with the sound from these rear channel speakers.

The Height Rear Surround channels' elevation shall be 30° higher than ear level, i.e. at least 20° higher than the lower channels, as seen from the reference listening position. In case the height of the back wall in theaters with stadium seating is not sufficient to maintain the ideal angle between lower and Height Surround channels, the Height channels shall be mounted on the ceiling so that the minimum angle of 20°, seen from the reference listening position, can be maintained.

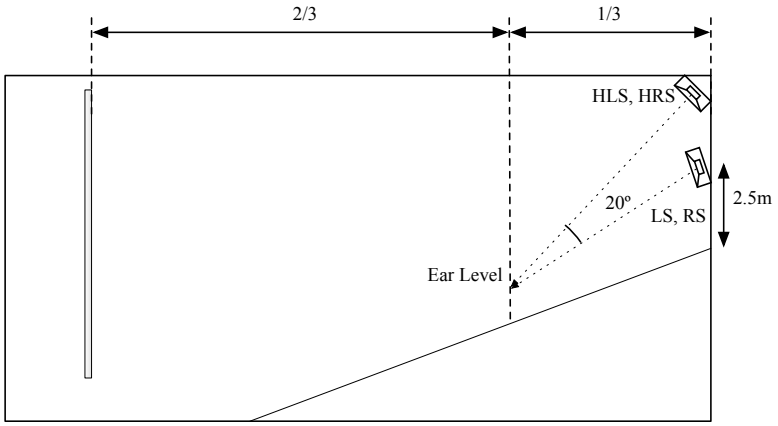


Figure 13 - Back Surround elevation with sufficiently Height back wall

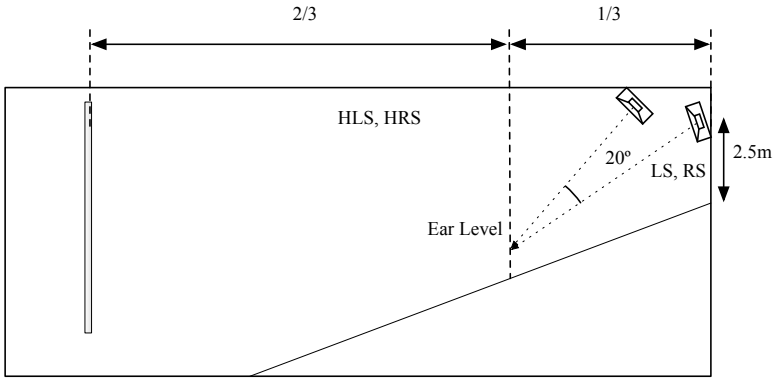


Figure 14 - Back Surround elevation with low ceiling

If there are other seats in a mixing room targeted for Auro 13.1 or AuroMax, the lower Rear Surround speakers shall be mounted such that they are directed or aimed at the horizontal plane of the reference mix position and be high enough to allow adequate coverage of the review seating area. Positions mounted higher than 10° should be avoided to allow adequate separation between the height channels.

3.4 Wide or 'Proscenium' Speakers

In the AuroMax 26.1 playback configuration, four additional speakers are installed on the side walls in the area between the screen and the first regular Side Surround speakers. Preferably this should be in the middle of this area, but if this is not possible due to obstacles such as exit doors, they should be placed rather closer to the screen (but not obstructing the video projection).

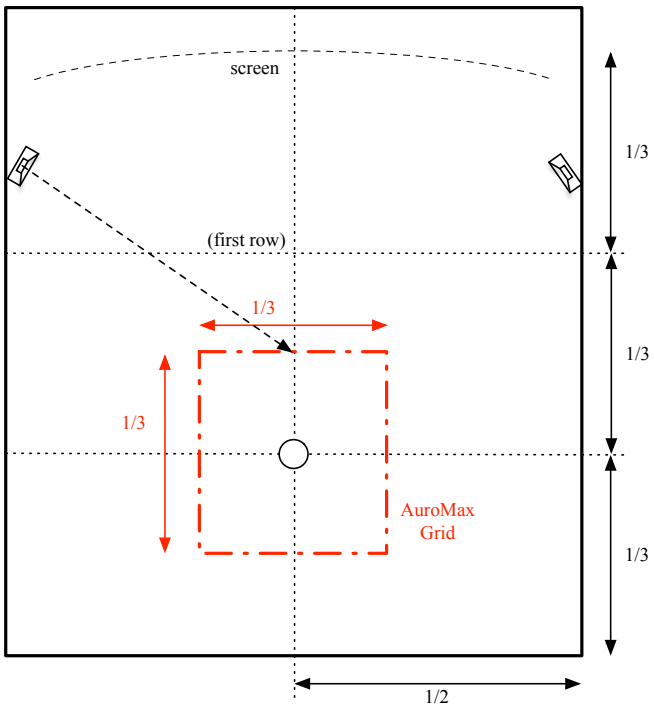


Figure 15 - Wide or Proscenium Speakers

These should be angled towards to middle of the front side of the AuroMax Grid.

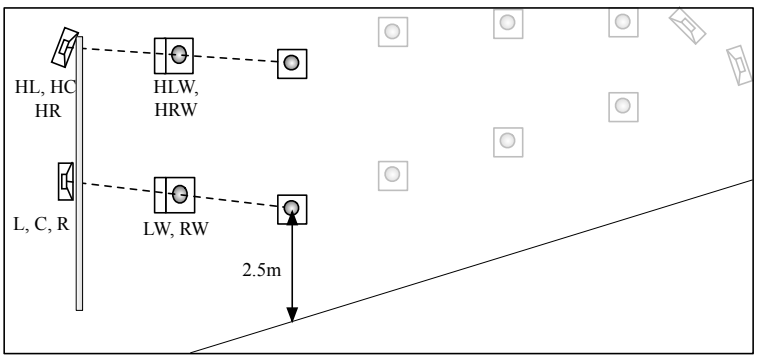


Figure 16 - Wide speakers elevation

For optimum performance the elevation of the lower Wide channels shall be the average of the lower Screen channels' and the frontmost lower Surround speakers' height. For safety reasons a minimum height of about 2.5m shall be maintained. For the Height Wide channels, the elevation shall be the average of the Height Screen channels' and the frontmost Height Surround speaker' height.

There shall be no objects or materials obstructing or interfering with the sound from these Wide channel speakers.

3.5 Top/Ceiling Channels

In most auditorium and mixing rooms, the use of multiple Top channel speakers shall be necessary to maintain an even spread of the sound in the auditorium and allow for adequate diffuse power coverage.

For small and medium-sized rooms, the use of 2 top channel speakers is recommended to minimize cancellation issues. These speakers shall be wired as one discrete channel but be aligned as a stereo pair (one per amp channel). For all other rooms, the total number of top speakers shall be equal to the number of speakers used in one of the side surround arrays (e.g. 4 side surround speakers → 4 top speakers (2x2)).

The speakers shall be mounted in two columns and be evenly spread on the ceiling of the auditorium to maximally enlarge the sweet spot and allow for the use of smaller, lightweight speakers.

The front most speakers shall be mounted at 1/3 of the distance between the first row of seats and the back wall, the backmost speakers at 2/3 this distance from the screen. Starting from the center line of the auditorium, the outermost speakers shall be mounted at 1/6 the width of the auditorium,

For theaters wider than 25m, a third row of speakers can be added in the middle of the auditorium to increase the power coverage.

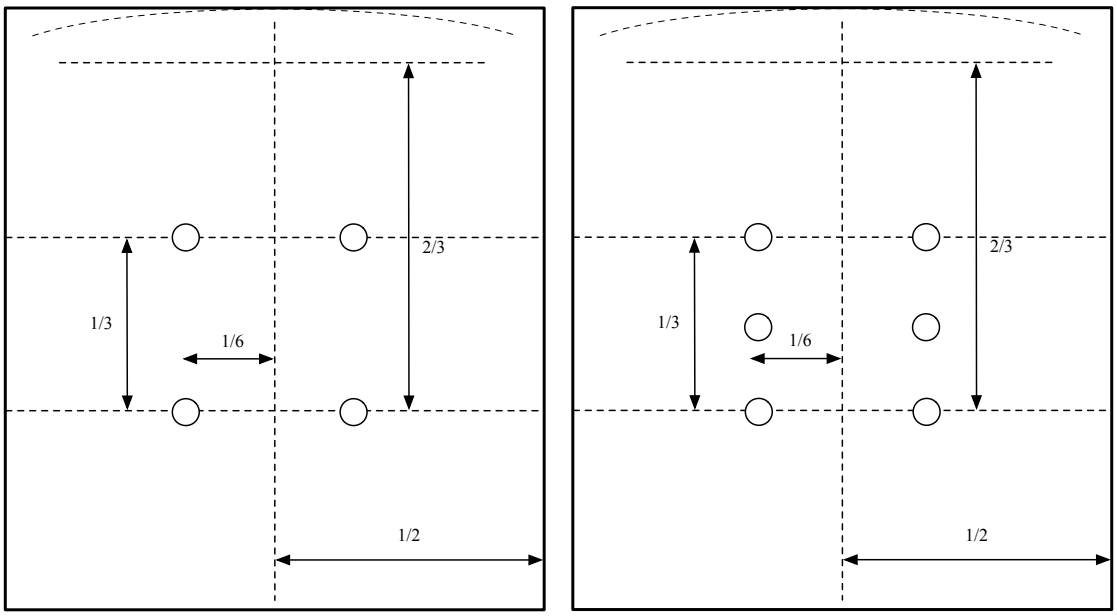


Figure 17 - Multiple Top channels in large rooms (top view)

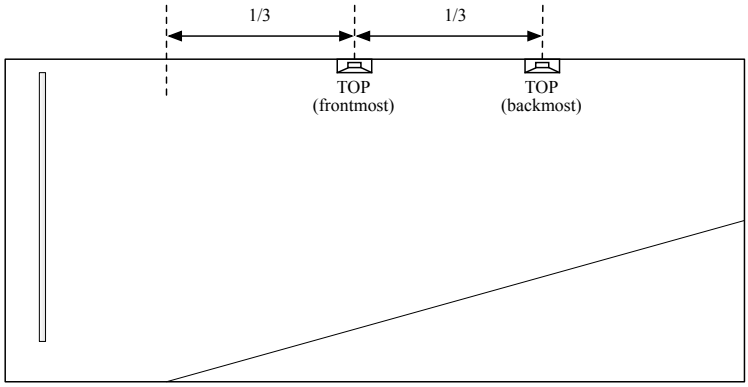


Figure 18 - Multiple top channels in large rooms (side view)

3.6 Subwoofer

The main subwoofers shall be mounted at the base of the screen, as close as possible to the wall/floor intersection.

Individual units shall be clustered together as tightly as possible in order to take maximum advantage of mutual coupling.

Bass Management is a mandatory element of the AuroMax playback configurations. The subwoofers used to reproduce the low frequencies of the Surround and Height Surround channels shall be mounted on the side and/or rear walls in such a way that the coherence with the mid and high frequencies of those signals is maintained at all time.

4 ELECTRICAL, MECHANICAL AND ACOUSTICAL REQUIREMENTS

4.1 Screen Channels

The screen channels shall be supported by at least a two-way speaker system. The Height channels should be of the same type of the (existing) lower screen channel systems so optimal timbre matching can be achieved

4.1.1 Electrical and acoustical requirements

- Frequency Response: 20Hz-19kHz ±3dB
- Power/Sensitivity: The speakers shall have a sensitivity of approx. 103 to 106dB/W/m.
- Headroom: Power handling capacity shall be appropriate for the given volume of the auditorium: 105dB-C SPL
- Dispersion Pattern:
    - Horizontal angle: 90° (-6dB; averaged from 400Hz to 12kHz)
    - Vertical angle: 50° averaged (-6dB; averaged from 400Hz to 12kHz)

4.2 Surround Channels

The side and rear surround channels shall be supported by at least a two-way speaker system. The Height channels should be of the same type of the (existing) lower Surround channel systems so optimal timbre matching can be achieved

4.2.1 Electrical and acoustical requirements

- Frequency Response: 20Hz (75Hz minimum)-18kHz ±3dB
- Power/Sensitivity: The speakers shall have a sensitivity of approx. 95 to 97dB/W/m.
- Headroom: Power handling capacity shall be appropriate for the given volume of the auditorium.
    - Standard exhibition room: min. 99dB-C SPL per zone
    - Premium exhibition room: min. 105dB-C SPL per zone
    - Post-production room: min. 102dB-C SPL per zone
- Dispersion Pattern:
    - Horizontal angle: 100° averaged (-6dB; averaged from 400Hz to 12kHz)
    - Vertical angle: 80° averaged (-6dB; averaged from 400Hz to 12kHz)

4.3 Wide ('Proscenium') Channels

The Wide channels shall be supported by at least a two-way speaker system. The lower and Height Wide channels should be of the same type of the (existing) Screen channel systems so optimal timbre and level matching can be achieved

4.3.1 Electrical and acoustical requirements

- Frequency Response: 20Hz-19kHz ±3dB
- Power/Sensitivity: The speakers shall have a sensitivity of approx. 103 to 106dB/W/m.
- Headroom: Power handling capacity shall be appropriate for the given volume of the auditorium.
    - Standard exhibition room: min. 99dB-C SPL
    - Premium exhibition room: min. 105dB-C SPL
    - Post-production room: min. 102dB-C SPL
- Dispersion Pattern:
    - Horizontal angle: 90° (-6dB; averaged from 400Hz to 12kHz)
    - Vertical angle: 50° averaged (-6dB; averaged from 400Hz to 12kHz)

4.4 Ceiling Channels

4.4.1 Electrical and acoustical requirements

- Frequency Response: 20Hz (75Hz minimum)-18kHz ±3dB
- Power/Sensitivity: The speakers shall have a sensitivity of approx. 91 to 95dB/W/m.
- Headroom: Power handling capacity shall be appropriate for the given volume of the auditorium.
    - Standard exhibition room: min. 99dB-C SPL per zone/speaker*
    - Premium exhibition room: min. 105dB-C SPL per zone/speaker*
    - Post-production room: min. 102dB-C SPL per zone/speaker*

    (*: in AuroMax, Top zones can consist of a single speaker)
- Dispersion Pattern:
    - Horizontal angle: 90° averaged (-6dB; averaged from 400Hz to 12kHz)
    - Vertical angle: 90° averaged (-6dB; averaged from 400Hz to 12kHz)

4.4.2 Mechanical requirements

The ceiling speakers must not exceed ~35kg and include sufficient mechanical mounts to support secure mounting with safety connections and meet UL 1480 (commercial/professional use) and UL 2043 (air handling spaces) requirements.

The ceiling speakers must also support a mechanism that allows them to be easily serviced.

4.5 Subwoofer(s)

4.5.1 Electrical and acoustical requirements

Frequency Response: 20Hz-150Hz (-10dB at 25Hz)

Power/Sensitivity: The speakers shall have a sensitivity of approx. 105dB/W/m. They shall have a power handling capacity appropriate for the given volume of the auditorium.

5 CALIBRATION

5.1 Auro 11.1 / Auro 13.1

All channels shall be calibrated to ISO2969 specifications.

Essentially this is specified as measured at 85dB-C at reference level for the screen channels and Top channel (VoG) and 82dB-C for the surround channels using Pink Noise at -20dBFs (SMPTE ST-2095-1). The channels should be equalized to achieve X-Curve electro-acoustical response characteristics. All channels must maintain 20dB (±2dB) of headroom above reference levels.

#	Abbr.	Ref Level (dB-C)
1	L	85
2	R	85
3	C	85
4	LFE	89~91
5	Ls	82
6	Rs	82
7	LB	82
8	RB	82
9	HL	85
10	HR	85
11	HC	85
12	T	85 (2 x 82)
13	HLs	82
14	HRs	82

Note that in case 4 or more speakers are used for the Top channel (Voice of God), the levels of each column (Left and Right column of speakers) should be aligned to reach 82dB-C. Combined this will then give 85dB-C.

In case some of the height speakers are mounted on the ceiling, resulting in a placement closer to the main seating position than the wall-mounted speakers, separate level and time alignment compensation should be considered to maintain equal loudness across the theater.

In a theater equipped for Auro 13.1 playback, the alignment table above should guarantee compatibility with standard 5.1 Surround, 6.1, 7.1 as well as Auro 11.1.

5.2 AuroMax

For AuroMax playback, all screen channels and each Surround zone shall be calibrated at **85dB-C** at reference level using Pink Noise at -20dBFs (SMPTE ST-2095-1).

Calibration must be performed by measuring in multiple locations in the room. Screen channels, Wide speakers and Top and Surround zones near the rear of the room shall be measured in the PLP. However, the levels of the frontmost Surround and Top zones shall be measured in a location corresponding to the middle of the front edge of the AuroMax Grid (indicated as (p) in Figure 6).

All channels and zones must maintain a sufficient amount of headroom above these reference levels (see chapter 4). Note that for the Surround zones the headroom per speaker will vary depending on the number of speakers in a zone.

6 BASS MANAGEMENT

For systems using Surround and Height speakers with limited low frequency response, a Bass Managing system should be installed to faithfully extend the total response of the reproduction system.

6.1 Bass Management Configuration

The frequencies below the cross-over frequency of the Bass Management system should be summed with the LFE signal and routed towards the subwoofers. The signals can be distributed over multiple subwoofers, e.g. one at each side in the back of the auditorium.

The signal flow then looks as follows:

Ls, LB, HLs and T (-4.5dB) go to Room SUB Ls

Rs, RB, HRs and T(-4.5dB) go to Room SUB Rs

If the Height Screen channels need Bass Management as well, they still need to by routed to the Main Subwoofer.

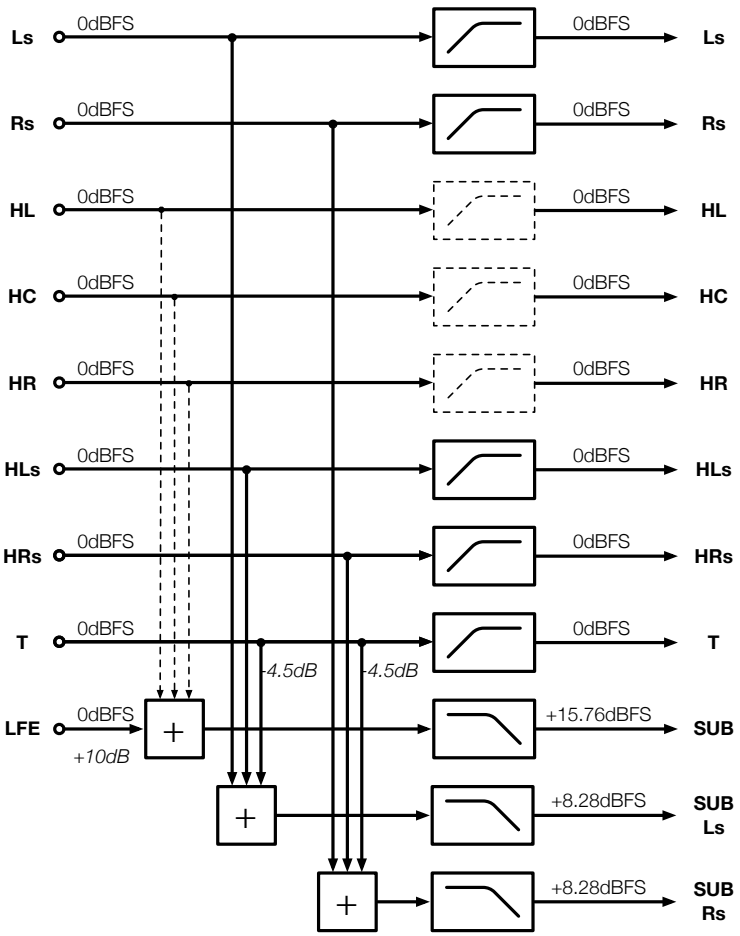


Figure 19 - Bass Management with multiple subwoofers (optionally for Front Height channels)

To avoid overload in the subwoofer channels, make sure there is sufficient power to handle to sum of all these channels.

The additional subwoofers in the room (SUB Ls/SUB Rs) can then be smaller, requiring less headroom to handle the total power of the summed signals. They should also be positioned asymmetrically along the theater length (i.e. not at the same distance from the Screen).

Alternatively, if no additional subwoofers can be installed in the theater, the low-frequency content can also be added to the subwoofers in the front of the theater.

Mind that this subwoofer channel will require a lot more headroom to handle the sum of all the signals.

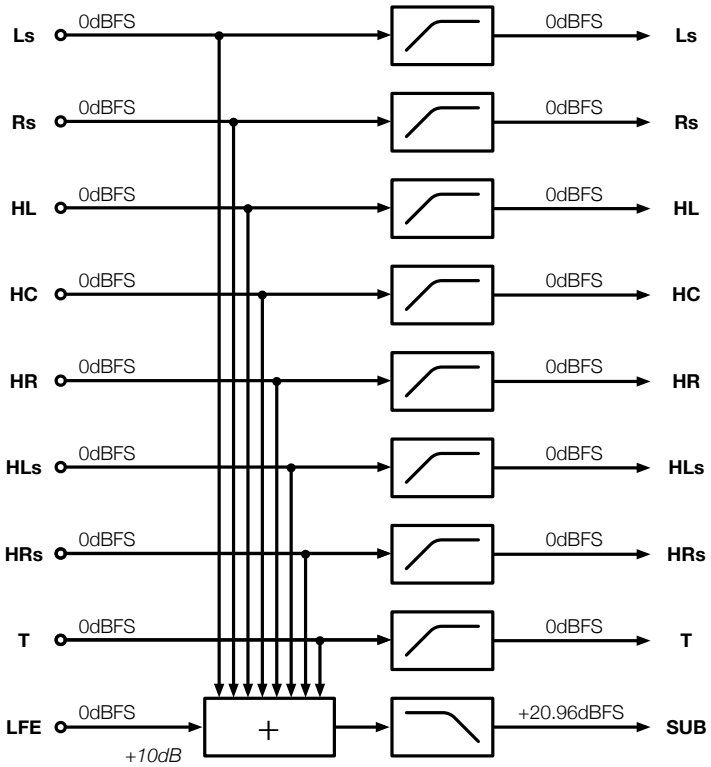


Figure 20 - Bass management on all channels except Main Screen channels, using a single Subwoofer channel

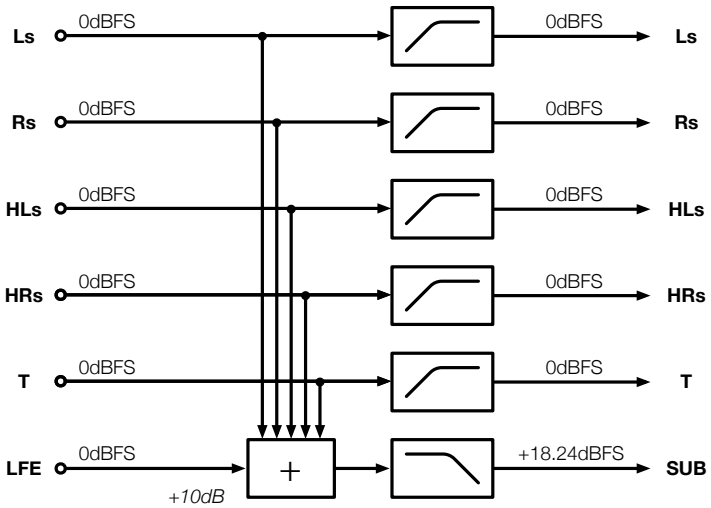


Figure 21- Bass Management on Surround and Height Surround channels, using a single Subwoofer channel

6.2 Cross-over frequency

The cross-over frequency for the Bass Management system should be between 40Hz and 100Hz, depending on the capabilities of the selected speakers.