Live Sound Reinforcement Application Guide for PreSonus StudioLive™ AI-Series Loudspeakers

PreSonus CONTRACTOR

StudioLive™ AI-Series PA Applications Guide

STUDIOLIVE™ Active INTEGRATION TRADE MARK

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1. Overview

Studio monitors are designed to accurately reproduce music across a broad spectrum without signal loss or distortion but they can't handle the SPL demands and other necessities of a live show.

Conventional PA speakers can deliver plenty of volume but except for very high-end systems, they can't deliver the extremely clear, accurate sound one expects in a studio. As a result, a PA speaker that delivers studio-monitor quality has remained an unfulfilled fantasy—until now.

fulcrum ACOUSTIC®

This fantasy has, at last, become reality, thanks to a partnership between PreSonus and Fulcrum Acoustic's legendary engineer David Gunness (formerly of EAW and Electro-Voice).

Rather than take the usual brute-force approach to PA-speaker design, the team designed a coaxial loudspeaker that would employ Fulcrum's unique DSP-based approach.

The result is PreSonus StudioLive™ AI-series Active Integration Loudspeakers, the first affordable, active PA speaker systems that deliver studio-monitor accuracy—exceptionally clear, coherent sound—while supplying the features and protection systems required to mix a live show that sounds great in a wide variety of venues, with virtually any musical genre.

These features include wireless and wired control of all setup, tuning, and monitoring functions, using an iPad® or laptop.

The StudioLive AI series consists of three full-range systems and a subwoofer. All models are self powered and utilize onboard DSP.

StudioLive AI speakers have been custom tuned using Fulcrum Acoustics' Temporal Equalization™ algorithms. The internal phase, alignment and FIR filters are not individually user-adjustable; however, each loudspeaker offers different contours that adjust these parameters to customize your system for your application. Custom EQ, delay, and group functions can be applied on top of these contours via the User Preset and can be adjusted from within SL Control Room for iPad, Mac OS X, and Windows.

The Active Integration Difference

StudioLive Active Integration (AI) loudspeakers combine advanced DSP and networkability. The onboard 24-bit, 96 kHz processor operates at 350 MHz and features assimilated USB 2.0 and 100 Mb Ethernet connections.

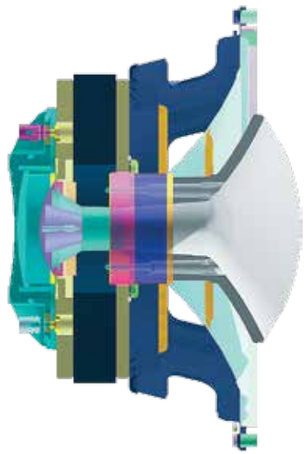
Because of this, AI loudspeakers can be directly wirelessly remote controlled by iOS devices and OS X or Windows computers when connected to the same wireless router network.

All AI products currently run a Linux kernel that allows support for the included USB wireless module, as well enabling the included Ethernet port to connect directly to a standard local area network (LAN).

The DSP's speed also allows for an unprecedented amount of dynamics and effects processing.

CoActual™ Onboard

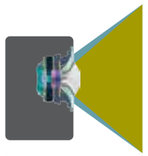
Each full-range AI-series loudspeaker is based on an eight-inch CoActual coaxial speaker for high- and mid-frequency reproduction.



The aural sensation of transparent sound that is typical of coaxial systems is, of course, beneficial in mains but is also helpful in proximate applications such as stage monitoring, front-fills, under-balcony fills, and FOH live monitoring. Coaxial speakers offer many benefits in theory; CoActual speakers make benefits a reality.

Multiway loudspeaker designs generally suffer from the changing relationship between the listener and the speaker elements. A coaxial loudspeaker's response behavior is symmetric in both the horizontal and the vertical axes. This means that whatever response is observed at a given angle with respect to the axis is the same at that angle in the opposite direction. In other words, the loudspeaker's behavior is "mirrored" about its axis.

Asymmetrical dispersion pattern from two separate sources.



Symmetrical dispersion pattern from a single point source.

Another benefit of the CoActual speaker design is that the crossover transition is undetectable (inaudible and immeasurable), not just on axis, but also at other angles. CoActual speakers accomplish this by using time correction to effectively make the acoustic centers of both the mid and HF driver the same—that is, by delaying the woofer back to the same plane as the compression driver.

This signal alignment allows AI-series loudspeakers to produce transient signals with the least possible change in the shape of the waveform. The sounds we wish to reinforce in a sound system are dominated by transient information. Consonant sounds in speech, percussive sounds, and the attack and decay portions of all musical instrument sounds are transients.

These transients consist of complex combinations of many frequencies, and the phase relationships of the individual harmonics are a critical part of the characteristic "sound" of an instrument or voice. Only an optimally aligned loudspeaker can reproduce them accurately.

This is a significant element in sonic transparency, definition, and intelligibility, yet it is very seldom discussed, let alone adequately addressed, in professional audio.

Temporal Equalization™

While DSP has long been included in loudspeakers, it has generally been handled as an additional feature, rather than a part of the design of the loudspeaker itself. Designers and engineers typically build the best physical loudspeaker they can and then use DSP filters to improve performance and to provide the end-user with some EQ options.

In contrast, StudioLive AI-series loudspeakers were designed with Fulcrum Acoustic's TQ™ Temporal Equalization algorithms from the beginning. TQ provides a fully addressable, fairly large Finite Impulse Response (FIR) filter. This filter allows for the implementation of more detailed frequency-response adjustments; more important, we can implement the precise temporal (time domain) filters that are responsible for the most remarkable TQ benefits. Loudspeakers tuned with TQ provide a crisper stereo image, greater soundstage depth, more separation between the components of a complex mix, increased resistance to feedback, more seamless transitions between distributed loudspeakers, and a less fatiguing listening experience at very high SPLs.

StudioLive AI-Series Models

The StudioLive AI-Series offers three 3-way full-range models (312AI, 315AI, and 328AI) as well as an 18" subwoofer (18sAI). Each full-range loudspeaker is phase and time-aligned to form a true 4-way system when paired with an 18sAI subwoofer, with or without the 100 Hz highpass filter engaged.

With most 4-way systems, leaving frequency content below 100 Hz in the full-range loudspeaker can introduce destructive cancellations with the highest frequencies that are reproduced by the subwoofer.

StudioLive AI-series loudspeakers are designed to avoid this problem when combined with an 18sAI subwoofer. This means that for applications where a frequency overlap at 100 Hz is beneficial, you can achieve bigger bass sound without any extra effort.

For applications that require a more linear frequency response between the subwoofer and full-range content, simply engage the highpass filter on the full-range AI-series loudspeaker.

This will also readjust the phase and time-alignment to keep it in phase with the 18sAI subwoofer. As a result, you can create the best 4-way system for your application.

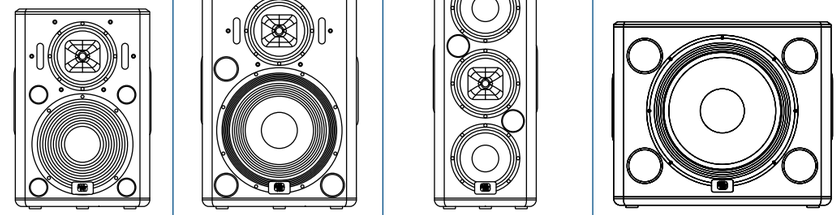
The three full-range speakers all have the same high-frequency dispersion characteristics: 90˚H x 60˚V. Make sure your design utilizes this pattern to cover the listeners as much as possible, while steering away from reflective surfaces like walls, floors, ceilings, and windows.

All models have a maximum SPL greater than 130 dB.

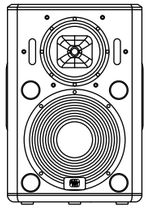
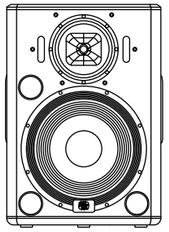
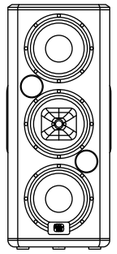
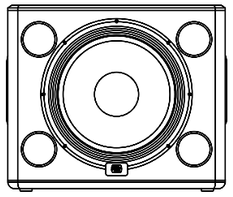
Please refer to the ***PreSonus Rigging Guide*** for proper installation guidelines for your loudspeakers.

Note: Installation of StudioLive AI-series loudspeakers should only be done by a licensed and insured professional.

2. At a glance: StudioLive AI-series loudspeakers



	312AI	315AI	328AI	18sAI
Configuration	3-Way, Triamplified Loudspeaker System	3-Way, Triamplified Loudspeaker System	3-Way, Quad-amplified Loudspeaker System	Powered Subwoofer, Ported
Frequency Response (-10 dB)	50 Hz - 23 kHz	46 Hz - 23 kHz	54 Hz - 23 kHz	29 Hz - 141 Hz
Frequency Response (-6 dB)	56 Hz - 22 kHz	52 Hz - 22 kHz	59 Hz - 22 kHz	32 Hz - 110 Hz
Nominal Coverage (-6 dB)	90 x 60	90 x 60	90 x 60	n/a
Maximum Peak SPL	131 dB	131 dB	133 dB	135 dB
Crossover Frequency	LF: (overlapped) 100 Hz - 1 kHz, HF: 1.8 kHz	LF: (overlapped) 100 Hz - 1 kHz, HF: 1.8 kHz	1.7 kHz	n/a
Directivity Index (DI)	10 dB, >500 Hz	10 dB, >420 Hz	10 dB, >460 Hz	n/a
Directivity Factor (Q)	10.0, >500 Hz	10.0, >420 Hz	10.0, >460 Hz	n/a
Transducer				
LF Transducer	12" ferrite	15" ferrite	2 x 8" ferrite	18" ferrite
MF Transducer	8" CoActual™	8" CoActual™	8" CoActual™	4"
HF Transducer	1.75" compression driver	1.75" compression driver	1.75" compression driver	n/a

	312AI	315AI	328AI	18sAI
				
Amplifier				
Type	Class D	Class D	Class D	Class D
Total Power Output	2,000W (total power without protection algorithms & limiter enabled)	2,000W (total power without protection algorithms & limiter enabled)	2,000W (total power without protection algorithms & limiter enabled)	1,000W (total power without protection algorithms & limiter enabled)
LF Power	2 x 500W bridged	2 x 500W bridged	2 x 500W	2 x 500W bridged
MF Power	500W	500W	500W	n/a
HF Power	500W	500W	500W	n/a
Rated THD	<0.05% (20 Hz - 20 kHz)	<0.05% (20 Hz - 20 kHz)	<0.05% (20 Hz - 20 kHz)	<0.05% (20 Hz - 20 kHz)
Dynamic Range	119 dB (A-weighted)	119 dB (A-weighted)	119 dB (A-weighted)	119 dB (A-weighted)
Bandwidth	20 Hz - 20 kHz	20 Hz - 20 kHz	20 Hz - 20 kHz	20 Hz - 20 kHz
Cooling	Free air convection	Free air convection	Free air convection	Free air convection

System configuration suggestions

The following pages will demonstrate some system configurations for common rooms. The size and shape of your room and the application for which it will be used greatly determines how many speakers you will need and how they should be placed. In every situation you should keep in mind two important design factors: your loudspeaker's coverage pattern and half-space loading.

Each full-range StudioLive AI loudspeaker offers offer the same 90˚ horizontal x 60˚ vertical coverage pattern. Be sure to pay close attention to these angles when using your speakers. Rotating the cabinet changes the horizontal and vertical coverage.

When configured for stereo use, make sure the cabinets are not placed too wide for the room or too far back into the corners. Too wide of a placement will direct too much energy onto the walls and can potentially add destructive interference to the room. Adjust the left and right speakers, as well as the toe-in angle, to produce the best stereo image. If a room is very narrow, a mono cluster might be a better choice.

Wherever you place your loudspeakers, you should be aware of half-space loading. Half-space loading occurs when a speaker comes in close contact with, or touches, a hard surface, like a floor or wall. As its name indicates, this type of summation happens when the circular radiation of the speaker is blocked by a hard surface and is forced to radiate in a crescent shape. Depending on the proximity and position, there may be a boost in low-frequency energy. Testing your speaker placement and doing critical listening tests will help determine the best final location for your loudspeaker system.

If your speakers are sitting on the floor, you can expect a certain amount of half-space loading. If you are using your speakers as floor wedges, you might want to experiment with using the highpass filter to compensate for increased low energy. In some cases, this might improve intelligibility. Using the Floor Monitor DSP contour will also help you get the best use out of your StudioLive AI loudspeakers in this position.

3.1 Stereo System

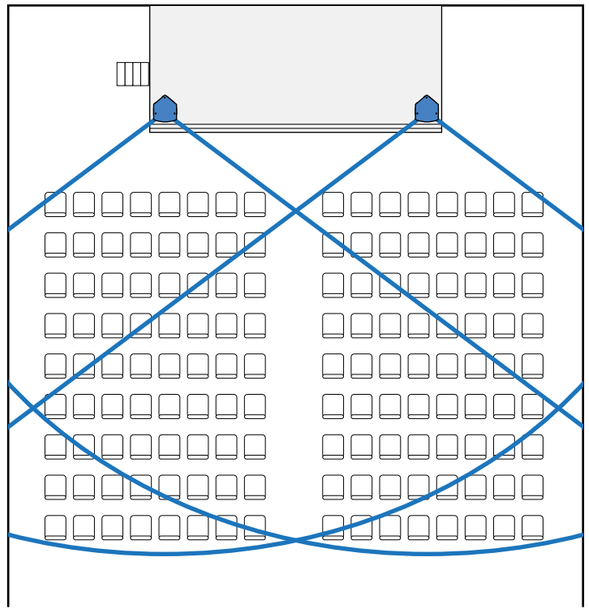
A stereo system allows panning and adds depth to the acoustic image. This is good for speech reinforcement and greatly enhances live or prerecorded music. Locate speakers to give the best horizontal coverage. Ensure that the listeners are well covered by the pattern.

3. System Configuration Suggestions

3.2 Mono Cluster with Down Fill

Center or mono systems can provide a simple, economical solution for venues not too heavily vested in music, and where speech intelligibility is the priority. As with a stereo system, make sure the coverage pattern of the speaker has its energy focused on the audience.

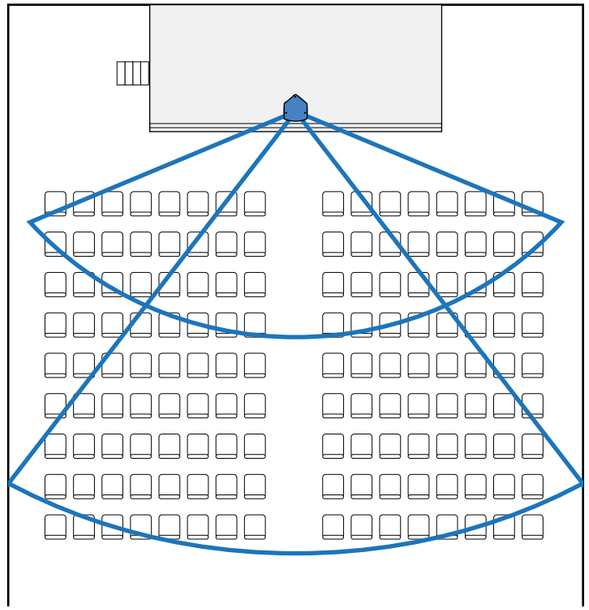
This graphic actually shows two speakers. The upper speaker is for throwing to the back of the room and the lower speaker is covering the space in the front of the room closest to the stage.



Stereo System

3.3 LCR System

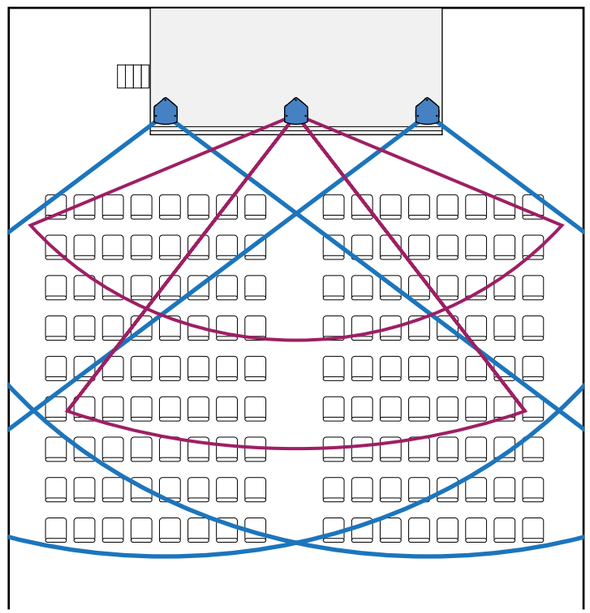
An LCR system is a stereo system with center speakers added. This configuration allows panning and adds depth to the acoustic image. This type of system will provide more control than a basic stereo system and is ideal in situations where music and speech intelligibility are equally important.



Mono Cluster with Down Fill

3.4 Vertical Coverage

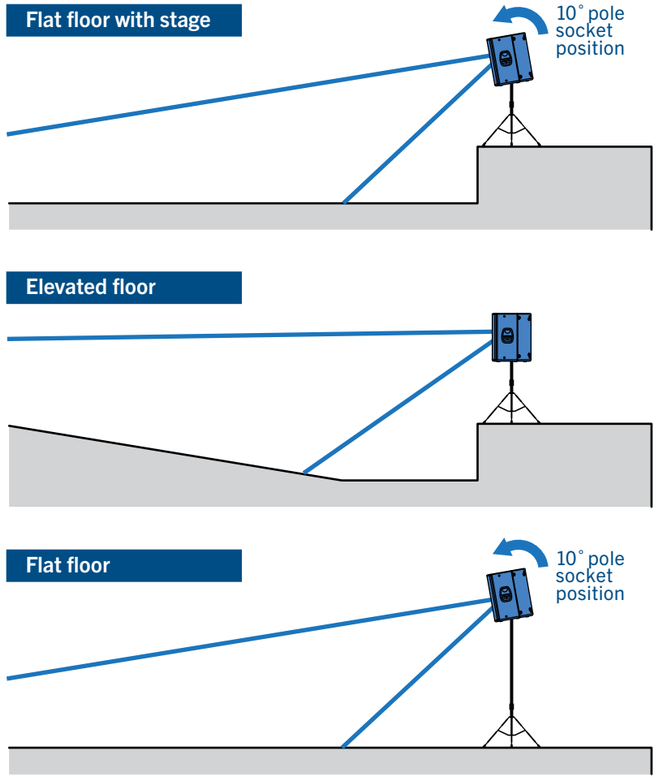
Whichever speaker is chosen for a specific project, the vertical coverage is just as important as the horizontal coverage. If you are using a ground-stack approach with pole mount, make sure your coverage matches the listening plane. Suspension of speakers will provide even further control.



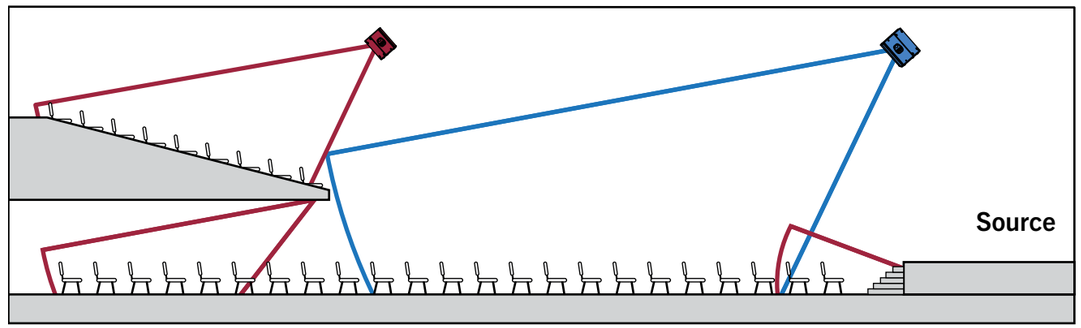
LCR System

Each StudioLive AI-series full-range loudspeaker features dual-position pole mounts. Using the 10˚ downward tilt mount will focus the loudspeaker's energy onto the audience and avoid destructive reflections. This is ideal for situations where the loudspeaker is mounted atop a tripod stand and placed on a stage, or where the pole-mounted loudspeaker is on the floor and the coverage area is relatively shallow (conference, coffee house, etc.).

More complex speaker placements could result in different audio arrival times in the various zones and must be time aligned. Using multiple sets of speakers in a live performance can make a huge difference in the quality of the sound.



3.5 Auditorium with Balcony Delays and Front Fill

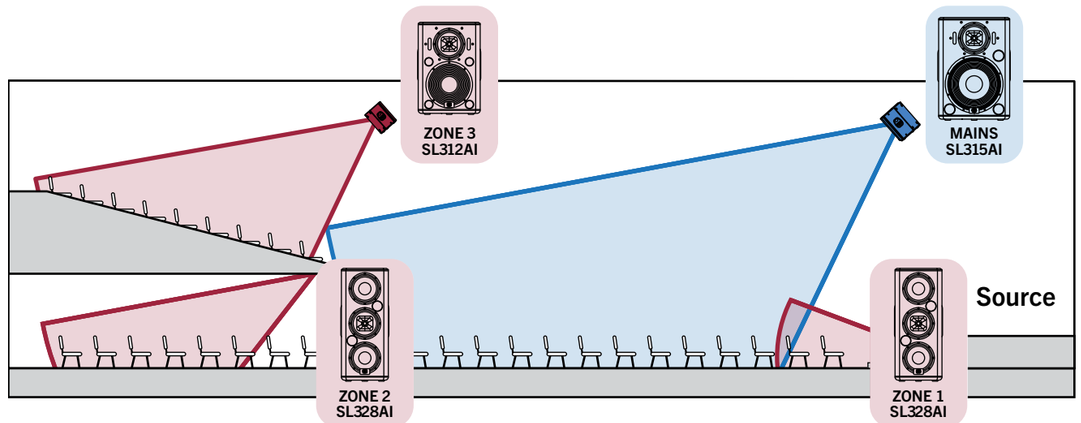


Rather than relying on a pair of front-of-house speakers to fill the entire room, you can create listening zones throughout the room so that your front-of-house system only needs to be loud enough to cover the front of the room. This allows you to lower the level, give the front-row listeners' ears a break, and get better fidelity from your speakers.

Delay systems allow you to provide the same listening experience throughout the entire venue by extending the reach of the FOH system. The onboard DSP on the StudioLive AI-series loudspeakers allows you to achieve this experience without any additional equipment or wiring.

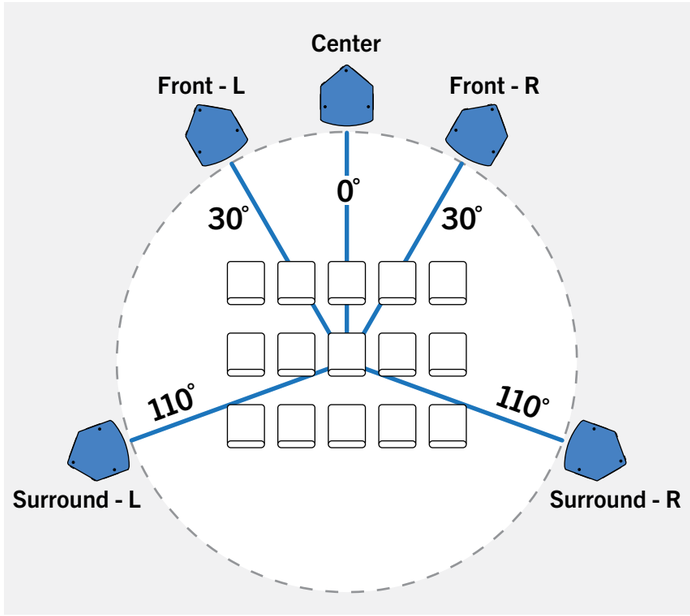
Measure the distance and divide by 1,100 (speed of sound in fps) to get a starting point for the amount of delay to apply. Fine tune the system with critical listening of program material or a live source.

- Delay all speakers to main system
- Front fills to main system
- Subwoofers to mains
- Downfill speakers (upper and under balcony) to mains
- Entire system to source on stage



3.6 5.1 Surround and Corporate Theater

5.1 systems can provide dramatic audio presentations, however for best results the 5.1 standard must be adhered to. Shown above are the correct angles for the 5.1 standard. As with other systems, adjust the horizontal coverage to accommodate the audience.



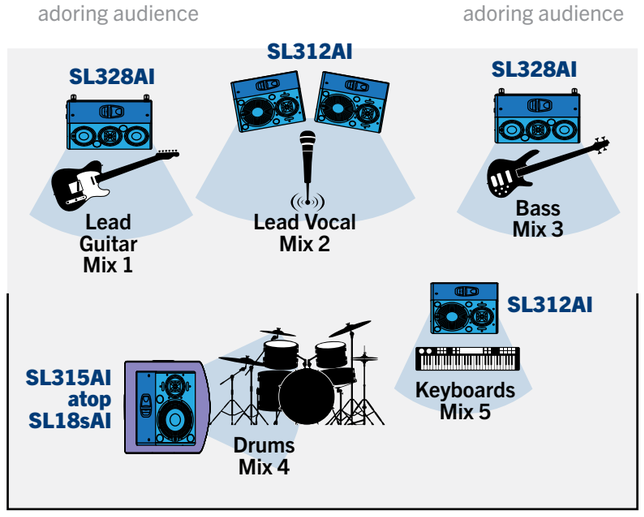
3.7 Monitor Systems

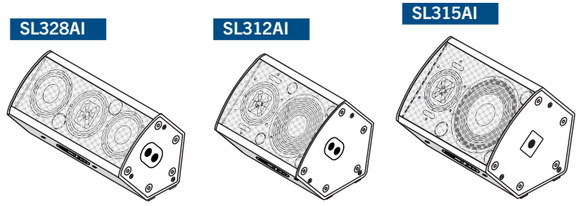
StudioLive AI PA-series full-range speakers make superb stage monitors. Each "reclines" at a 50˚ angle when laid on their sides.

At right is a typical stage monitor layout for a 5-piece band. For musicians who don't require as much low-frequency energy in their floor wedge (vocalist, keyboard), a 312AI is used. For musicians that need a little more bass, the 328AI is used.

The drum monitor in this example is a full-range 4-way system (315AI stacked atop 18sAI). This can be configured with or without the highpass filter engaged on the 315A, depending on how much 100 Hz overlap the drummer prefers.

For smaller stages, a 315AI atop a low tripod or in the horizontal floor wedge position will be more than adequate to function as a drum monitor.





3.8 Subwoofer Alignment

The 18sAI subwoofer has been designed and customized for use with the full-range AI-series loudspeakers. It features three delay presets to guarantee that your 4-way system stays in alignment:

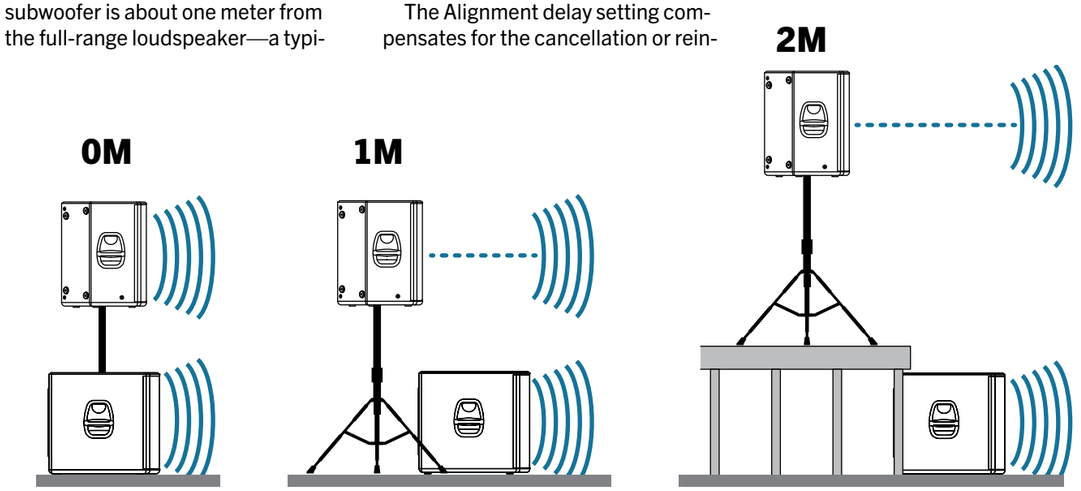
0M. Select this setting when the full-range system is directly over the subwoofer (i.e., mounted atop using the SP1BK sub pole accessory). No delay is added to the subwoofer amplifier output.

1M. Select this setting when the subwoofer is about one meter from the full-range loudspeaker—a typical distance when the loudspeaker is on an adjacent tripod stand. A delay of about 2.9 ms is introduced to the signal that is output through the subwoofer amplifier.

2M. Select this setting when the subwoofer is about two meters from the full-range loudspeaker—typical when the full-range system is on the stage and the subwoofer is on the floor. A delay of about 5.9 ms is introduced to the signal that is output through the subwoofer amplifier.

The Alignment delay setting compensates for the cancellation or reinforcement of low frequencies when the same frequencies are reproduced by two sound sources that are set some distance apart.

Low frequencies in the crossover region between full-range and subwoofer have wavelengths that are several feet long (the wavelength of a 150 Hz wave is about 7.5 ft!), which means that reinforcement and cancellation will occur as the waves interact in the room.

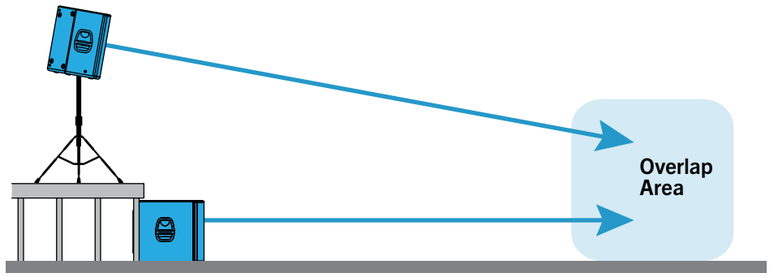


Alignment Delay

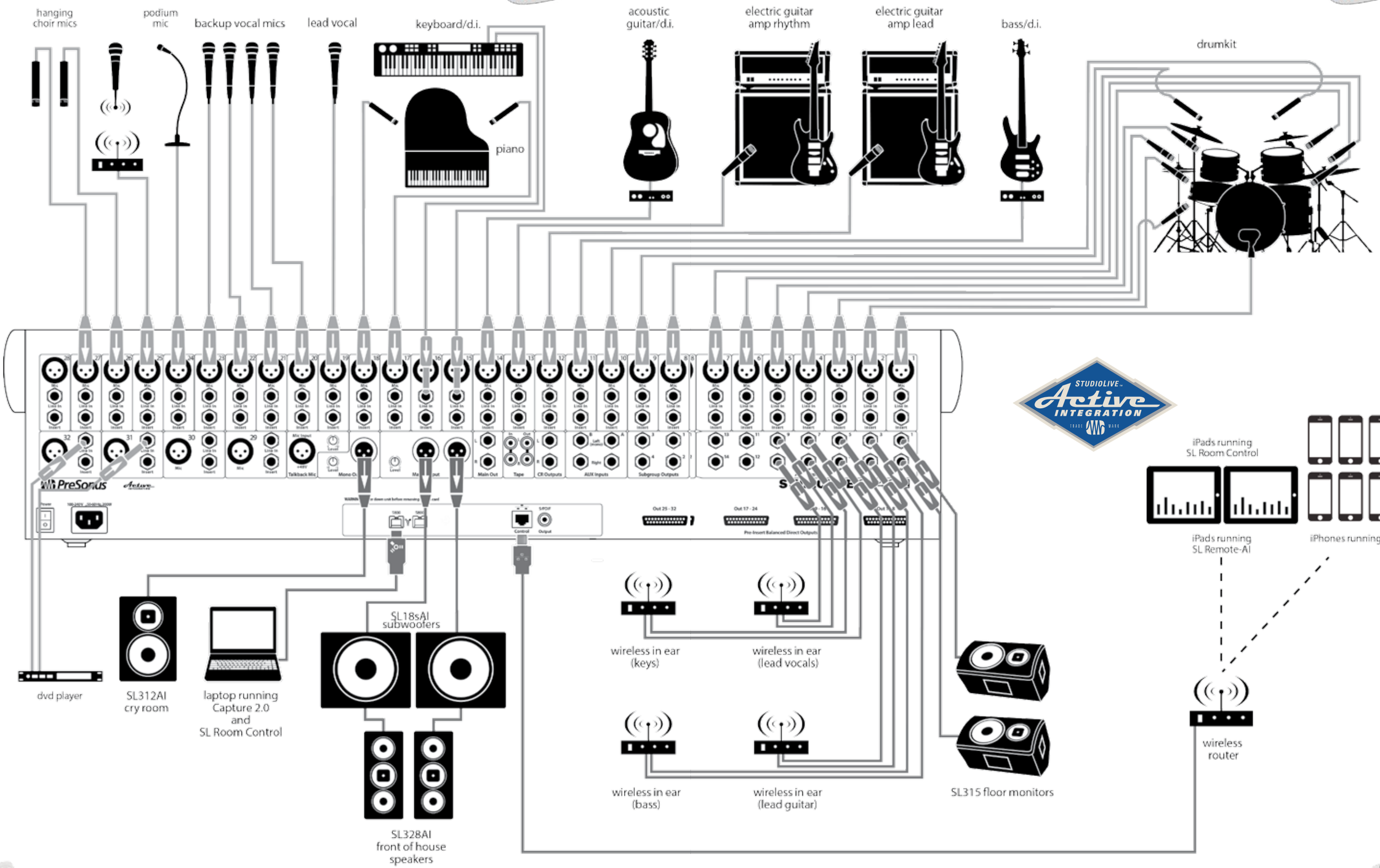
The Alignment delay provides compensation for this effect when the loudspeaker is about the same distance away from, or in front of, the subwoofer, as specified in the setting. As room acoustics will influence effectiveness, we recommend listening tests using the different Alignment settings in conjunction with alternate Polarity settings to determine the best results.

If you are aligning for a custom installation or the subs must be located some distance from the main speakers, you will need to do some calculation.

Find the spot back in the room where coverage from the main speakers and the subwoofers overlap. Measure the distance from the overlap area to each speaker location. Subtract the smaller distance from the larger. Divide that number by 1,100 and apply that delay value to the speaker that is closest. Keep in mind that the overlap area may be behind front-of-house.



4. Example Hookup Diagram: Small to Medium Church



StudioLive AI-Series PA Applications Guide

StudioLive™ AI-Series PA Applications Guide

SL315AI File Resources

To obtain these documents, please go to www.presonus.com/products/Studiolive-315AI/downloads:

AI Series Users' Manual:
PreSonus_StudioLive_Manual_EN.pdf
Data Sheet:
PreSonus_StudioLive_315AI.pdf
2D CAD drawing:
PreSonus_StudioLive_AI-Series_PA.dxf
A&E Specs:
PreSonus_StudioLive_315AI_AE.doc
Applications brochure:
PreSonus_StudioLive_AI-Series_Applications.pdf
Compliance statement:
PreSonus_StudioLive_315AI_Compliance.pdf

Related SL315AI Products

- WF-150 Wi-Fi wireless LAN adapter
- M10AI-Kit M-10 mounting kit
- SLS315AI-Cover dustcover
- SP1BK mounting pole
- 355-NRG-COAX-8: 8" coaxial driver
- 355-NRG-LO-FREQ-15: 15" low-frequency driver
- 600-NRG0182: SLS315AI grille
- 600-NRG0153: Handle assembly

SL18sAI File Resources

To obtain these documents, please go to www.presonus.com/products/Studiolive-18sAI/downloads

AI Series Users' Manual:
PreSonus_StudioLive_Manual_EN.pdf
Data Sheet:
PreSonus_StudioLive_18sAI.pdf
2D CAD drawing:
PreSonus_StudioLive_AI-Series_PA.dxf
A&E Specs:
PreSonus_StudioLive_18sAI_AE.doc
Applications brochure:
PreSonus_StudioLive_AI-Series_Applications.pdf
Compliance statement:
PreSonus_StudioLive_18sAI_Compliance.pdf

SL312AI File Resources

To obtain these documents, please go to www.presonus.com/products/Studiolive-312AI/downloads:

AI Series Users' Manual:
PreSonus_StudioLive_Manual_EN.pdf
Data Sheet:
PreSonus_StudioLive_312AI.pdf
2D CAD drawing:
PreSonus_StudioLive_AI-Series_PA.dxf
A&E Specs:
PreSonus_StudioLive_312AI_AE.doc
Applications brochure:
PreSonus_StudioLive_AI-Series_Applications.pdf
Compliance statement:
PreSonus_StudioLive_312AI_Compliance.pdf

Related SL312AI Products

- WF-150 Wi-Fi wireless LAN adapter
- M10AI-Kit M-10 mounting kit
- SLS312AI-Cover dustcover
- SP1BK mounting pole
- 355-NRG-COAX-8: 8" coaxial driver
- 355-NRG-LO-FREQ-12: 12" low-frequency driver
- 600-NRG0181: SLS312AI grille
- 600-NRG0153: Handle assembly

Related SL18s Products

- WF-150 Wi-Fi wireless LAN adapter
- D18S sub dolly
- SLS18sAI-Cover dustcover
- SP1BK mounting pole
- 355-NRG-LO-FREQ-18: 18" low-frequency driver
- 600-NRG0183: SLS18sAI grille
- 600-NRG0153: Handle assembly

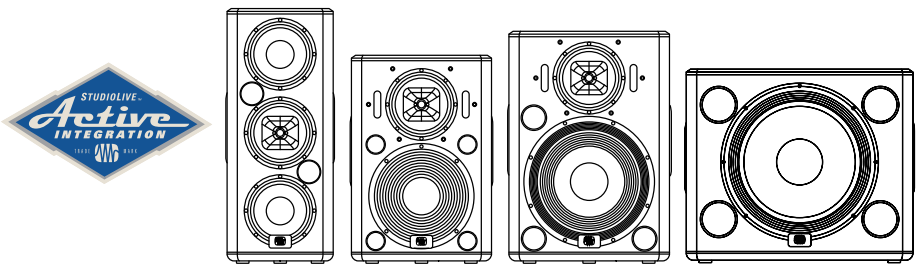
SL328AI File Resources

To obtain these documents, please go to www.presonus.com/products/Studiolive-328AI/downloads:

AI Series Users' Manual:
PreSonus_StudioLive_Manual_EN.pdf
Data Sheet:
PreSonus_StudioLive_328AI.pdf
2D CAD drawing:
PreSonus_StudioLive_AI-Series_PA.dxf
A&E Specs:
PreSonus_StudioLive_328AI_AE.doc
Applications brochure:
PreSonus_StudioLive_AI-Series_Applications.pdf
Compliance statement:
PreSonus_StudioLive_328AI_Compliance.pdf

Related SL328AI Products

- WF-150 Wi-Fi wireless LAN adapter
- M10AI-Kit M-10 mounting kit
- SLS328-Cover dustcover
- SP1BK mounting pole
- 355-NRG-COAX-8: 8" coaxial driver
- 355-NRG-LO-FREQ-8: 8" low-frequency driver
- 600-NRG0176: SLS328AI grille
- 600-NRG0153: Handle assembly
- 600-NRG0205: Sliding foot bracket



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