

# CEPro Advantage Series

Diagrammatic  
Guide to In-Ceiling  
Speaker Placement  
for Home Theater,  
Multiroom Audio



# CE Pro Advantage Series: Diagrammatic Guide to In-Ceiling Speaker Placement for Home Theater, Multiroom Audio

**E**very experienced designer and installer knows exactly where to place in-ceiling speakers to achieve the best possible sound. But sometimes the ideal positions are compromised based on room configurations, ceiling heights, stud locations, HVAC ducts or other challenges.

They say “a picture is worth a thousand words,” which is why this quick reference guide uses diagrams that technicians can quickly reference. This Advantage Series White Paper is a good tool for newbie installers as well as veterans to answer questions like:

- How far apart should in-ceiling speakers be placed in a distributed audio setup based on different ceiling heights?
- How far away from a wall-mounted flat panel should a center channel in-ceiling speaker be placed?
- How far should the spread be for an LCR configuration in a ceiling?
- How far apart should rear surrounds be placed in a 7.1 configuration?

# Diagrammatic Guide to In-Ceiling Speaker Placement for Home Theater, Multiroom Audio

**T**HIS QUICK REFERENCE DIAGRAMMATIC GUIDE OF WHERE TO PLACE IN-ceiling speakers for home theater and distributed audio applications--based on seating positions, room acoustics and ceiling height—is a quick reference for technicians and designers.

## Why In-Ceiling Speaker Placement is Important

In small rooms, dealers must remember that sound waves don't just pass by the listener, but they also bounce and reflect. Also, while some low frequencies get absorbed, some also get reflected or resonated back into the room. In most cases, rooms are too small to support low frequencies causing tonal and spatial distortion. This ends up masking the low-level resolution and limiting the dynamic range. Also, flutter echo due to parallel surfaces can be problems in small rooms also.

Thus, speaker location is important because it enables the accurate portrayal of a musical image and timbre. If speakers are located too closely to walls, it is possible that certain low frequencies will become exaggerated and these frequencies will be dictated by a room's dimensions. Conversely, if a listener is seated or walking in the voids between these speakers, he will have a hard time hearing the related frequency. Moreover, if speakers are placed too close to large surfaces, then mid- and high frequencies will reflect and interfere with the sound coming directly from the speakers.

Reflections off of large objects and walls cause the brain to miscalculate a sound's point of origination and even cause the brain to not even recognize what type of instrument is producing the sound.

Years ago before the rapid development of the home acoustics field, many music enthusiasts set their systems up by using the "golden triangle" rule, which said a listener's seat should be equidistant apart from his speakers.

That rule is still a good starting point today. If speakers are too close together in relation to the listener, it narrows the system's soundstage, while speakers that are placed too far apart aren't able to create a cohesive soundstage. Of course, all this depends on the specific speaker dispersion pattern, room acoustics and customer preferences.

Another setup rule is called “toe in.” Toeing in is a method in which speakers with directional tweeters are aimed in a manner to create a stereo image vs. pointing the speakers “straight ahead” for a more spacious soundstage. Toeing in ensures tonal and spatial balance, but the process to achieve these traits can often reduce the amount of treble reaching the listener’s ears. So in some cases, speakers with directional tweeters might need to be aimed either straight ahead or even 2 feet in front of the listener.

## Tools of the Trade

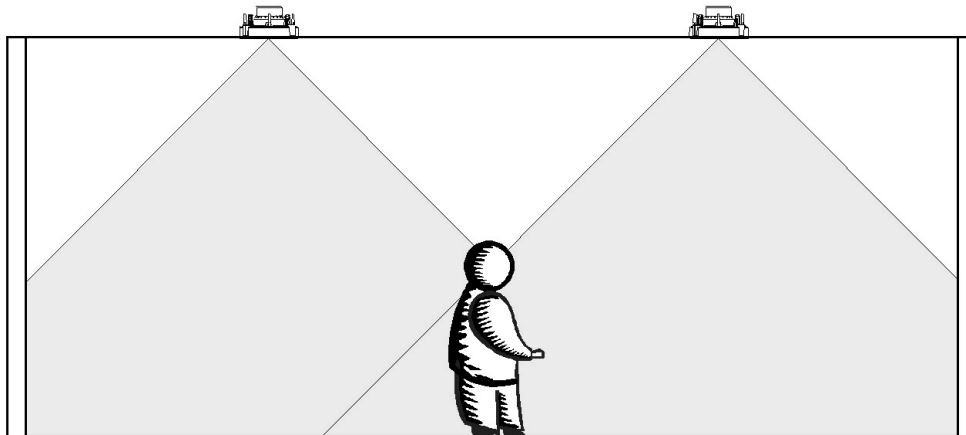
Technicians, of course, often need to use their ears to determine the listening sweet spot, but other tools that should be used include a sound pressure level (SPL) meter, a real-time analyzer (RTA), and advanced testing products such as Music Articulation Test Tone (MATT) equipment and Time Energy Frequency (TEF) equipment.

Acoustical engineer Norman Varney, founder and CEO of A/V Room Service, Ltd., uses the RTA set to a flat/slow 1/12th octave setting to establish a baseline for the subwoofer crossover and output, and an SPL meter (type 1) to match a system’s SPL readings to within 1dB or less. In addition, he also employs a proprietary software program he designed that estimates the placement of speakers and seating positions within a room to avoid room-mode issues.

“Once on site, I check the room for ‘squareness’ and I figure out where my center line is and use a tape measure to get me in the ball park for speaker/listener locations. I sometimes use the MATT equipment to assess the articulation between the speakers and the room, but typically I use familiar recordings. I want to establish optimal bass response before working on the mids and highs. I determine the listening position first and then move to the speakers. I mark with masking tape to play with fine tuning from inches to around ¼-inch. I use the TEF equipment to set up the time alignment of speaker drivers within a cabinet[s] to the client’s ear distance and height, when applicable.”

From there he begins the toe-in process by using white noise to get in the ball park for toe-in positioning before moving on to the arduous task of finalizing everything.

“I use a bubble level to level and plumb the speakers and a laser to match their toe-in within a fraction of an inch by aiming to the back of the room or some point well behind the listener. Most of these tasks interact with each other, and require going back and forth, starting with course movements at first and progressively becoming finer,” he warns.



**Distributed Audio Placement**

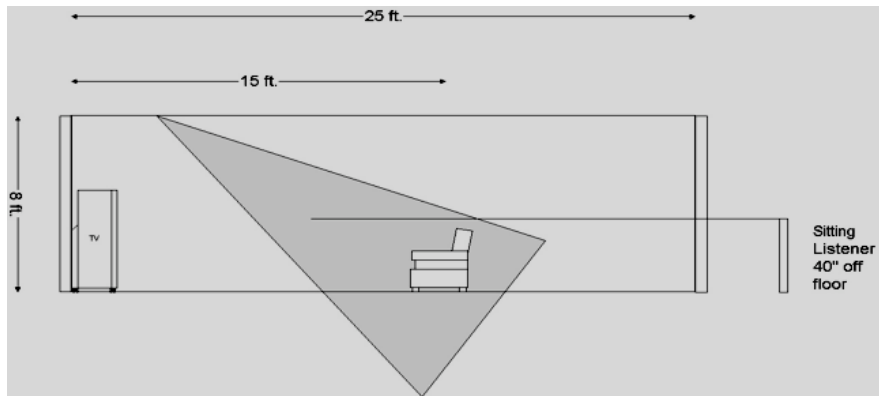
## Multiroom Audio In-Ceiling Speaker Placement

Remember that sound disperses from an in-ceiling speaker in a circular pattern. To avoid dead spots or “nulls” or sound volume differences, in-ceiling speakers need to be placed the proper distance apart so that the soundstage overlaps. A person moving throughout the zone should never have a sound gap. The overlap should occur precisely at the head height of the average person. Likewise, speakers placed too close together won’t image well in stereo and will waste money for the client because you will be installing more speakers than is necessary. Dealers should consult installation manuals for optimum spacing.

<b>Speaker spacing in feet for a distributed audio system</b>		
	<b>Standing Listener</b>	<b>Seated Listener</b>
<b>8 foot ceiling</b>	<b>5.7'</b>	<b>9.5'</b>
<b>10 foot ceiling</b>	<b>9.7'</b>	<b>13.5'</b>
<b>12 foot ceiling</b>	<b>13.7'</b>	<b>17.5'</b>
<b>14 foot ceiling</b>	<b>17.7'</b>	<b>21.5'</b>

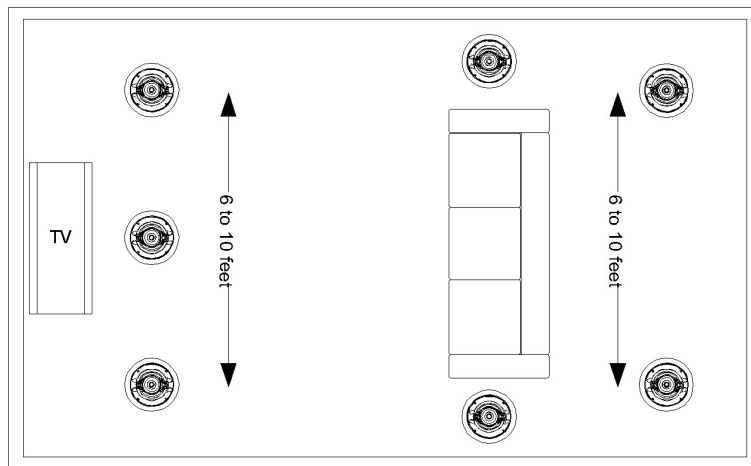
## Multiroom Audio Speaker Distance Spread Based on Ceiling Height

The circular sound dispersion of an in-ceiling speaker will vary based on the ceiling height. Here are some guidelines for the speaker spacing based on ceiling height and whether the listener is standing or seated in a distributed audio environment.



## In-Ceiling Soundstage for Home Theater

The most important speaker in a home theater environment is the center channel. Approximately 70 percent of all dialog in any movie comes from the center channel. That's why it is vitally important that the center channel emit directional as well as reflected sound to the listener. Here is a basic guideline for a listener seated 15 feet from the flat panel. The soundstage from the center channel should be wide enough to envelop the listeners' entire seated position.

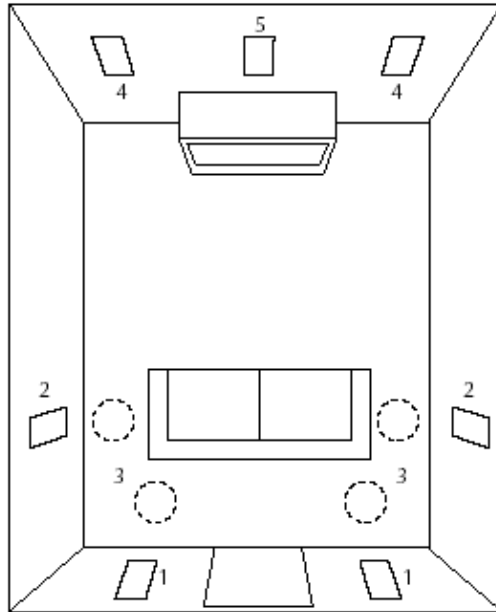


**Seven Channel Home Theater Placement**

## 7.1-Channel In-Ceiling Surround Sound Placement

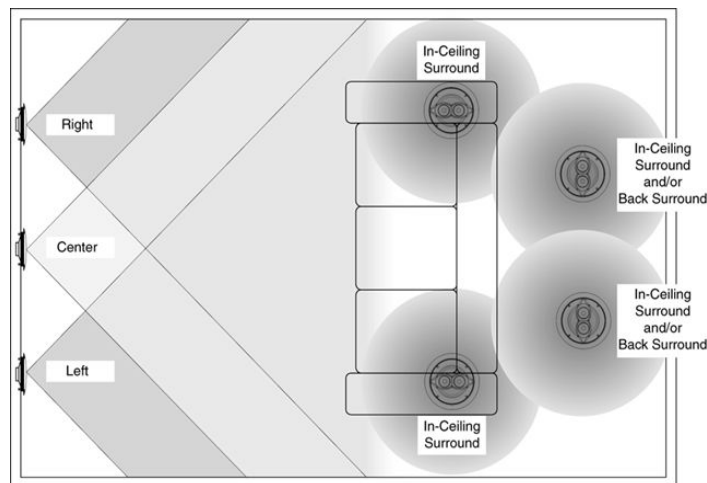
Since the center channel is where most of the dialog is coming from, the viewer/listener needs to perceive that audio is emitting from the flat panel, not from the ceiling. Note now the LCRs are placed away from the front wall where the TV is located. This is so the soundfield coming from the center channel will literally bounce off the flat panel toward the listener.

In a 7.1-channel setup, note the preferred spread of the LCR in-ceiling speakers between 6 to 10 feet. The side channel speakers should be located equal to the seating position but wider than both the left and right speakers, as well as wider than the rear surrounds. Meanwhile, the spacing spread for the rear surrounds should be equivalent to the spread of the LCRs.



## Mixing In-Ceilings with In-Walls in Home Theater

It is not uncommon for systems to mix in-wall speakers (especially as the LCRs) with in-ceiling (especially as the rear surrounds). Dealers should not necessarily shy away from this. Here is a quick diagram of what that might look like.



## Rear In-Ceiling Spacing

Note how the circular dispersion patterns for an in-ceiling 7.1 channel setup create a series of overlapping, yet distinct areas. Remember that a subwoofer can be placed anywhere in the room since bass signals are non-directional.

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