



COMBINED AURO-3D AND DOLBY ATMOS SETUP

Guidelines and Background

Rev.: 4, Date: 2016 Feb 19

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1 INTRODUCTION

With the advent of multiple '3D Sound' or 'Immersive Sound' systems, such as Auro-3D, Dolby Atmos, DTS:X and MPEG-H, consumers are provided with a new dimension in listening experiences. Each proponent uses their own technologies to provide this experience though the introduction of dedicated Height-channels with or without the use of object-based audio technologies.

Although the differences in technologies and distribution methods can be solved through various software and hardware solutions, one major obstacle can only be implemented by the customer: the speaker setup.

DTS:X and MPEG-H are fairly neutral and have no real recommendations, other than that they intend to support the ITU-standardized playback formats. At first sight, this approach provides more freedom, but this approach in fact gives the creators of the content no guarantee that the consumer will hear it as intended and visa versa, the consumer cannot be sure about what was intended. Additionally, it is hard to do quality checks when no real recommendations are provided.

However, both Auro-3D and Dolby are very concerned about the preservation of the artistic intent and offer an end-to-end solution with very specific guidelines on how to setup the speakers for their specific systems. In an ideal world these configurations would be 100% compatible and interchangeable; in reality, however, there are quite some important differences, especially in how the Height and Top channels need to be installed, making it hard for content creators and users alike to build a single speaker setup that falls within the requirements of both Auro-3D and Dolby Atmos.

In this document, we attempt to give guidelines for a combined setup, based on some psycho-acoustical principles, as well as practical experience in the field. Three distinct options will be provided, ranging from full compatibility with the Auro-3D specifications to a compromised setup that tries to give the best of both worlds.

2 PRINCIPLES BEHIND THE AURO-3D SPEAKERS LAYOUT

The Auro-3D speaker layouts were specifically developed with the aim to provide the most life-like Immersive Sound experience (Quality) as intended by the creators and in the most practical and economical way (Efficiency) everywhere.

The combination of the speaker layouts and Auro-3D's unique technology offers a scalable solution (Auro 8.0 up to Auro 13.1) consistently delivering the same immersive experience as intended by the creators to all consumers. The AuroMax system adds object-based technology and builds further upon the same speaker layouts (typically starting from Auro 22.1 or Auro 26.1).

"The closer to natural sound, the more immersive is the sound experience"

(Anno 2006 AES Convention Paris/San Francisco by Wilfried Van Baelen, inventor of the Auro-3D speaker layouts).

But more speakers doesn't imply that the sound reproduction will be more natural or more immersive. Every additional channel or speaker has its impact, not only in the setup but also in the workflow and distribution (bandwidth etc). Multiple parameters need to be balanced to deliver the best immersive sound quality as efficiently as possible.

In the following chapters, a short introduction to Immersive Sound will be given.

2.1 Immersive Sound

Immersive Sound is often simply translated as 'Surround Sound with Height'. Although technically correct, it should be noted that there is much more to it.

Surround Sound formats are in practice only 2-dimensional, positioned in the horizontal plane around the listener and allowing sound to be produced from left to right and from front to back. Immersive Sound formats thus add the third dimension, allowing sound to be also produced from top to bottom.

Auro-3D® was the first format capable of reproducing a 3D space, with a complete end-to-end solution for all markets,. The added experience brought by the addition of this third dimension can be much closer to what is experienced in real life and is the result of the combination of a number of elements. The most obvious elements is that sounds we expect to come from above now also do so (e.g. bird in a tree, airplane flying over...). However, perhaps less intuitively understandable, but nevertheless more important, is that an Immersive Sound system can also capture and reproduce the many '3D reflections' of those sounds, building a natural-sounding sound field as we experience it in real-life.

The majority of real-life sound consists of 3D reflections that are crucial for our brain to analyse the sound field. Many agree that 'timbre' or 'tone color' is the dominant parameter in the reproduction of natural sound and that those reflections are a crucial contributor for this. The speaker layouts as defined in the Auro-3D® format, are capable of reproducing

those 3D reflections, creating “a coherent, vertical stereo field around the listener”, which allows for more depth, transparency and definition of the source localizations.

The method to reproduce the sounds in this 3-dimensional environment can be technically very different: *channel-based*, such as the original Auro-3D formats, *object-based*, such as Dolby Atmos, or DTS:X and the upcoming AuroMax format in Cinema, or even *scene-based*, using Ambisonics, one of the techniques used in MPEG-H (which also provides channel- and object-based audio delivery). It is clear that the final experience counts, not what technique was used to achieve this experience (contrary to what a lot of marketing would like you to believe).

All methods are usable to reproduce the individual sound sources in the 3D environment. It is claimed that object-based systems are best positioned to fulfil this tasks, thanks to their independency of the final reproduction system. This might be true to some extent, but depending on the installed speaker system. However, when playing back the same sound scene on the same speaker system, very little difference will be observed between the different systems, if any at all.

However, with a carefully chosen speaker layout, a channel-based system is more suited to capture and reproduce the crucial information that makes up the complete natural sound field, including information about the original recording environment (room), size and distance of the sources and many more elements. This is why all object-based audio systems also include a channel-based component, often referred to as the ‘bed’, carrying this crucial information, next to the objects which often only carry the direct sound of the elements (often as mono-objects). Dolby Atmos home has a 7.1 surround sound bed (2D) while Auro-3D® is the only Immersive Sound format on the market that can reproduce a true 3D space with channel-based (beds) audio only, providing a consistent experience on all Auro-3D playback systems everywhere.

2.2 Reproduction of a 3D space

2.2.1 Human hearing

Throughout evolution, human hearing has evolved with an emphasis on the horizontal plane at ear level. Using the two ears at either side of the head, various cues are used to detect the position of the sound sources (Inter-aural Level Differences (ILD), Inter-aural Time Differences (ITD) and Spectral Information). Ideally, a real sound source is placed at every conceivable position a sound can be originating from. Clearly not a feasible option.

However, thanks to various psycho-acoustical effects, the human brain is able to interpret audio signals reproduced speakers in a way that allows sounds to appear coming from directions in between those speakers (the so-called ‘phantom’ sources, allowing us to hear a sound originating from a location where no loudspeaker is installed). This stereophonic effect works extremely well in the frontal horizontal plane (thanks to the ears at either side of the head), but much less so in the lateral plane (no ears on front or back of the head) and not at all in the vertical direction (because there is no ear on top of the head to capture the vertical time and level differences). This is why regular stereo already provides a nice-sounding experience in front of the listener, while 5.1 surround does not seem to add the same results from the sides.

Is sound coming from directly above key to an immersive sound experience?

Since there were not too many predators attacking human beings from above, the sensitivity for sounds from above is far less than for those originating at ear level. Next to this, not many source sounds or reflections come from directly above. As such, it can be understood that it does not make sense to limit the sound system's ability to only reproduce sounds coming from the top. That's why the difference between Auro 9.1 and Auro 10.1 (adding Auro-3D's third layer, the Top layer) is rarely making any difference in the immersive sound experience.

2.2.2 Vertical Coherence

Due to the lack of vertical precision in the human hearing system, it is not possible to experience 'phantom sources' between vertically spaced speakers in the same way as can be perceived in the horizontal plane.

A typical stereo setup places the two speakers at 60°. Despite its limitation to only position sounds between the speakers, it is still capable of reproducing a feeling of "depth" from recordings using time differences. The experience of "depth" is a psycho-acoustic result of a "horizontal coherent stereo field", which is also further extended in a Surround setup.

However, this does not work in the same way in the vertical plane. Various tests have shown that the coherence in the vertical axis falls apart when the angle between 2 vertically placed speakers exceeds 30° to 35°. The two speakers become audible as two distinct sources, which is a very unnatural experience. Subconsciously, it feels like an effect instead of delivering a natural immersive experience.

Most source sounds and their 3D reflections originate from around ear-level up to about 30° elevation. This is not only in nature but also in small and large rooms such as churches. The Ceiling or "Voice of God" channel is therefore less important than Auro-3D's unique Height layer to achieve a natural immersive sound. Once 3D reflections are reproduced by the Ceiling channel (Top or Voice of God channel) only, it actually starts sounding very unnatural.

The combination of Auro-3D's Surround layer and its unique Height layer creates a "*vertical stereo field*" all around the listener, capable of reproducing a natural coherent sound field in the horizontal AND vertical axis. The resulting immersive sound field can then be achieved with native source material (ambiances, classical music etc) as well as when using the Height layer in a more creative way, spreading the sounds between Surround and Height layer. This not only provides more transparency, but also creates a higher emotional impact since real sound in 3D, with a coherent sound field in all directions as reproduced by Auro-3D, allows our brain to focus on the content instead of on 'interpreting' the signals. Listening to Auro-3D thus becomes more relaxing than listening to Stereo or Surround.

2.2.3 Number and positions of speakers

When defining a speaker configuration for Immersive Sound, it is important to take all these elements into account. This is exactly what happened when defining the Auro-3D compatible systems, starting from Auro 8.0

Various tests and studies have shown that at least a cube, using quadraphonic Height layer on top of a quadraphonic ear-level layer, is needed to reproduce a convincing 3D space (cube) . The Top or Height layer needs to be positioned with approximately 30° elevation to achieve a consistent sound field and avoid that the different layers become too distinct, reducing the naturalness of the experience (see 2.2.2)

As a result, all Auro-3D speaker setups include this important Height layer, capable of reproducing the vertical stereo field all around the listener. As part of the foundation of the format they are as such also defined as channels in all Auro-3D formats, allowing for easy-to-produce and predictable, consistent results during the reproduction.

In cinema, Dolby Atmos provides only 2 such channels, which are then positioned directly above the listening area. This has two effects: a) overhead channels cannot contain the all-important reflections that define a truly, natural 3D sound field and b) the distance with the Surround layer becomes too big (ca 45°-60° elevation), eliminating the vertical stereo-effect. As a consequence, these channels become 'detached', greatly reducing their ability to reproduce natural sound, especially with ambiance-rich content such as sports events or music. In the Home version of Atmos, the Top channels are even limited to be used for rendering of objects (or object-clusters) only, reducing the possibilities for natural, life-like sound even further since a real Immersive Sound field can not be achieved with a 2D Surround bed combined with distinctly placed sounds in 3D.

All Auro-3D speaker setups, from Auro 8.0 up to Auro 13.1 and AuroMax 26.1, contain at least the 4 Height speakers that are crucial to reproduce a natural-sounding immersive and true 3D sound field, delivering a consistent and compatible experience with all Auro-3D content. The additional speakers, including the third layer above the listener (the Top), are useful to maintain the optimum experience as the room grows.

Dolby Atmos, however, starts with 5.1.2, using only 2 Top speakers placed above the listener, with limited added experience as it is not able to fully reproduce a real 3D space. The experience when playing back the same content over the various setups, from 5.1.2 to to 5.1.4, 7.1.2, 7.1.4, etc... can therefore vary dramatically and leaves content makers as such with a more 'unpredictable' result..

2.2.4 Screen channels

With a good Immersive Sound system, it should also be possible to create better positioning in front of the listener, often linked to what is happening on the screen. Since most of the sound is coming from the screen channels and not from the Surround channels, delivering the best screen sound became one of Auro-3D's priorities. The Front Height channels of the Auro-3D speaker layouts, also referred to as the Height Screen channels, allow sounds to be positioned over the whole area of the screen, including on the vertical axis, providing a better visual-auditory coherence. For installations with large screen, Auro-

3D setups using a Height Center speaker (e.g. Auro 11.1) are recommended, which then provide 6 screen channels, distributed over 2 layers covering the whole screen.

Thanks to the marketing behind object-based audio, many people think that better positioning of sounds on the screen and in the room is the most important factor of an immersive experience. However, studies have shown that tone color or timbre is actually the dominant element in the perception of natural sound. This is the main advantage of using Auro-3D screen channel setup, which creates more depth and transparency and an overall much more natural sound for all kinds of applications (music, movies, games, sports events, etc.).

In contrast, Dolby Atmos uses only a single layer of 3 channels behind the screen. For extremely large screens, 2 optional speakers can be added that are not part of the channel-based 'beds' but only used for object-based sounds. This single line of speakers not only reduces the better on-screen placement, but also creates a larger gap between the screen channels and the overhead speakers, reducing the coherence of the sound field to a large extent.

2.2.5 An efficient system

From information theory it can be shown that more than 400,000 speakers would be required to faithfully reproduce a 3D sound field in an area with a diameter of about 2 meters, as is also opined by well-known researchers such as M. Gerzon and T. Holman (THX). The art thus becomes to create an illusion that is as natural as possible with the minimum amount of speakers, related to the size and shape of a room. The goal of the

Auro-3D format is to always offer the best immersive sound experience with the minimum amount of speakers.

Thanks to the stereophonic effect, it is fortunately possible to create convincing approximations with far less speakers. This works best in front of the listener, but less so to the sides and in the back.

5.1 Surround systems typically suffer from such 'holes' at the side, creating a feeling of separation between the sound in the front and the back of the listener. The introduction of the separated Side and Back speakers in 7.1 Surround was an attempt in

solving this, but was not always successful, due to the practical implications of such a setup.

With the introduction of the Height layer, this phenomenon is greatly reduced as the additional reflections coming from above already help the brain to better understand the positioning without the need of the additional speakers. As such, Auro 9.1 is based on the standard 5.1 Surround setup (acc. to ITU-R BS.775) and is considered the most practical and economical way to provide a true 3D sound reproduction without the typical artefacts mentioned above.

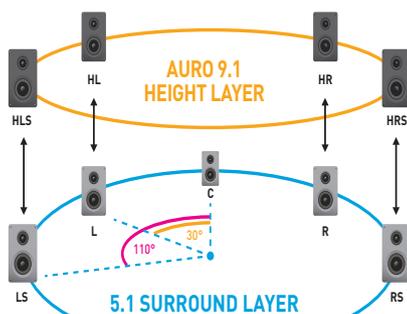
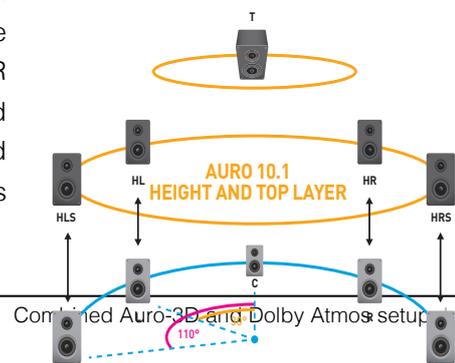


Figure 1 - Auro 9.1 Speaker Setup



For larger rooms, the addition of the third Top layer (also known as ‘Voice of God’ channel), completes the full hemisphere. Auro 10.1 is therefore the most efficient setup with 3 layers, while still providing compatibility with 5.1 Surround.

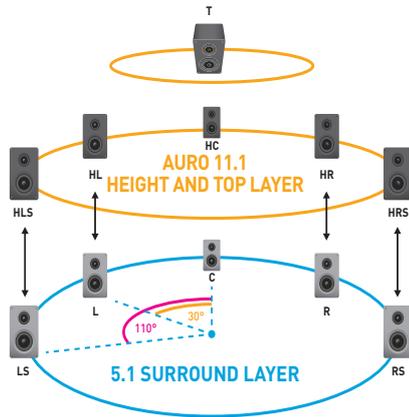


Figure 3 - Auro 11.1 Speaker Setup

Auro 11.1 has become the preferred choice for Cinema Theaters. The use of large screens in combination with the 6th screen channel, the Height Center channel, then provides the most natural on-screen positioning and vertical spread. Home Cinema systems using this system then become the most practical system with full compatibility with movies produced in Auro 11.1.

In those case where compatibility with 7.1 Surround is requested, Auro-3D provides a 2-layer setup, Auro 11.1 (7.1+4), as well as a full 3-layer setup, Auro 13.1 (7.1+5+1)

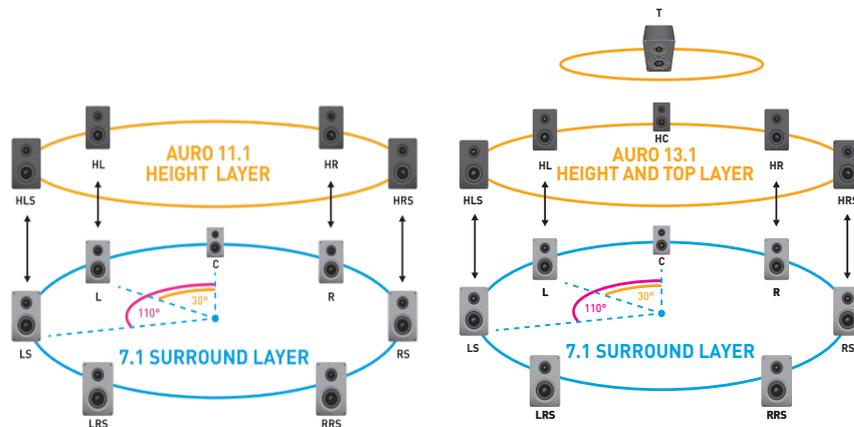


Figure 2 - Auro 11.1 (7.1+4) and Auro 13.1 (7.1+5+1) Speaker Setups

While Dolby Atmos provides speaker setups based on 5.1 and 7.1 surround, the positioning of the overhead speakers varies greatly, only provides two layers (missing the crucial Height layer) and cannot reproduce a cohesive sound field due to the overhead placement only.

2.2.6 Cross-market compatibility

The Auro-3D Systems have been designed to provide consistency between all markets, from large cinema theaters to home theaters and even cars. This ensures that content creators can be confident that what is heard by the listener, is what was heard during the production. This preservation of the artistic intent is a key element of the Auro-3D format.

The difference between Dolby Atmos installations in cinema and at home, however, are a lot bigger, often requiring mixing engineers to adjust the mix when producing the home version. One of the reasons is the difference in elevation of the Surround layers: in cinema this is much higher (25°-35°) than at home (0°-10°), whereas for Auro the elevation is kept as close to the standard as possible (ca 15°). Auro-3D systems are therefore capable of reproducing ear-level sounds in a much more natural way than Atmos for cinema system, which is reflected in the content as well.

Another reason is the placement of the Atmos ceiling speakers, which are closer to each other in the cinema, than at home. While not a problem for discrete sounds, this can change the spatial experience from ambiances (with reflections) dramatically.

As mentioned earlier, all these issues are not present in the Auro-3D configurations, thanks to the 3-layer concept and cross-market compatibility.

The use of object-based technology mainly promises better localization of some “objects”. To achieve that, more speakers need to be installed as individually driven channels. Using a 7.1 Surround layer will not enhance the accuracy of some sound elements using object-based technology compared to a 7.1 Surround channel-based system. To experience any difference in the accuracy of those objects more speakers need to be added in that horizontal layer. The difference in elevation between installations for cinemas and home theaters also influences this positioning accuracy.

During the development of the Auro-3D formats, a conscious choice was made for speaker layouts with full cross-market compatibility, providing a scalable solution while maximally preserving the artistic intent.

The Auro-3D formats maximize the 3D immersive sound experience with channel-based content (scaling from Auro 9.1 with 2 layers up to Auro 13.1 with 3 layers), making the experience more consistent on each Auro-3D playback system.

In contrast, competing formats only use a 2D format as channel-based foundation and solely rely on object-based technology to create the third dimension with mostly mono or stereo objects, lacking in crucial 3D reflections and leading to a less natural sounding experience.

(Auro-3D’s approach also has many advantages in the existing production workflow where Auro-3D is the only immersive sound format on the market that can maintain the mastering process, a crucial part of the workflow in pop-music. Due to limitations in the rendering process, this mastering process cannot be performed in object-based formats.)

3 COMBINING AURO-3D AND DOLBY ATMOS

In the previous chapters it has been shown that good Immersive Sound is not only created with discrete sounds coming from above the listener, but rather requires crucial ambient information provided by reflections from all around the listener. It has also been shown that this information cannot be reproduced by overhead speakers alone, but that it is best reproduced by a Height layer at 30° elevation, which is then also capable of providing better imaging in the vertical direction, especially when combined with the third, Top layer.

All Auro-3D speaker configurations provide the necessary channels to faithfully reproduce this information, whereas the Dolby Atmos layouts lack the Height layer and are therefore limited in their capabilities to reproducing reflections from above, which is not natural.

Thanks to these crucial properties, various experiments performed by users and experts have lead to a conclusion that *“Auro-3D content played back over the Atmos speaker layouts does not sound good at all and is too far away from the artistic intent while Atmos played back over Auro-3D speaker layouts typically sound very good”* (feedback on social media). Some informal tests have even shown that, with various kinds of content, most of the Atmos content sounds even better over an Auro-3D speaker layout than over an Atmos speaker layout.

Auro-3D content typically contains a lot of ambient information (reflections) in the Height channels. This is especially true for music productions, but also for movies and games. When reproducing these ambient sounds from above the listener when played back on an Atmos layout, this starts to sound extremely unnatural, and is therefore not easily accepted by the audience.

Dolby Atmos content, however, creates height information using mostly discrete objects, often with a minimum amount of ambient information. When these sounds are played back over the Auro-3D Height layer, this still sounds very acceptable, even when the exact placement of the objects is not 100% as intended. Moreover, the Atmos system already inherently suffers from such differences, as the rendering to a 5.1.2 layout with only two overhead speakers will be vastly different from rendering to a 7.1.4 system.

Going further, the vastly reduced experience provided by the ‘Dolby-enabled’ speakers even further reduces the experience of a ‘real’ Atmos system, when compared to the results obtained by an Auro-3D system. As the Dolby-enabled speakers use a combination of reflected sound from the ceiling (which mathematically can come from only two positions above the listener) and psycho-acoustic processing to create a virtual Height experience, the actual listening experience is much further from what the artist intended than what can be delivered by playing Atmos content over an Auro-3D system.

The conclusion is therefore that, if a combined setup is required, it is advised to stay as close to an Auro-3D setup as possible, compromising on the Atmos specifications where needed. This not only ensures the best possible listening experience, but also provides compatibility with other systems, such as standardized by ITU and used by MPEG-H and DTS:X.

4 IN PRACTICE

In this chapter, three different configurations will be described. Each configuration is based on the Auro-3D speaker layouts, but introduces some compromises to allow for better compatibility with Dolby Atmos.

All configurations introduce the use of the **Height layer**, which is crucial to provide the best possible Immersive Sound from your setup. Thanks to the placement above the Surround speakers and the possibility to use wall-mount speakers, this is often much more practical than the use of ceiling speakers.

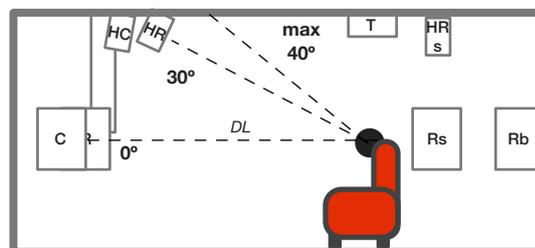
For the full Auro-3D specification, please refer to the **Auro-3D Home Theater Setup Guidelines** on the Auro-3D website..

4.1.1 Front Height

It is NOT recommended to use the Dolby Atmos Top Front ceiling speakers as Front Height speakers for Auro-3D. This would introduce two problems:

1. the Front Height speakers are positioned too far into the room, breaking the coherence with the lower Front speakers and screen, as well as coming too close to the listener, changing the timbral character of the sound (see 2.2.2 - Vertical Coherence).
2. The Front Height speakers become too close to each other (and are not in line with the ear-level Left and Right Front channels) reducing the ability to create a wide horizontal spread in the Height layer, reducing the immersive experience even further.

It is therefore recommended to keep the Front Height speakers as close to the specifications for Auro-3D as possible, preferably above the lower Front speakers and above the screen. If the setup needs to be closer to the Dolby requirements, bringing the speakers closer towards the listening position while mounted on the ceiling is possible, preferably at 30° elevation, but not exceeding an elevation angle of 35°.



When positioning the Front Height speakers on the ceiling, slightly closer to the listening position, it is important to make sure the direct distance to the Front Height speaker does not become smaller than 80% of the distance from the lower Front speakers (e.g. if the distance to the Front is 3m, the Front Height speakers should not be closer than 2.4m).

Auro-3D Compatibility Level	Front Height Position
Level I (preferred)	Elevation: Typ: 30°; min: 20°; max: 35°; positioned above lower Front speakers or behind screen; not in front of screen
Level II	Elevation: Typ 30°; positioned on ceiling; slightly closer to listening position in front of screen (not closer than 80% of distance DL with lower Front speakers)
Level III (NOT recommended)	Elevation: Typ 30°; max: 40°; positioned on ceiling; closer to listening position.

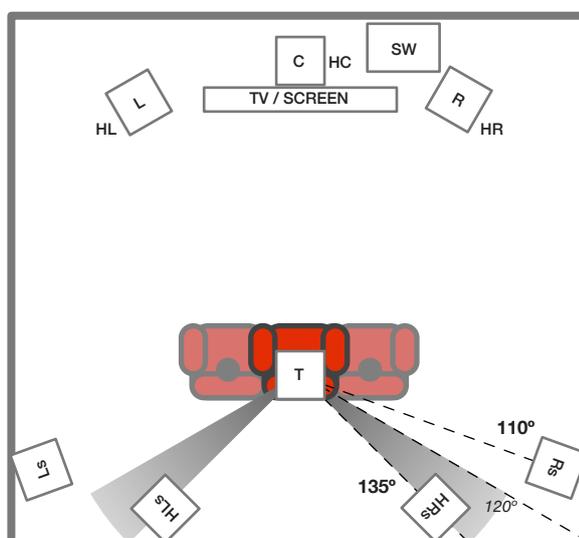
4.1.2 Rear Height

Combining the Auro-3D Rear Height speakers and Atmos Top Rear speakers is the most difficult. The Auro-3D speakers are normally positioned at an azimuth of 110° and an elevation of 30°m, while the Dolby Atmos speakers should be positioned in line with the Front Left/Right speakers and at an elevation of -45°. In most situations these positions are rather far away from each other.

The best solution is to install both sets of speakers and switching between the two setups for the different kinds of content.

If a single combination is required, it is recommended to position the Rear Height speakers at ca 135° azimuth (bringing them further to the back and closer to each other), with an elevation not exceeding 40°. This should bring the speakers somewhat half way the ideal positions of each system.

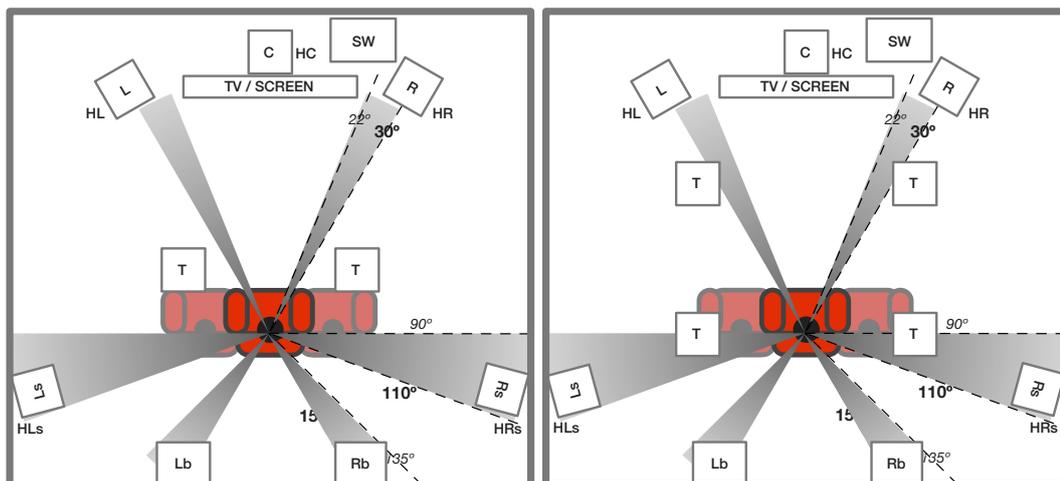
In that case it also better to position the Rear Surround speakers slightly further to the back (to ca. 110°)



Auro-3D Compatibility Level	Rear Height Position
Level I (preferred)	Azimuth: Typ: 110°; min 100°; max: 120° Elevation: Typ: 30°; min: 25°; max: 40°; positioned above lower Surround speakers
Level II	Azimuth: Typ: 110°; max: 120° Elevation: Typ: 30° positioned on ceiling; slightly closer to listening position (not closer than 80% of distance with lower Surround speakers); slightly closer to each other
Level III (NOT recommended)	Azimuth: Typ: 135° Elevation: Typ 30°; max: 40°; positioned on ceiling; closer to listening position and closer to each other

4.1.3 Top

When introducing the **Top layer**, two or four speakers can be positioned on the ceiling. Following the Atmos specifications for these speakers allows them to be used as Atmos overhead speakers, provided the amplification system allows for such routing.



Auro-3D Compatibility Level	Rear Height Position
Level I (preferred)	Elevation: Typ: ±30°; min: ±20°; max: ±40° 4 speakers spread equally above the listening area
Level II	Elevation: Typ: 90°; min: 60°; max: 120° 4 speakers positioned on ceiling; slightly further from listening position; slightly closer to each other
Level III (NOT recommended)	Elevation: Typ 90°; min: 60°; max: 120° 2 speakers positioned directly above the listening area

5 HOME VS. CINEMA - STANDARDS

Various standards and recommendations exist for the different applications of multi-channel sound in different environments such as cinema, broadcast and home use. The two most used recommendations are the ITU-R BS.775 standard for multi-channel sound from the International Telecommunications Union (an international standardization body) and the THX recommendations for cinema (a commercial organisation).

The ITU recommendation is the most used standard for 5.1 Surround Sound in broadcast and home cinema applications. One of the recommendations is to install the speakers of the Surround system at “ear-level” (typically between 90 and 120cm height). This has the big advantage that most sound sources (with their origin at ear level) can be reproduced as in real life. Sounds that move from the front channels to the surround channels (e.g. cars, bikes passing by, etc..) can be positioned where we expect them. A good audio-visual coherence allows for our brain to believe that the sound we experience relates to what is seen on screen., increasing the immersive experience.

In practice, regular 5.1 Surround systems suffer from a ‘hole’ between front and back speakers, due to the way the human hearing system works, making the sound jump from front to back. When adding a quadraphonic Height layer, like in Auro 9.1, this effect is dramatically reduced, eliminating the need for 7.1 surround as a basic layer in order to solve that issue. Installing a 7.1 Surround system is also not practical in most home cinemas, whereas 5.1 is much easier. There is also often place above the corner speakers of a 5.1 system to add Auro-3D’s unique Height Layer, making it a practical solution for real 3D Immersive Sound.

The THX 5.1 standard became famous in the professional cinema industry and was also adopted in high-end home cinemas. But there is a big difference between a sound system designed for a large theater with hundreds of seats and a system for a home theater with 10 to 20 seats. In order to create good dispersion of the sound in a cinema theater, the speakers need to be installed higher than ear-level (THX recommendation is based on a 15° elevation angle). The same is true for the screen channels although most of the source sounds at screen have their apparent origin below the middle of the screen.

This is not the case in a small room where sound can be equally spread across the room without the need of elevating the speakers that high. Installing the surrounds higher than ear-level might make sense for 5.1 or 7.1 Surround sound systems because not all sounds originate from ear-level and a compromise can be made by elevating them up to 15° as done in large theaters. But when installing additional layers to reproduce the Height information, it is much better to install the ear-level layer as defined in the ITU recommendations.

Dolby Atmos’ speaker installation for cinemas is not based on the existing THX 5.1 surround standard. The surround speakers are positioned substantially higher, much closer to each other and with completely different orientation towards approximately the middle of the room. This results in a different sound experience than coming from a standard 5.1 system.

All sounds seem to come from above since ear-level sounds cannot be experienced with speakers that are installed so high. The smaller distance between the surround speakers and their orientation towards a single sweet spot area is not only making this area smaller but also results in a less natural sound when reproducing the channel-based content (on average more than 85% of the sound energy in a Dolby Atmos mix) or a standard 5.1 Surround mix.

Dolby Atmos recommendations also position the speakers behind the screen higher ($2/3$ instead of $5/8$ in the THX recommendation) to improve horizontal alignment between the screen channels and the elevated surround channels. The background for this is that isolated objects should not 'jump' to different heights when moving in the horizontal plane around the audience.

The Auro-3D formats (including AuroMax) do not suffer from this problem since they use 2 layers on the walls instead of a single layer. Additionally, they are based on the existing 5.1 surround standard speaker layouts already installed in the room, not only behind the screen but also around the audience. This compatibility between professional and home cinemas also allows for a better translation of the cinema experience into the home. Taking in account that the home cinema is also used for other content than movies (games, music, live events, sports etc...) it really make sense to install the ear-level and height layers as defined by the Auro-3D format. They are easier to install and the overall result will be better for all kinds of content.

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