



FreeSpace 3 Flush-mount Loudspeakers

Design Guide

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Overview

Introduction

This design guide covers the basic concepts for the use of the FreeSpace 3 system in business music applications. The FreeSpace 3 system is ideally suited to background and foreground music applications with ceiling heights between 8 and 16 feet (2.4 to 5 meters). The 2.25-inch driver used in the FreeSpace 3 system provides more consistent coverage in low ceiling applications, compared to other loudspeakers, and the Acoustimass bass module provides deep, rich bass that appears to fill the room. The FreeSpace 3 system is compatible with 70V, 100V and 8 Ω amplifiers, and is capable of delivering up to 95 dB-SPL in a typical application with a 12 feet (3.5 meters) ceiling height.

Overview

All system designs begin with a set of requirements. The system requirements can be as simple as, "it has to sound great" or as detailed as, "it must play background-level music at 5 dB above the ambient noise level of the restaurant's main dining room, which is 65 dB." The challenge is to gather the right set of requirements, and then turn them into a set of criteria that you can use to create your design. It is important to remember that you are the designer and should use your own intuition and decision skills when planning a project in addition to calculations.

There are four key requirements that need to be identified to deliver the right system:

Loudness: What sound pressure level (SPL) is required for this application?

Response: What bandwidth is required for the type of program material that will be used?

Coverage: How consistent must the sound be across the entire coverage area?

Each of these requirements can be easily converted into a specification that we can use to create our system design. If we understand the customer's needs in these four areas, we can deliver a design that will — at a minimum — meet their needs and — at best — exceed their expectations.

For the purposes of this design guide, we will assume that you are familiar with the system requirements for a commercial audio system and are ready to focus on loudspeaker selection, creation of a loudspeaker layout, and defining the necessary amplifier power needed to power the design.

Design Guidelines

When creating a design that uses FreeSpace 3 loudspeakers, you should consider the following:

Recommended mounting height for FreeSpace 3 satellites is between 8 and 16 feet (2.4 and 4.8 meters).

One FreeSpace 3 satellite should always be placed near the bass module to further reduce localization.

Do not place bass modules along the center line of the room; offset bass modules from the center line using a staggered layout.

Maximum SPL for a typical application is between 85 and 90 dB-SPL.

Always add 25% headroom to your amplifier to accommodate various types of program material.

Design Worksheet

Use the following worksheet to create a design using FreeSpace 3 loudspeakers.

Step 1: Room Layout

Using the graph paper on the last page, create a sketch layout of the room.

Step 2: Loudness

Maximum SPL Capability

Confirm that FreeSpace 3 loudspeakers will meet your loudness requirement. Find your mounting height and follow the column down to see the maximum continuous output level.

Maximum Continuous Output Level							
Mounting height	m	2.4	3	3.7	4.3	5	
	ft	8	10	12	14	16	
FreeSpace 3		96	95	95	94	93	dB-SPL

Step 3: Response

Confirm that FreeSpace 3 loudspeaker will meet your response requirement. If the loudspeaker that meets your response and loudness requirement does not meet your mounting needs, select one that provides more bandwidth and also meets your mounting needs.

FreeSpace 3 Frequency Response	
	Frequency response (-10 dB)
FreeSpace 3 flush-mount satellites	170 Hz – 20,000 Hz
FreeSpace 3 Series II Acoustimass module	40 Hz – 315 Hz
FreeSpace 3 system	40 Hz – 20,000 Hz

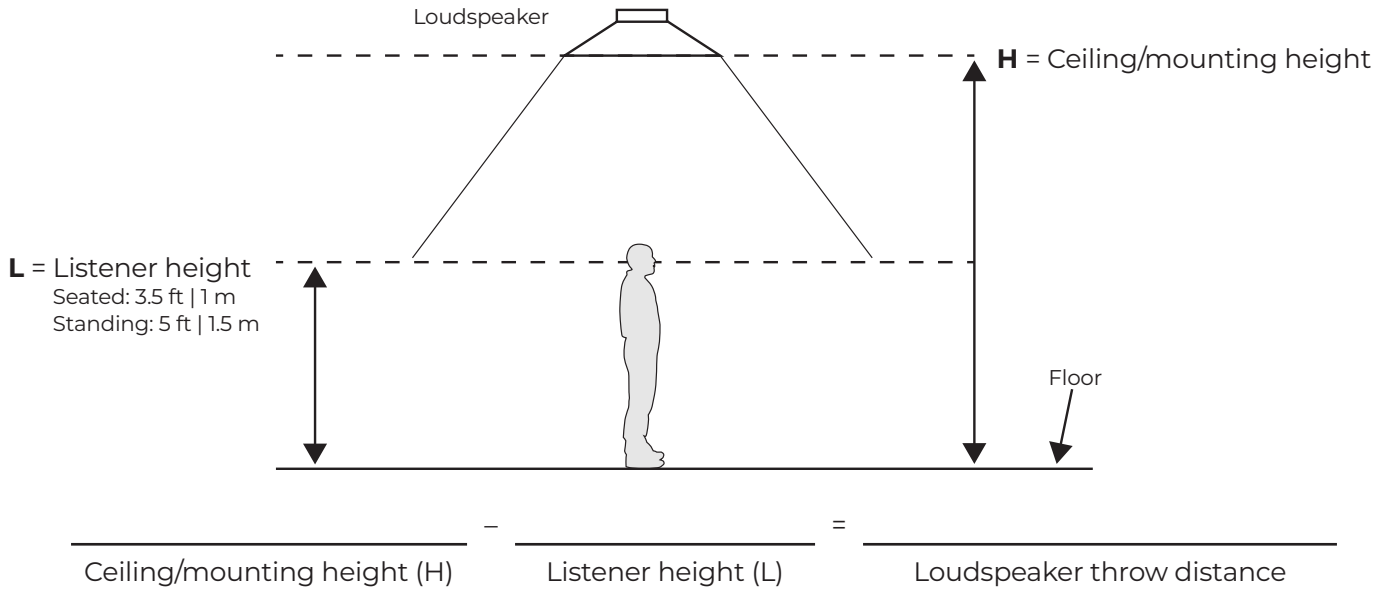
Note: Frequency response and range are measured on-axis with recommended active EQ in an anechoic environment.

Step 4: Coverage

Determining Loudspeaker Quantity and Spacing

The goal is to fill a rectangle-shaped room with coverage circles at your desired density. Using the graph paper on the last page, create a sketch layout of the room. Using your sketch of the room, follow the steps below to create a layout with the loudspeaker spacing that meets your coverage requirement.

- A. Calculate the loudspeaker throw distance by subtracting the **listener height (L)** from the **ceiling/mounting height (H)**.

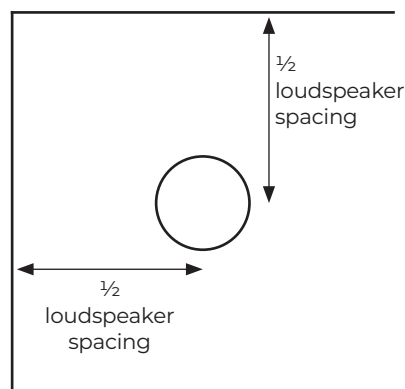


- B. Calculate the loudspeaker spacing distance by multiplying the loudspeaker throw distance by the coverage multiplier.

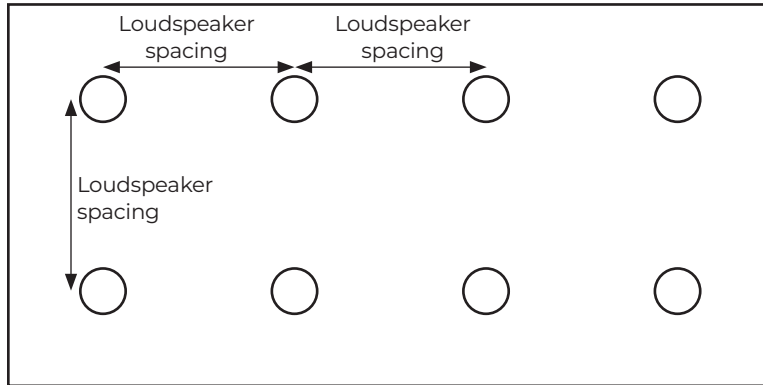
Coverage	Multiplier
Premium	2.0
Standard	2.5



- C. Place the first loudspeaker at 1/2 LSD from any corner of the room.



- D. The remaining loudspeakers are arranged on a square grid pattern using the LSD. If a loudspeaker would be placed on or beyond the perimeter of the room, delete that row/column of loudspeakers.



- E. After the last loudspeaker is placed, center the loudspeakers in that row to create new offset distances out from each wall, which may be unique from 1/2 LSD.

Step 5: Bass Loudspeaker Layout

Using your sketch of the room, create a bass loudspeaker layout with the correct number of bass modules to meet your coverage requirement.

- A. Determine the quantity of bass modules required for your system layout.

Coverage	Number of bass modules required
Premium	Total satellites ÷ 2
Standard	Total satellites ÷ 4

- B. Use the spacing guidelines below, determine the minimum spacing between two or more FreeSpace 3 Series II Acoustimass modules.

FreeSpace 3 bass module mounting height	2.5 ft (8 m)	3 ft (10 m)	3.5 ft (12 m)	4.8 ft (16 m)
Minimum spacing of bass modules	20 ft (6 m)	25 ft (7.5 m)	30 ft (9 m)	35 ft (11 m)

Note: Placing a ceiling subwoofer within 0.9 meters (3 feet) of a wall increases its output by 3 dB. Placing it within 0.9 meters (3 feet) of a corner increases its output by another 3 dB (6 dB total) and also reduces reflections that can create audible interference (bass cancellations) in the listening area.

Step 6: Calculate Required Amplifier Size

Determine which loudspeaker tap is required for this design.

FreeSpace 3 Series II Acoustimass module							
Mounting height	m	2.4	3.0	3.6	4.2	4.8	
	ft	8	10	12	14	16	
TAP	25 W	87	86	86	85	84	dB-SPL
	50 W	90	89	89	88	87	
	100 W	93	92	92	91	90	
	200 W	96	95	95	94	93	

Note: Room reverberation could add as much as 4 dB system gain, which is not factored into the measurements. Designing without room gain will ensure you don't under-plan your design, and amp attenuation is possible at the job site if you exceed the average room SPL target during measurement. Values below 70 dB are omitted—select a higher tap.

- A. In this loudspeaker tap chart, find the column for mounting height for this design.
- B. Follow the column to the desired maximum SPL.
- C. Follow the row across the chart to determine the required loudspeaker tap.
- D. Calculate the required amplifier power:

$$\frac{\text{Number of loudspeakers required}}{\text{Number of loudspeakers required}} \times \frac{\text{Required loudspeaker tap}}{\text{Required loudspeaker tap}} = \frac{\text{Power required}}{\text{Power required}}$$

- E. Calculate the required amplifier size:

$$\frac{\text{Power required}}{\text{Power required}} \times \frac{1.25}{\text{Headroom}} = \frac{\text{Amplifier size}}{\text{Amplifier size}}$$

SmartBass: Application of SmartBass processing

If your design is using a PowerSpace+ amplifier; or your design utilizes a dedicated Bose Professional DSP, such as the Commercial Sound Processor CSP models; or any of the ControlSpace ESP or EX models; you have the option of applying SmartBass to your loudspeaker output channel. This uses Bose Professional EQ presets, dynamic EQ, and excursion limiting tuned to each model and room calibration. This will prevent lower background-level music from sounding thin, but also ensures the sound is consistent at various SPL levels. At louder levels, SmartBass also allows for more musical limiting than traditional voltage limiters.

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Graph Paper

