Cardioid subwoofer array settings

Cardioid subwoofer arrays can be used to direct the output of an array of subwoofers in order to limit excessive amounts of bass in undesired locations. Cardioid arrays can be used to keep bass off of a stage, stop destructive reflections, or just keep the bass aimed toward the intended audience and not the surrounding area. This paper details the setup and use of DSP settings which Electro-Voice has created for use with the XCS312 and the Xsub loudspeakers.

In general, cardioid loudspeaker arrays use a combination of forward-firing and rear-firing (cancellation) loudspeakers to create a desired polar pattern. This can be done using several methods; however, the method used for the settings discussed here is the traditional cardioid approach. In this approach, the cancellation loudspeaker(s) has the appropriate DSP applied to it in order to match the response of the forward-firing loudspeaker(s) at the back of the array. The cancellation speaker is then inverted in polarity, which interacts with the response of the forward-firing loudspeakers, resulting in drastically reduced output at the back of the array. Additionally, the response from the cancellation woofer wrapping around the front of the array will sum with a small positive gain. When used appropriately, up to 25 to 35 dB of cancellation can be achieved.

By adjusting the setup of the cancellation loudspeaker, the maximum attenuation can be achieved at different locations on the backside of the array. Although this is essentially variable, we have provided several common options. These common options are: cardioid, where maximum cancellation happens at 180; super cardiod, where maximum cancellation happens at ~130; or dipole, which achieves maximum cancellation at ~90.

Xsub v5.0 cardioid and supercardioid ground-stack array settings

Electro-Voice has created three new IRIS-Net SPS files which can be used to create both cardioid and supercardioid loudspeaker arrays using Electro-Voice Xsub loudspeakers. Using these settings, a user can control the directivity pattern of an array of Xsubs to reduce the SPL directly behind the array (cardioid) or at roughly 135 degrees off-axis from the center of the array (supercardioid). The user may choose which pattern best suits their needs.

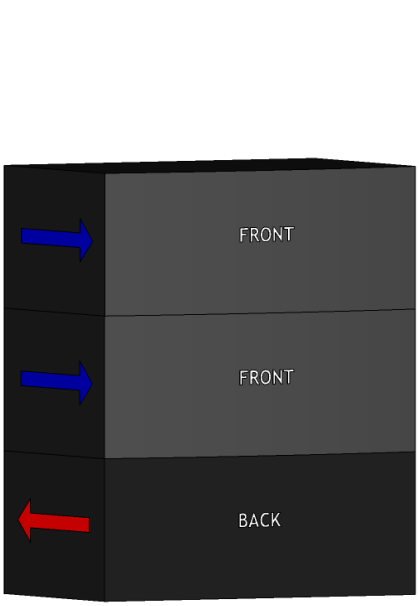
These settings will work in several ground-stacked configurations. It is important that you align the boxes properly. This requires aligning the stacking feet so that all four feet of each box are aligned with the adjacent box's receiving cups. All steerable subwoofer arrays must also have sufficient room behind them—with little or no reflective surfaces—in order to function. Any surface behind the array will change the response of the system and affect the polar pattern of the system. All cardioid or supercardioid arrays have a cancellation speaker, or a speaker that is facing backwards. The relative placement of this speaker to the forward-firing loudspeakers is critical to the quality of the array. Always use the same DSP setting on the cancellation loudspeakers. Mixing the cardioid and supercardioid settings would not be advantageous.

Vertical arrays:

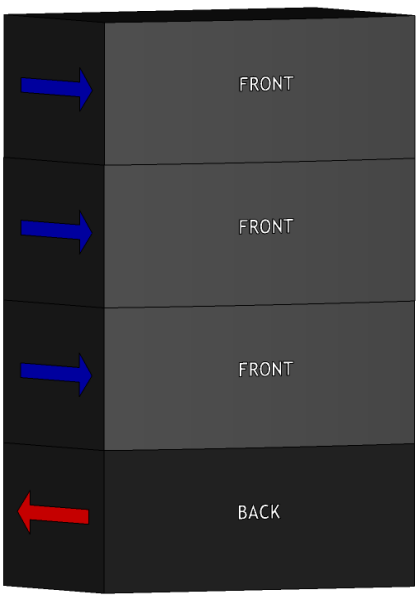
The first configuration is a three-box vertical array. In this array, the cancellation speaker works best if it is at the bottom. Therefore place the cancellation speaker first so that it is facing where you would require maximum cancellation. Then place two additional Xsub loudspeakers on top of the cancellation speaker facing towards the audience. Make sure that all the feet are aligned

properly and that the stack is stable. If you use Xsub bottom dollies, you can stack the loudspeakers on the dolly; this will not adversely affect the results of the array.

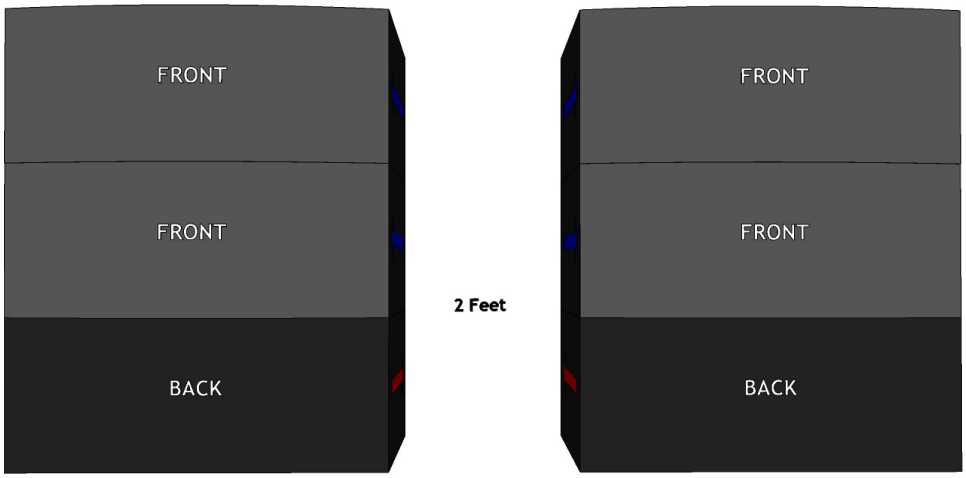
To increase the size of the array, either add one additional forward-facing loudspeaker to this stack or place a duplicate of this array next to this loudspeaker. It is important to leave at least two feet of space between arrays to allow the waves from the front to propagate naturally to the rear of the loudspeaker.



Three-box array



Four-box array



Two sets of three-box vertical arrays spaced appropriately

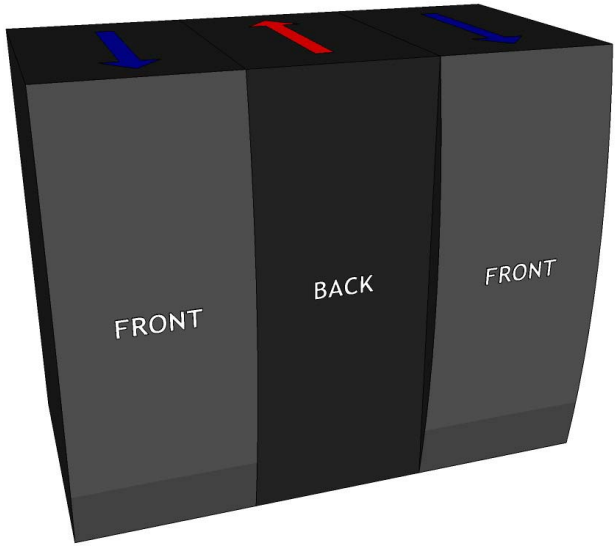
Wire the system so that the cancellation loudspeaker is independent of the forward-facing loudspeakers. Apply the Xsub Front FIR_Drive v5.0 settings to forward-facing loudspeakers.

Apply the Xsub Cardioid Rear FIR_Drive v5.0 settings to the cancellation loudspeaker for a cardioid pattern. Apply Xsub Super Cardioid Rear FIR_Drive v5.0 to the cancellation loudspeaker for a supercardioid pattern.

If the loudspeakers are set up correctly as described above, you should achieve 20 to 30 dB of cancellation from 100 Hz down.

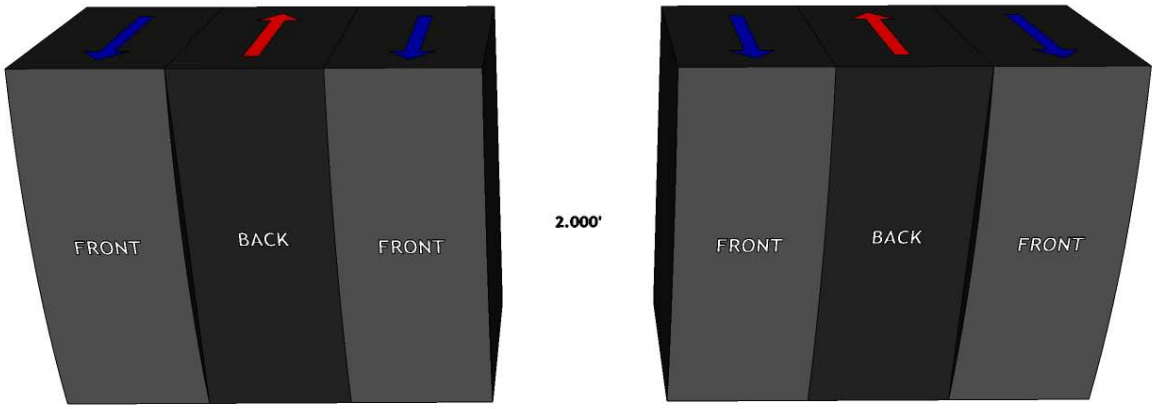
Horizontal arrays:

The second option for creating cardioid arrays is to place the loudspeakers on their ends and align them to create a horizontal array. Again, the boxes should be aligned using the stacking feet and the receiving cups of adjacent boxes. For best results, the cancellation loudspeaker should be in the middle of two forward-facing Xsub loudspeakers. The cancellation loudspeaker must be facing the opposite direction from the intended audience area and towards the area of desired cancellation.



Three-box horizontal array

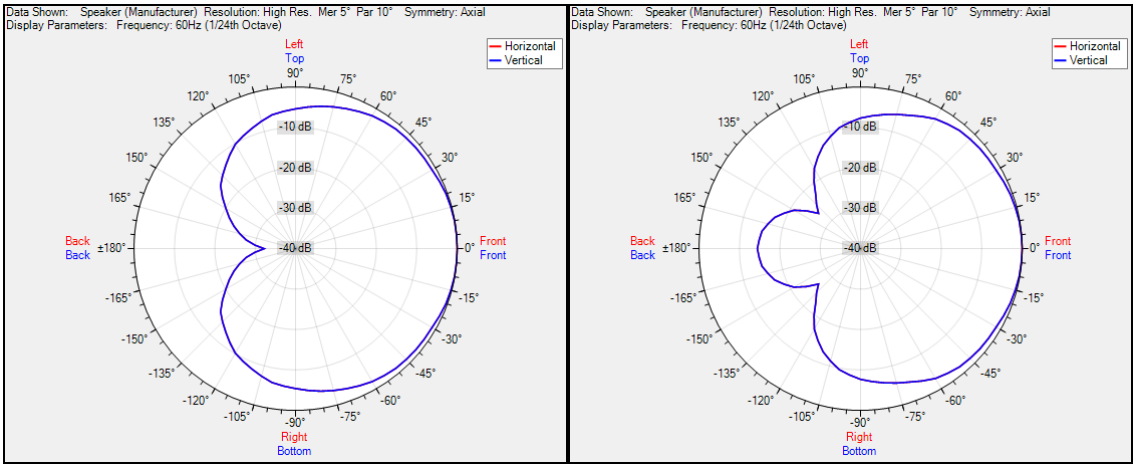
To increase the array size, the best option is to repeat the three-box horizontal array while leaving at least two feet between arrays. Again, this spacing is required to allow the sound from the front of the loudspeaker to naturally propagate to the rear of the loudspeaker.



Two sets of three-box horizontal arrays appropriately spaced

As with the vertical arrays, wire the system so that the cancellation loudspeaker is independent of the forward-facing loudspeakers. Apply the Xsub Front FIR_Drive v5.0 settings to the two front loudspeakers. Apply the Xsub Cardioid Rear FIR_Drive v5.0 settings to the cancellation loudspeaker for a cardioid pattern. Apply Xsub Super Cardioid Rear FIR_Drive v5.0 settings to the cancellation loudspeaker for a supercardioid pattern.

If the loudspeakers are set up correctly as described above, 20 to 30 dB of cancellation from 100 Hz down should be obtained. Below are actual measured results from a three-box Xsub horizontal array with both cardioid and supercardioid settings applied.



Cardioid Supercardioid

The Xsub v5.0 settings are Electro-Voice FIR-Drive DSP settings. They include a combination of proprietary IIR equalization, delay and polarity control, as well as Peak Anticipation (PA) limiters and Thermal Energy Management and Protection (TEMP) limiters.

XCS312 v3.0 cardioid, Supercardioid, and dipole ground-stack or flying array settings

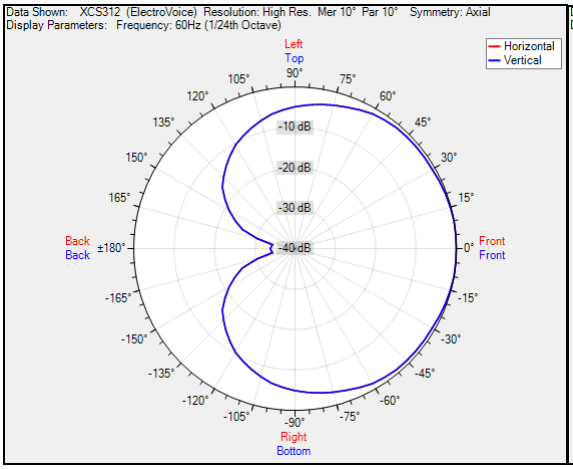
Electro-Voice has created four new IRIS-Net SPS files which can be used to create cardioid, supercardioid, and dipole loudspeaker arrays using Electro-Voice XCS312 loudspeakers. Using these settings, a user can control the directivity pattern of an array of XCS312 loudspeakers to reduce the SPL directly behind the array (cardioid), at roughly 135 degrees off-axis from center of the array (supercardioid), or at roughly 90 degrees from the center of the array (dipole). Users may choose which pattern best suits their needs.

The Electro-Voice XCS312 loudspeaker is a preconfigured cardioid subwoofer. This model comes complete with its cancellation speaker and front speakers appropriately spaced for ideal cardioid response.

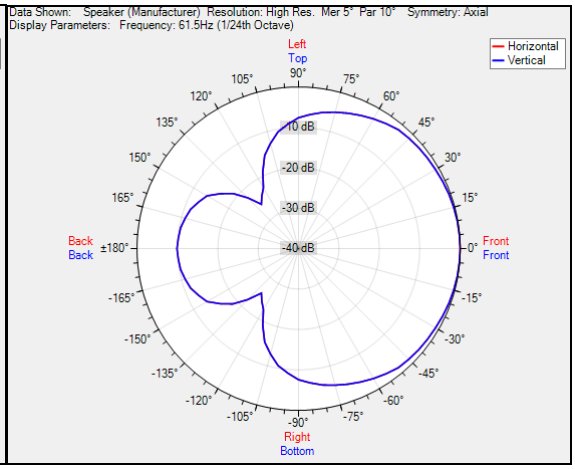
This loudspeaker is designed to be used in flown vertical arrays and will therefore perform best in this scenario. If the loudspeakers will be used in a ground-stack scenario, the suggestions from the Xsub cardioid settings can be applied here as well. At least two feet of space should be left in between adjacent stacks of XCS312 loudspeakers. The cancellation will not be as effective if this space is not left between the boxes.

The four IRIS-Net SPS files include a standard front setting that can be used with all three options (cardioid, supercardioid, and dipole). Simply apply the XCS312 Front FIR_Drive v3.0 setting to the forward-facing loudspeakers and any one of the three options to the rear-firing cancellation loudspeakers. Do not mix the cancellation loudspeaker settings in the same array.

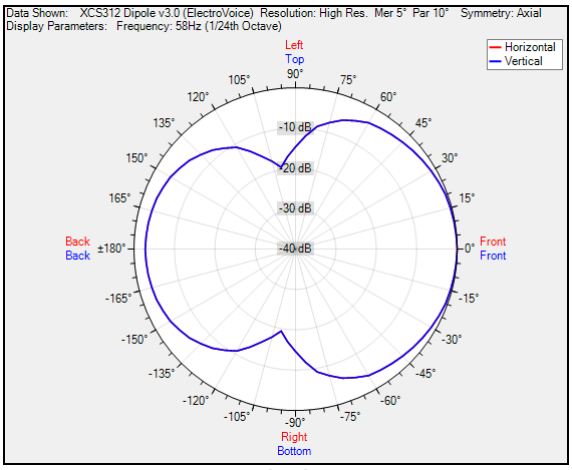
Below are actual measurements of each of the three options on an array of XCS312 loudspeakers. As shown in the diagrams below, the amount of rejection is different between each option. However, 20 to 40 dB of maximum rejection can be achieved depending on the setting chosen.



Cardioid



Supercardioid



Dipole

The XCS312 v3.0 settings are available in Electro-Voice FIR-Drive DSP settings or standard DSP. The FIR-Drive settings include a combination of proprietary IIR equalization, delay and polarity control, as well as Peak Anticipation (PA) limiters and Thermal Energy Management and Protection (TEMP) limiters.

Let us help you get the most out of your sound reinforcement system by ensuring the highest level of performance and reliability. We are here to assist with the best loudspeaker settings, firmware, and software for the loudspeaker, processor, and amplifier combination you are using, along with the most up-to-date support literature and software.

Please contact one of the Electro-Voice Technical Support Teams at one of the locations listed below.

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