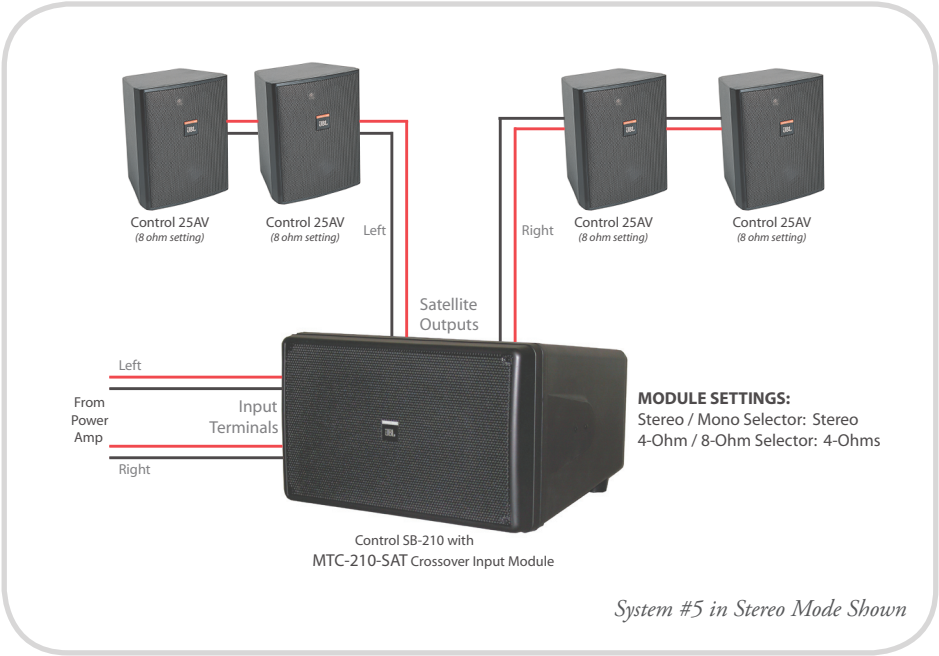
APPLICATION GUIDE

Subwoofer-Satellite Systems

Using Control SB-210 & SB-2 Subwoofers



System #5 in Stereo Mode Shown

Using subwoofers and satellite loudspeakers with a pre-engineered passive crossover built into the subwoofer can be a very effective way of achieving high-fidelity sound economically for applications requiring greater bandwidth than is typically possible from full-range speakers alone.

When applied properly, small subwoofer-satellite systems – often referred to as ***"sub-sat"*** systems – can provide high fidelity sound for a wide variety of applications, such as restaurants, retail stores, hotels, music cafes, leisure venues, sports bars & lounges, fitness centers, themed applications, and many more.

This guide provides recommended subwoofer-satellite configurations that work well together. In addition, the ***Connection Information*** and ***System Design*** sections provide important information for applying these subwoofer-satellite systems properly.

Table of Contents

SUB-SAT SYSTEMS AT A GLANCE

Detailed Information About Each System and Application Guidelines are on the Following Pages.

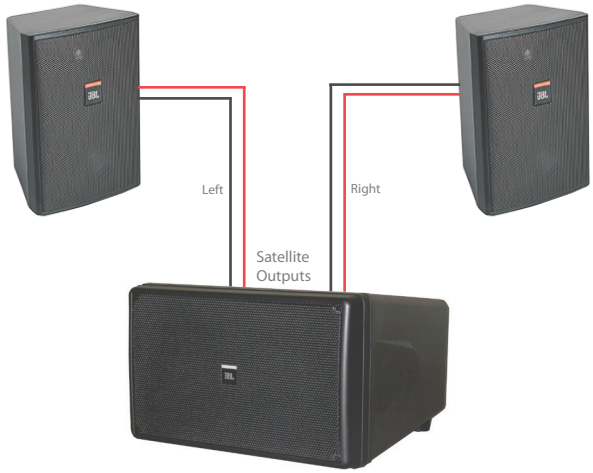
System Number	Products	Applications	SPL (Max Cont. @ 20 ft)	Modes	Ω Per Amp Channel
Surface-Mount *(On-Wall)* Satellite Speakers					
System 1 (CCS6000)	4 x Control 23 1 x SB-2	Light volume ambient music in medium size spaces where four speakers are needed.	87 dB	Stereo Only	4Ω
System 2	2 x Control 25AV 1 x SB210 1 x MTC-210-SAT	Light to medium volume ambient music in small to medium sized spaces where two satellite speakers are enough to cover the area.	91 dB	Mono	8Ω
				Stereo	4Ω
				70V/100V *(with MTC-210**T**-SAT)*	*n/a*
System 3	2 x Control 28 1 x SB210 1 x MTC-210-SAT	Medium volume ambient music in small spaces where two satellite speakers are enough to cover the area.	95 dB	Mono	8Ω
				Stereo	4Ω
				70V/100V *(with MTC-210**T**-SAT)*	*n/a*
System 4	2 x C29AV-1 1 x SB210 1 x MTC-210-SAT	High volume, high-fidelity music reproduction in small spaces where two watellite speakers are enough to cover the area.	96 dB	Mono	8Ω
				Stereo	4Ω
				70V/100V *(with MTC-210**T**-SAT)*	*n/a*
System 5	4 x Control 25AV 1 x SB210 1 x MTC-210-SAT	Medium volume, high-fidelity music reproduction in larger spaces where 4 satellite speakers are needed to cover the area.	94 dB	Mono	8Ω
				Stereo	4Ω
				70V/100V *(with MTC-210**T**-SAT)*	*n/a*
In-Ceiling Satellite Speakers					
System 6	4 x Control 24C 1 x SB210 1 x MTC-210-SAT *(Mounting options for subwoofer described in System 6 text)*	Medium to high volume music reproduction where 4 in-ceiling satellite speakers are needed to cover the area.	96 dB *(at 10 feet)*	Mono	8Ω
				Stereo	4Ω
				70V/100V *(with MTC-210**T**-SAT)*	*n/a*

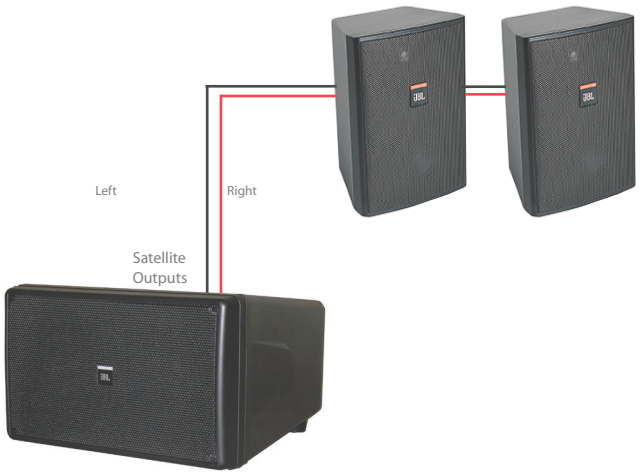
Important Satellite Connection Information For Mono (& 70V Mono) Systems

For Mono systems, always connect half the satellite speakers to one of the satellite speaker output terminals and the other half to the other satellite speaker output terminals. **Do NOT connect to only one of the sets of satellite output terminals.**

In order to avoid excessively low impedance loads to the power amp when using 4 satellite speakers (which could cause the power amplifier to fail), the satellite output terminals of the SB-210 in mono mode are connected in series with each other. This requires that speakers be connected to both sets of satellite output terminals, and that the load on each satellite output be matched.

Otherwise, there will be very little or no sound coming from the satellite speakers





CORRECT

For systems with 2 satellite speakers, put 1 on each set of the subwoofer's satellite output terminals (shown).

For systems with 4 satellite speakers, put 2 on each set of the subwoofer's satellite output terminal

WRONG

All satellite speakers on one of the sets of satellite output terminals and none on the other satellite output terminals.

Sub-Sat System Design

The exact configuration of a subwoofer/satellite loudspeaker system depends on a number of factors, such as:

- How large the room is and how many satellite speakers it will take to cover the room?
- Whether the distance between the satellite speakers allows a single subwoofer to cover the entire space?
- Whether the program material is light background music or dominant driving music?
- Where the subwoofer will be located in relation to room boundaries (wall, ceiling, corners)?

The system recommendations in this guide and the performance figures are based on some baseline assumptions which will not be correct for all applications. Adjustments may need to be made. A discussion of the considerations, baseline assumptions conditions and possible adjustment requirements is below.

General Objectives

Sensitivity Balance

The volume balance between the subwoofer and the satellite speakers in a passively crossed-over system is called sensitivity balance.

Targets:

a) **Sensitivity Balance –** Typically, the way the human hearing system works, the subwoofer needs to be 2 to 6 dB louder than the satellite speakers in order to sound balanced. The subwoofer/satellite systems in this guide are all structured to provide the proper range of sensitivity balance with the subwoofer located on a flat surface (wall, ceiling, floor). The sensitivity balance can be altered, as required, via an active graphic equalizer. The balance can also be altered by placing the subwoofer closer to more boundary surfaces -- see the "Subwoofer Location" section below for more about the effect of positioning.

b) **Maximum Sound Level Balance –** It is desirable for the subwoofer to be able to deliver adequate maximum sound output capability to keep up with the satellite speakers when they are driven at their maximum drive level. The subwoofer output of these systems is high enough to keep up with the satellite speakers at high drive levels.

Subwoofer Model Selection

All the systems in this guide use the Control SB-210 subwoofer, with the exception of the CCS6000 System, which uses the Control SB-2 subwoofer. Passive crossover networks are built-into SB-2 and available for SB-210, making it easy to structure subwoofer-satellite systems.

Designing for Other JBL Subwoofer Models

Other subwoofers from JBL Professional include Control 19CS In-Ceiling Subwoofer and Control 312CS High Power In-Ceiling Subwoofer. These subwoofers are intended to be used in actively crossed-over systems -- either contains a built-in passive crossover network.

For determining the proper number of Control 19CS subwoofers, use the Subwoofer Utility in the DSD Distributed System Design software (free download located on the Software Download page from the www.jblpro.com website).

For The Control 312CS subwoofer, use the "Control 300 Subwoofer Ratio Guide" posted in the Control 300 section of the Technical Library page on www.jblpro.com website.

Sub-Sat Design Considerations

Sound Level Capability

For each system in this guide, the Max SPL figure is listed, describing the continuous sound level that the system can maintain on a full-range basis with either speech or music program content, with 10 dB headroom for clear transient peaks.

For any installation, the satellite speakers might be located next to each other and cover exactly the same area, resulting in 6 dB of coupling between them, or they might be located far apart and have no overlap between then resulting in no coupling. The Max SPL figures listed in the charts assume somewhere in between, that there is some degree of overlap in coverage but not full overlap. Therefore, a coupling figure of 3 dB is utilized.

Actual Max SPL

For applications where there is very little overlap of satellite speakers, the actual Maximum SPL will be 3 dB lower for 2 satellite speakers (and 6 dB lower for 4 satellite speaker) than what is listed. For applications where there is almost full overlap (satellite speakers covering the same area), the actual Maximum SPL will be 3 dB higher for 2 satellite speakers (and 6 dB higher for 4 satellite speakers).

Subwoofer Location's Affect on Sensitivity and Maximum SPL

The system performance figures listed are based on the subwoofer being located away from boundary junctions and corners. For applications where the subwoofer will be placed at a 2-surface boundary junction (wall/floor, wall/ceiling, wall/wall), both the Sensitivity and the Maximum SPL of the subwoofer increases by 6 dB. For applications where the subwoofer is placed as a corner junction (wall/wall/ceiling or wall/wall/floor), the Sensitivity and the Maximum SPL of the subwoofer increases by 12 dB.

This can unbalance the subwoofer satellite sensitivity balance. It is a good idea to have an equalizer in the sound system to be able to adjust the bass level for proper balance. A parametric EQ allows for the best adjustment. For graphic EQ, a minimum of 15 bands is usually required to be able to set the EQ break point at the proper frequency.

Using the MTC-210-SAT Input Module

ALL these systems (except the CCS6000 System that utilizes a SB-2 subwoofer) utilize the MTC-210-SAT input module installed in the back of the Control SB-210 subwoofer. This module provides a full passive crossover consisting of a high-pass to the satellite speakers and low-pass to the subwoofer drivers.

4 Ohm / 8 Ohm Setting

(ie, Satellite Speaker Impedance Selector)
The module contains a header adjustment for setting the crossover to work properly with either 4 ohm or 8 ohm satellite loads per output.

Mono / Stereo Setting

The module also contains a header to set the system to operate either as a mono system with a single input (+ and -) wired to the Left/Mono input terminals, or as a full stereo system with Left input wired to Left input terminals and right input wired to Right input terminals.

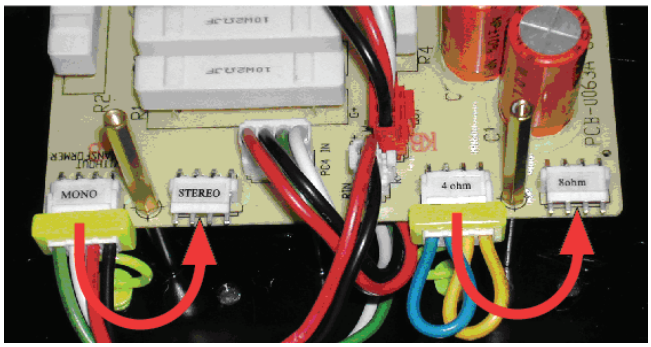


Figure 1
Setting Mono/Stereo and Satellite Impedance Headers on MTC-210-SAT (and MTC-210T-SAT) Input Module

Mono/Stereo and 4/8 Ohm selection is accomplished by moving the headers on the MTC-210-SAT Input Module before installing the module into the subwoofer. Yellow indicators move with the headers, annunciating the selected modes visibly on the back panel of the subwoofer after the module is installed. Header positions shown in the picture above are set to Mono with 4 ohms per channel of satellite speakers. Moving the headers in the position of the red arrows changes the settings to Stereo with 8 ohms per channel of satellite speakers.

Operation from a 70V/100V Distributed Speaker Line

A different SB-210 input module needs to be purchased for operating a subwoofer satellite system via 70V/100V. It is model MTC-210**T**-SAT, which includes input 70V/100V transformers as well as the built-in crossover network.

Speaker Type for 70V/100V Systems

Satellite speakers remain LOW-IMPEDANCE (non-T) models. **DO NOT use T-version satellite speakers for any of the satellite speakers, even those systems operated from a 70V/100V distributed speaker line.**

Adjusting Volume of 70V/100V System

Adjust the tap setting to change the amount of power that gets to the entire sub/sat system.

Multiple Systems

Multiple sub-sat systems can be utilized on a single 70V/100V distributed speaker line. Each can cover a different area with full-range sound. Systems can be mixed on a 70V/100V line as long as all the systems utilized the MTC-210T-SAT module. See Figure 2.

Subwoofer Distance Consideration

Even though it's not easy for the human ear to tell where the sound from a subwoofer is coming from (non-localizable), that doesn't mean that a single subwoofer can always cover an entire space.

The sound level from a subwoofer is louder nearby to the subwoofer and quieter farther away from it. As rooms get larger the level variation gets more uneven because the distance from the subwoofer gets longer. It may be necessary to add a second subwoofer on the other side of the room. Locating multiple subwoofers near the center of opposite walls within the room often works well, resulting in more even coverage of the entire room.

When greater subwoofer output is desired, an alternative is to locate the subwoofers near opposite corners of the room, although the subwoofers can get excessively loud in those corners compared to the rest of the room.

For rooms where very even subwoofer coverage is desired, a distributed subwoofer system might be a better solution than using one of the passive subwoofer/satellite systems from this guide. If so, see the subwoofer chapter of the JBL guide entitled *Designing Better Sounding In-Ceiling Business Music Systems*.

Affect of Room Size on Sound Level

The Max SPL figures listed for each system are based on a listening distance of approximately 20 feet.

For larger rooms where some listeners will be father than 20 feet from the speakers, the true sound level capability of the sub-sat system will be lower. For example, the Max SPL level at 40 feet -- twice the listening distance -- will be 6 dB lower than the listed figure.

In addition, as the room gets larger, there will be more level variation of the sound from both the satellite speakers and the subwoofer from place to place within the room. This can lead to unacceptably high variations in sound level, where the sound might be too loud in some areas and too soft in others.

In rooms where this is the case, it may be necessary to utilize more than one subwoofer/satellite system, or to use a more highly distributed system than a small subwoofer/satellite system is capable of doing.

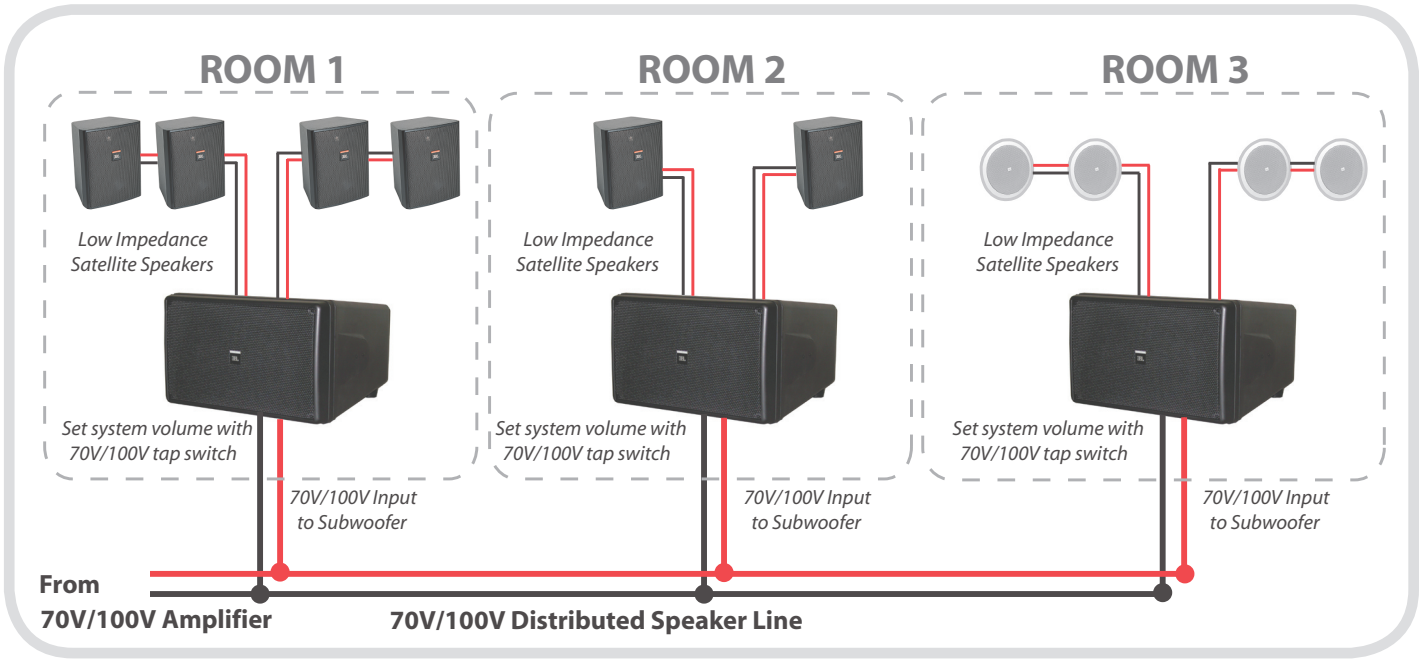


Figure 2
Multiple 70V/100V sub-sat systems on a single distributed speaker line.

Systems with **SURFACE-MOUNT** (on-wall) Satellite Speakers

System #1: CCS6000 System

4 pcs Control 23 with Control SB-2

Application
Light volume ambient music in medium size spaces where four speakers are needed.

Max Continuous Average SPL (at 20 feet)
87 dB (with peaks of 97 dB)

Stereo/Mono Capability
Works best as a stereo system with separate input for left and right inputs.

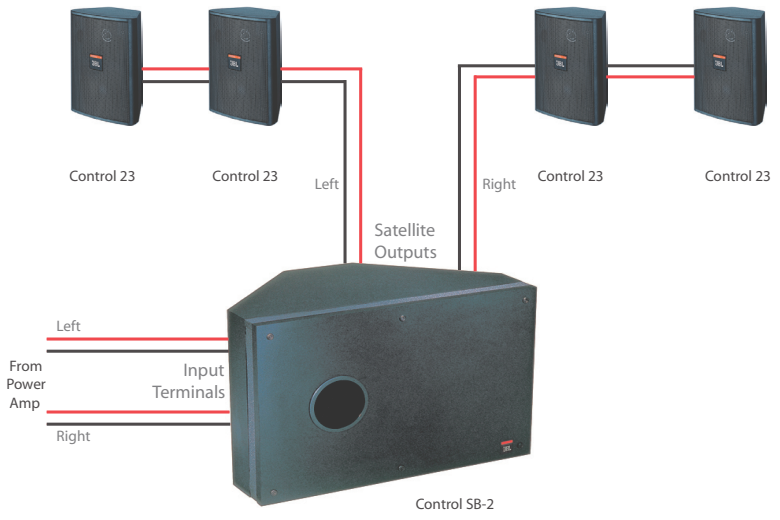
Connection
Connect 2 pcs of Control 23 to each satellite output (Left and Right). Do NOT connect all 4 satellite speakers to a single satellite output.

Application Note:
This combination produces a great full-range sound with flat frequency response, usable from 38 Hz to 22 kHz.

Do NOT use a different quantity or model of satellite speaker. Changing to a different, higher sensitivity, satellite model unbalances the subwoofer/satellite sensitivity balance *(see "Consideration" notes above)*, resulting in the mids and highs being overly dominant. Similarly, changing to fewer Control 23 speakers results in a different load impedance resulting in incorrect crossover point. This system works properly only with 4 pcs Control 23 speakers – they were designed to be used together.

CCS6000 System (Stereo Only)

SPL (at 20 Feet):
84 dB Continuous (peaks of 94 dB)



Stereo System Connection Note

Ensure that the polarity hookup of the left and right inputs is correct. If one of the inputs is connected backwards (out of polarity), the subwoofer will not produce much (if any) bass.

System #2

2 pcs Control 25AV & Control SB-210

Application: Light to medium volume ambient music in small to medium sized spaces where two satellite speakers are enough to cover the area. This system produces excellent high fidelity sound quality with very strong bass.

Max Continuous Average SPL (at 20 feet): 91 dB (with peaks of 101 dB)

Max Output Balance -- The subwoofer has substantially higher maximum output capability than the satellite speakers, so this system has the capability of optionally being utilized in applications where the bass will be EQ'd substantially higher than the mids and highs. The system also works fine for flat-response applications.

Lower-Cost Option: Less expensive Control 25 speakers can be utilized instead of Control 25AV for a more cost-effective system. The system will have slightly lower overall fidelity, but will get 1 dB louder.

4 Ohm / 8 Ohm Setting: 8 Ohms

Stereo/Mono Capability: Either setting can be utilized.

Connection:

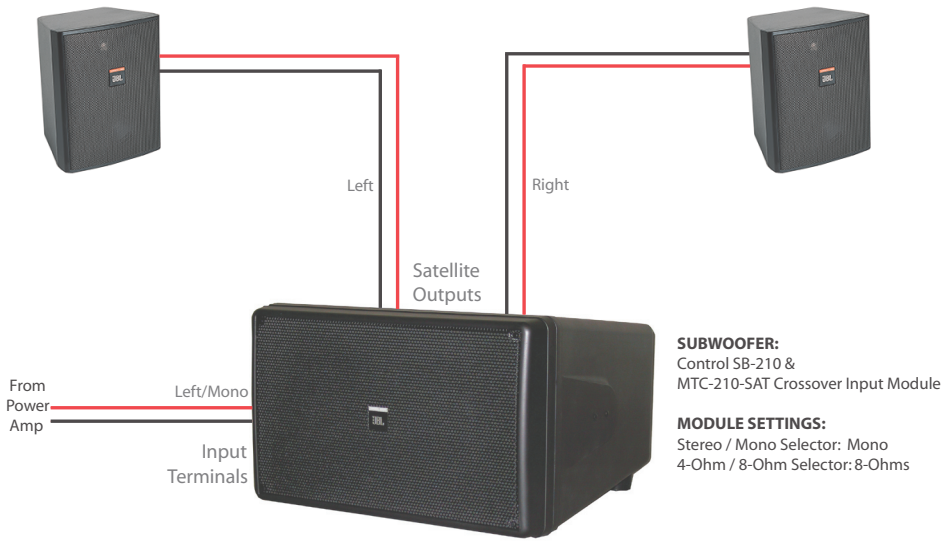
Mono Operation – Connect input to the LEFT/MONO input terminal. Put Stereo/Mono header into MONO position. Connect 1 pc of Control 25AV to each satellite output (LEFT and RIGHT). Do NOT connect both satellite speakers to a single satellite output.

Stereo Operation – Connect left and right inputs to the LEFT and RIGHT input terminals. Put Stereo/Mono header into STEREO position. Connect 1 pc of Control 25AV to each of the Satellite Outputs (LEFT and RIGHT)

Connection Diagrams

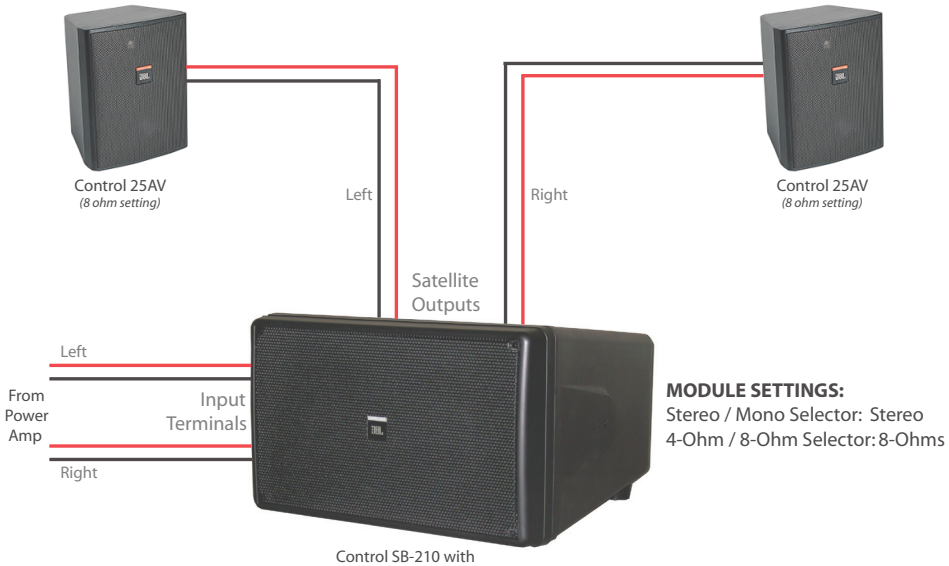
System #2 in Mono

SPL (at 20 Feet):
91 dB Continuous (peaks of 101 dB)



System #2 in Stereo

SPL (at 20 Feet):
91 dB Continuous (peaks of 101 dB)

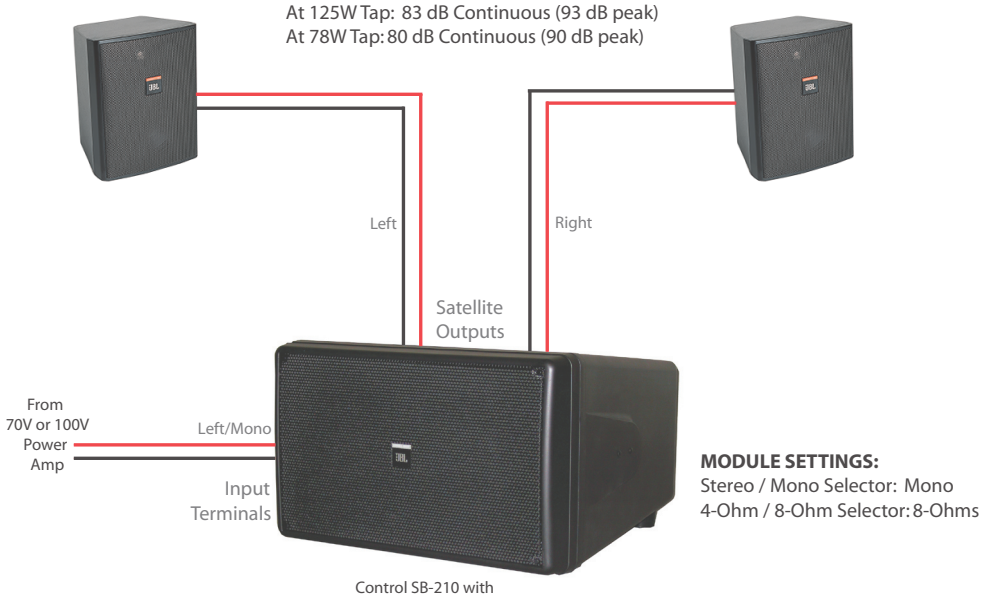


Stereo System Connection Note

Ensure that the polarity hookup of the left and right inputs is correct. If one of the inputs is connected backwards (out of polarity), the subwoofer will not produce much (if any) bass.

System #2 on 70V/100V Distributed Line

SPL (at 20 feet):
At 250W Tap: 86 dB Continuous (96 dB peak)
At 125W Tap: 83 dB Continuous (93 dB peak)
At 78W Tap: 80 dB Continuous (90 dB peak)



System #3

2 pcs Control 28 & Control SB-210

Application: Medium volume ambient music in small spaces where two satellite speakers are enough to cover the area.

Max Continuous Average SPL (at 20 feet): 95 dB (with peaks of 105 dB)

Max Output Balance -- The subwoofer has higher maximum output capability than the satellite speakers, so this system has the capability of being utilized for applications where the bass will be EQ'd substantially higher than the mids and highs. The system also works fine for flat-response applications.

4 Ohm / 8 Ohm Setting: 8 Ohms

Stereo/Mono Capability: Either setting can be utilized

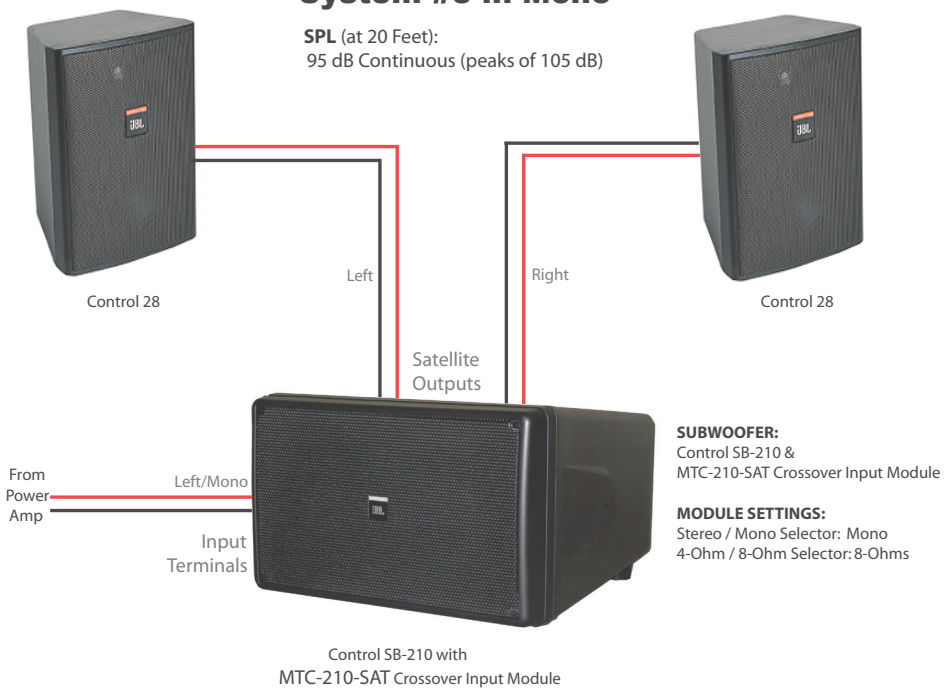
Connection:

Mono Operation – Connect input to the LEFT input terminal. Put Stereo/Mono header into MONO position. Connect 1 pc of Control 28 to each satellite output (LEFT and RIGHT). Do NOT connect both satellite speakers to a single satellite output.

Stereo Operation – Connect left and right inputs to the LEFT and RIGHT input terminals. Put Stereo/Mono header into STEREO position. Connect 1 pc of Control 28 to each of the Satellite Outputs (LEFT and RIGHT)

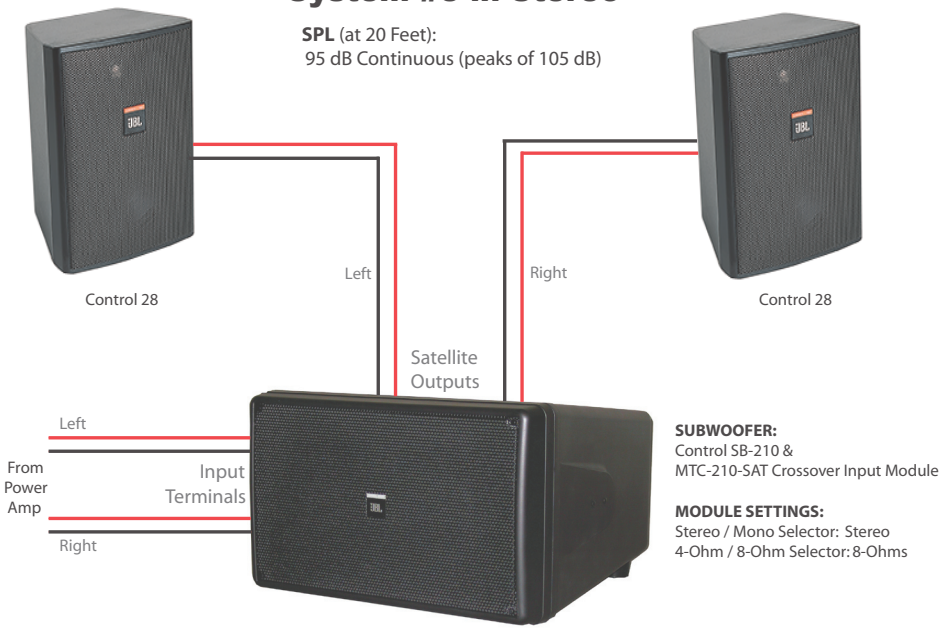
Connection Diagrams

System #3 in Mono



System #3 in Stereo

SPL (at 20 Feet):
95 dB Continuous (peaks of 105 dB)

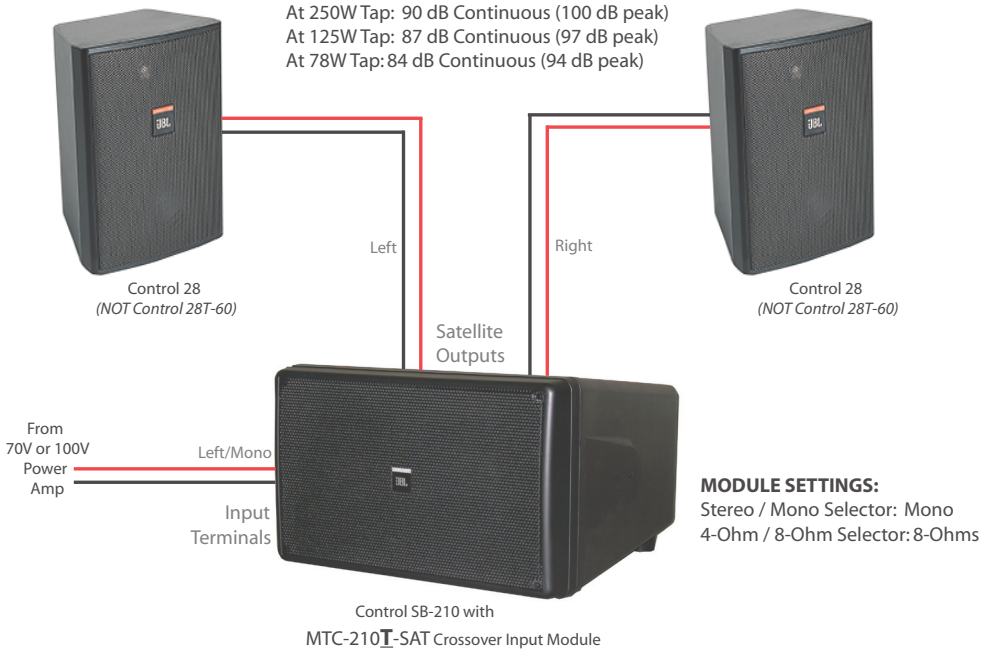


Stereo System Connection Note

Ensure that the polarity hookup of the left and right inputs is correct. If one of the inputs is connected backwards (out of polarity), the subwoofer will not produce much (if any) bass.

System #3 on 70V/100V Distributed Line

SPL (at 20 feet, by tap seetting on SB210):
At 250W Tap: 90 dB Continuous (100 dB peak)
At 125W Tap: 87 dB Continuous (97 dB peak)
At 78W Tap: 84 dB Continuous (94 dB peak)



System #4

2 pcs Control 29AV & Control SB-210

Application
High volume, high-fidelity music reproduction in small spaces where two satellite speakers are enough to cover the area.

Max Continuous Average SPL (at 20 feet)
96 dB (with peaks of 106 dB)

4 Ohm / 8 Ohm Setting
8 Ohms

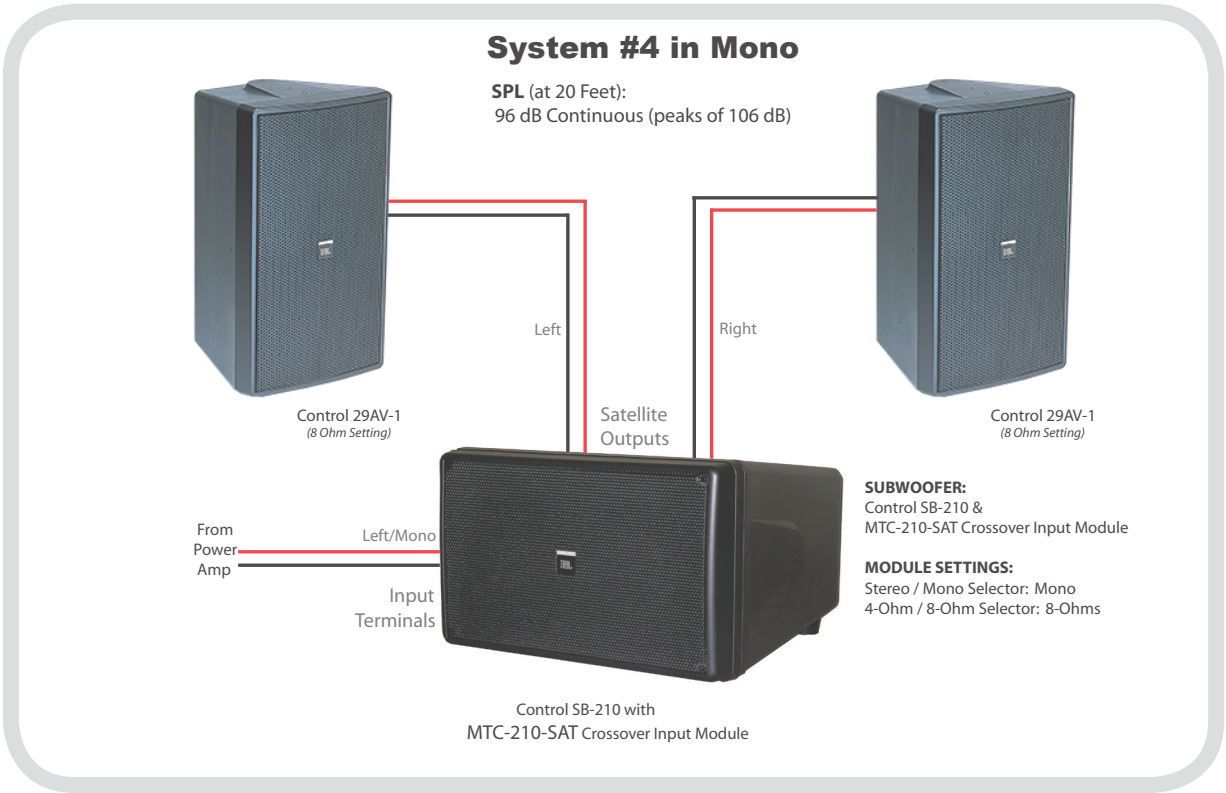
Stereo/Mono Capability
Either setting can be utilized

Connection
Mono Operation – Connect input to the LEFT input terminal. Put Stereo/Mono header into MONO position. Connect 1 pc of Control 28 to each satellite output (LEFT and RIGHT). Do NOT connect both satellite speakers to a single satellite output.

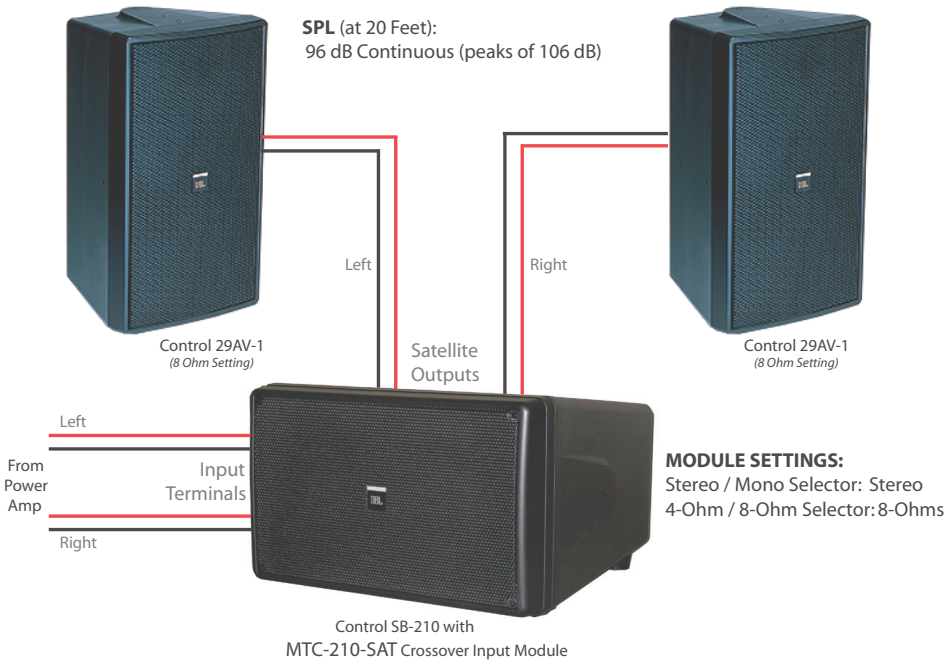
Stereo Operation – Connect left and right inputs to the LEFT and RIGHT input terminals. Put Stereo/Mono header into STEREO position. Connect 1 pc of Control 28 to each of the Satellite Outputs (LEFT and RIGHT)

Application Note
The Control 29AV-1 has the highest sensitivity (sound output per watt of input) of any of the satellite speakers in this guide, resulting in the bass from the subwoofer being lower, in relative sense, than some of the other sub/sat systems. For more dominant bass, additional subwoofer sensitivity can be attained by corner-loading the subwoofer (see "Sensitivity Balance" section, above). Alternatively, the subwoofer/satellite sensitivity balance can be altered with an in-line active equalizer.

Connection Diagrams



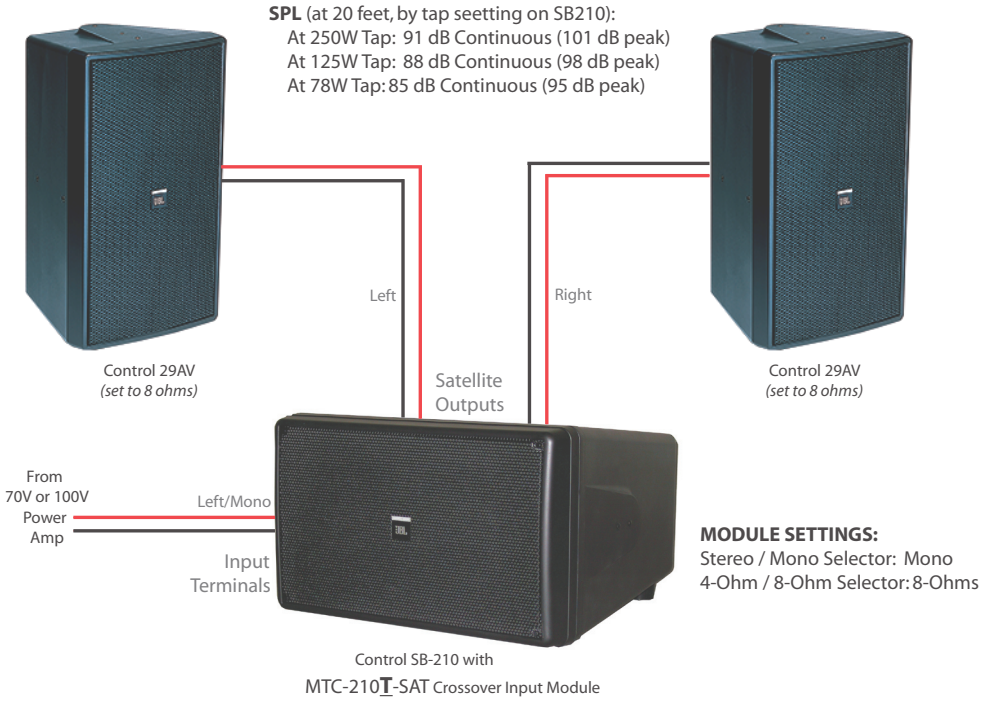
System #4 in Stereo



Stereo System Connection Note

Ensure that the polarity hookup of the left and right inputs is correct. If one of the inputs is connected backwards (out of polarity), the sub-woofer will not produce much (if any) bass.

System #4 on 70V/100V Distributed Line



System #5

4 pcs Control 25AV & Control SB-210

Application
Medium volume, high-fidelity music reproduction where 4 satellite speakers are needed to cover the area.

Max Continuous Average SPL (at 20 feet)
94 dB (with peaks of 104 dB)

Max Output Balance
The subwoofer has higher maximum output capability than the satellite speakers and the output capability can be further boosted by placing the subwoofer at a boundary junction or corner. This system has the capability of being utilized for applications where the bass will be EQ'd substantially higher than the mids and highs. The system also works fine for flat-response applications.

4 Ohm / 8 Ohm Setting
4 Ohms

Stereo/Mono Capability
Either setting can be utilized

Connection
Mono Operation – Connect input to the LEFT input terminal. Put Stereo/Mono header into MONO position. Connect 2 pcs of Control 25AV to each satellite output (LEFT and RIGHT). Do NOT connect all 4 satellite speakers to a single satellite output.

Stereo Operation – Connect left and right inputs to the LEFT and RIGHT input terminals. Put Stereo/Mono header into STEREO position. Connect 2 pcs of Control 25AV to each of the Satellite Outputs (LEFT and RIGHT)

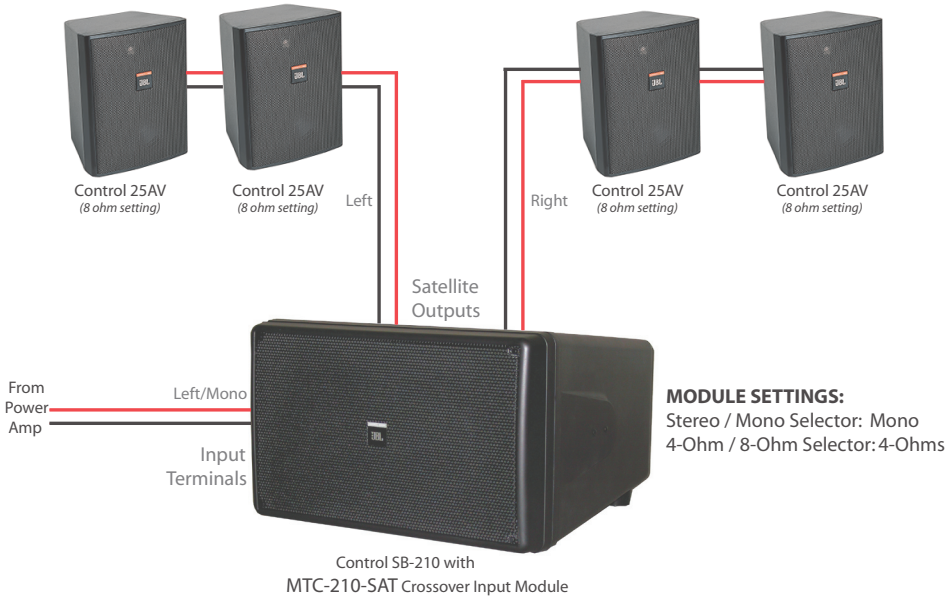
Application Notes
Balance -- The subwoofer has higher maximum output capability than the satellite speakers and the output capability can be further boosted by placing the subwoofer at a boundary junction or corner. This system has the capability of being utilized for applications where the bass will be EQ'd substantially higher than the mids and highs. The system also works fine for flat-response applications.

Variations -- Control 25 speakers can be utilized instead of Control 25AV for a more cost-effective system, resulting in slightly lower overall fidelity, but 1 dB louder SPL.

Connection Diagrams

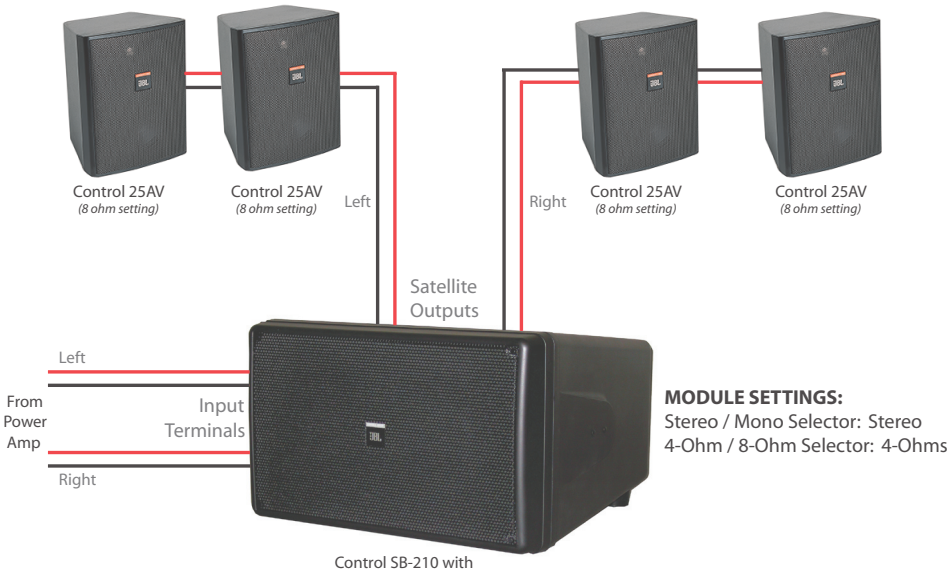
System #5 in Mono

SPL (at 20 Feet):
94 dB Continuous (peaks of 104 dB)



System #5 in Stereo

SPL (at 20 Feet):
94 dB Continuous (peaks of 104 dB)



MODULE SETTINGS:
Stereo / Mono Selector: Stereo
4-Ohm / 8-Ohm Selector: 4-Ohms

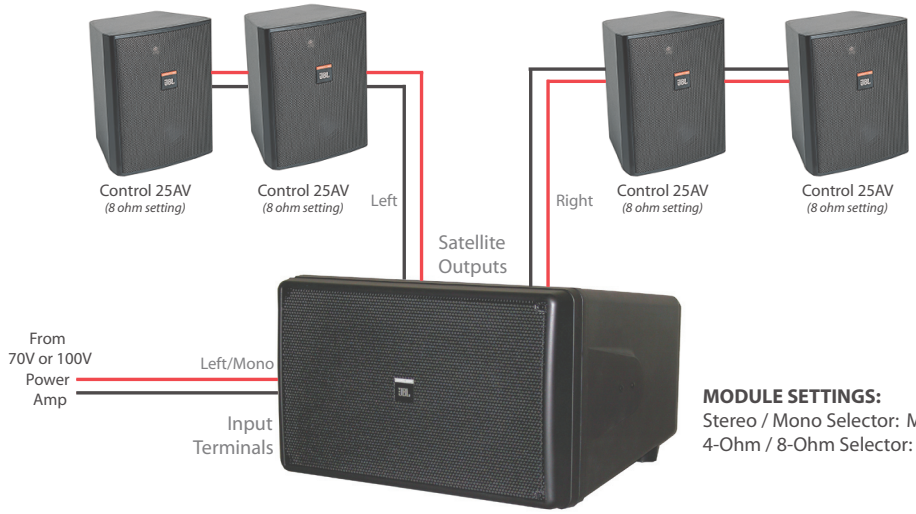
Control SB-210 with
MTC-210-SAT Crossover Input Module

Stereo System Connection Note

Ensure that the polarity hookup of the left and right inputs is correct. If one of the inputs is connected backwards (out of polarity), the sub-woofer will not produce much (if any) bass.

System #5 on 70V/100V Distributed Line

SPL (at 20 feet, by tap setting on SB210):
At 250W Tap: 94 dB Continuous (104 dB peak)
At 125W Tap: 91 dB Continuous (101 dB peak)
At 78W Tap: 88 dB Continuous (98 dB peak)



MODULE SETTINGS:
Stereo / Mono Selector: Mono
4-Ohm / 8-Ohm Selector: 4-Ohms

Control SB-210 with
MTC-210**T**-SAT Crossover Input Module

Systems with IN-CEILING Satellite Speakers

In-ceiling loudspeakers can benefit from the addition of a subwoofer. Often that takes the form factor of an in-ceiling subwoofer like Control 19CS or Control 312CS, but it may be desirable to use a subwoofer with a full passive crossover. For more information about model selection, see the "Subwoofer Model Selection" and "Designing for Other JBL Subwoofer Models" sections, above.

The SB-210 with MTC-210-SAT module is a subwoofer that contains a built in passive crossover, which makes it easy to structure subwoofer/satellite systems. With in-ceiling satellite speakers, the SB-210 can be mounted on a wall or ceiling via the MTC-210U U-bracket, suspended from the ceiling via built-in suspension points, or installed above an air grate grille in the ceiling.

System #6

4 pcs Control 24C with Control SB-210

Application: Medium volume, high-fidelity music reproduction where 4 in-ceiling satellite speakers are needed to cover the area.

Max Continuous Average SPL (at 10 feet): 96 dB (with peaks of 106 dB).

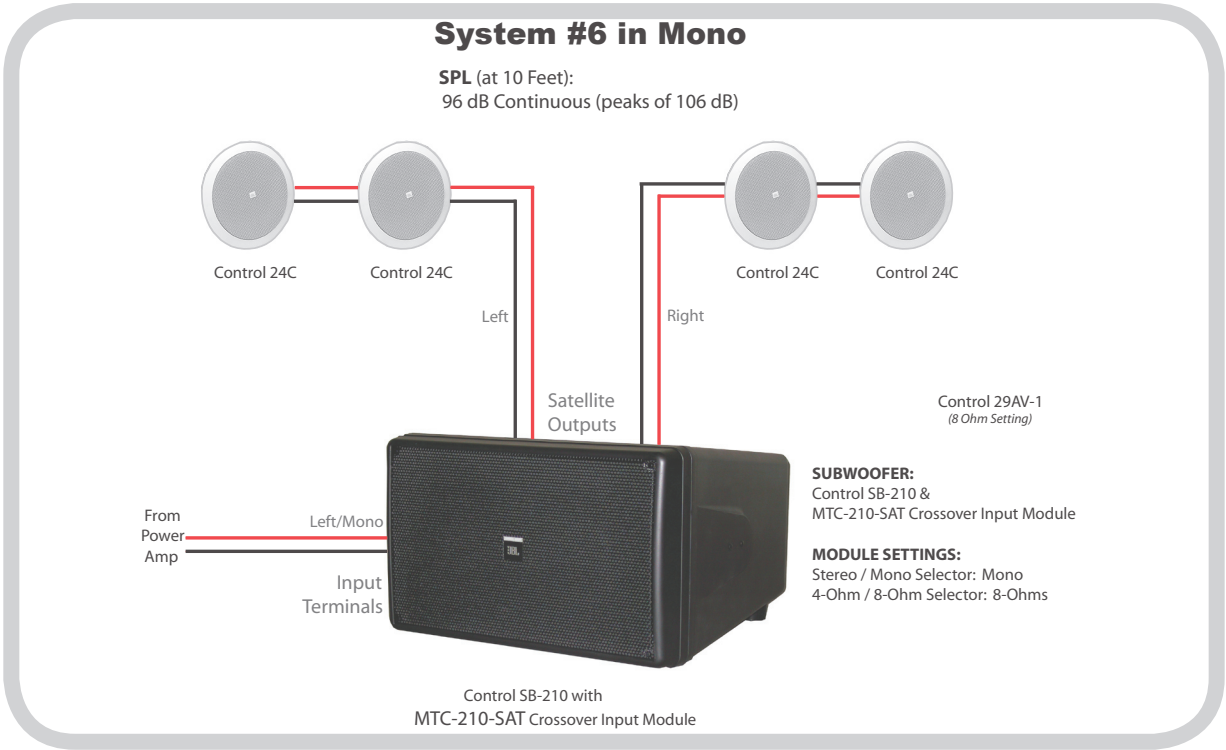
4 Ohm / 8 Ohm Setting: 4 Ohms.

Stereo/Mono Capability: Either setting can be utilized

Connection

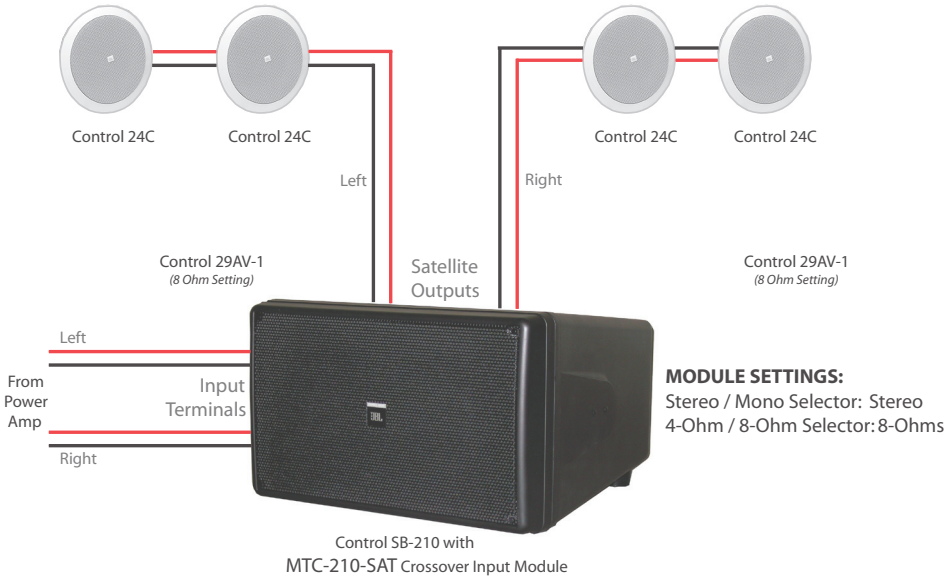
Mono Operation – Connect input to the LEFT input terminal. Put Stereo/Mono header into MONO position. Connect 2 pcs of Control 24C to each satellite output (LEFT and RIGHT). Do NOT connect all 4 satellite speakers to a single satellite output.

Stereo Operation – Connect left and right inputs to the LEFT and RIGHT input terminals. Put Stereo/Mono header into STEREO position. Connect 2 pcs of Control 24C to each of the Satellite Outputs (LEFT and RIGHT)



System #6 in Stereo

SPL (at 10 Feet):
96 dB Continuous (peaks of 106 dB)

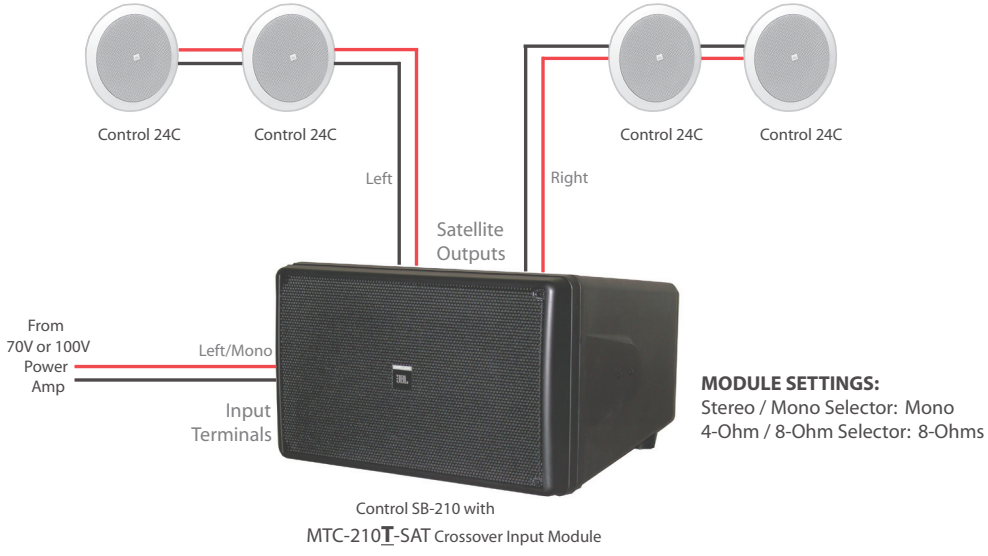


MODULE SETTINGS:
Stereo / Mono Selector: Stereo
4-Ohm / 8-Ohm Selector: 8-Ohms

Stereo System Connection Note

Ensure that the polarity hookup of the left and right inputs is correct. If one of the inputs is connected backwards (out of polarity), the subwoofer will not produce much (if any) bass.

System #6 on 70V/100V Distributed Line



MODULE SETTINGS:
Stereo / Mono Selector: Mono
4-Ohm / 8-Ohm Selector: 8-Ohms

JBL Professional
8500 Balboa Boulevard, P.O. Box 2200
Northridge, California 91329 U.S.A.

CC Sub Sat
11/06