Application Guide

Spaced SB2210 FSA Forward Steered Low-Bass Array

Jan/04 – Rick Kamlet (updated Apr/21)

Using three bass or subwoofer loudspeakers in a FSA Forward Steered Array configuration yields excellent bass directional control along with high output level. This paper shows 3 x SB2210s as an example, but similar steered bass/subwoofer arrays can be structured for a variety of applications.

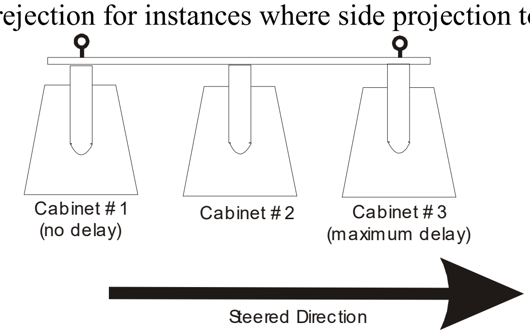
This level of previously unachievable low frequency pattern control can be useful for a variety of purposes, including:

- Venues such as nightclubs where you want high SPL on the dance floor yet might want to lower the SPL in nearby seating areas to allow conversation.
- Noise control in outdoor locations.
- To reduce destructive bass interaction in closed large venues such as enclosed stadiums and arenas. This reduces bass "rumble" and time smearing, improving bass fidelity and in many cases allowing bass where it would not have been possible otherwise.
- Providing for "delay subs" situated partway back in a room, which allows the main subwoofers to be played at a lower volume level.
- For keeping low frequencies off a stage area in live performance venues and houses of worship, reducing feedback. This reduces bleed-back through to performance microphones, improving the quality of the sound reinforcement.

Description -- Three speakers are spaced 24" apart (on center) with a delay settings of either straight delay, 130% over-delay or 150% "over-delay (to be defined below) yield very well-controlled coverage lobes and excellent rear attenuation in the 50 Hz to 100 Hz range. Other spacing distances do not work as well.

Delay Settings – Different delay settings are sent to each speaker cabinet. Using a "straight delay" means matching the delay to the distance between cabinets. "Over-delay" means increasing the delay figure – ie, 130% means increasing the delay time 30% longer than the straight delay setting.

The choice of settings depends on factors such as the bandwidth in which the subwoofer will be operational. Using a 130% delay may be the most effective for general applications. The straight delay maximizes rear rejection in the mid-bass to low-bass region, 130% delay is better for low-bass to mid-subwoofer range, and 150% delay is best for the true subwoofer range. 150% also provides the greatest degree of side rejection for instances where side projection to a stage must be minimized.



Aiming – Because there is no vertical offset between drivers, no down-angle aiming can be done electronically with this array (as larger FSA arrays can do). If an aiming angle other than horizontal is desired, the 3-speaker array must be physically aimed in the desired direction.

Ceiling-Mounting – The array can be installed on the ceiling using the available U-bracket or other methods. The relative coverage at off-axis angles will be similar to that shown, just restricted to the lower half of the polar.

Suspension – The installer is responsible for fabricating or constructing a frame and suspending the assembly safely. Depending on the application, a simple frame might be formed utilizing either flat bar stock metal or UniStrut-style members, attached either to the available MTC-210UB U-brackets (shown below) or attaching to end insert points on the speakers themselves.

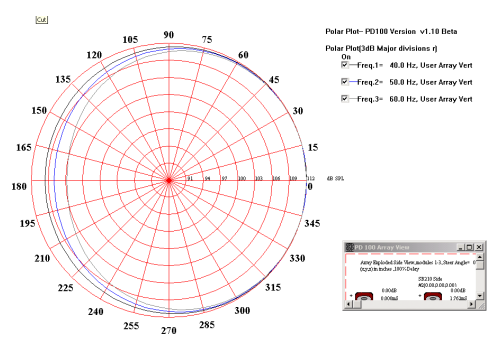
ARRAY 1
3 Speakers 24” Apart (On-Center) with “Straight” Delay

Following are predicted (and verified) coverage curves at frequencies from 40 Hz to 160 Hz with standard delay. Gridlines are 3 dB per division.

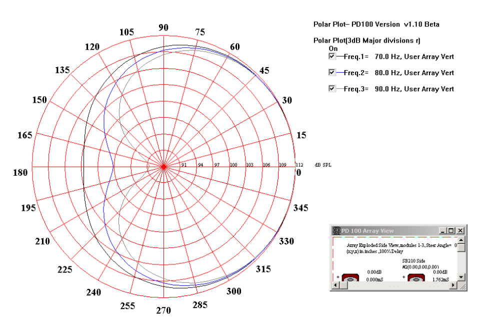
Delay Settings – The delays are 1.76 mS to the 2nd speaker and 3.52 mS to the 3rd speaker.

Rear Attenuation – 40 Hz shows only 3 dB rear attenuation and 50 Hz shows 4 dB. 60 Hz shows 6 dB rear attenuation. 70 Hz shows 9 dB. 80 Hz shows 15 dB. 90 Hz shows 21 dB. 100 Hz shows 21 dB. Small rear lobes appear at higher frequencies, with the rear lobe still being down 10 dB at 150 Hz.

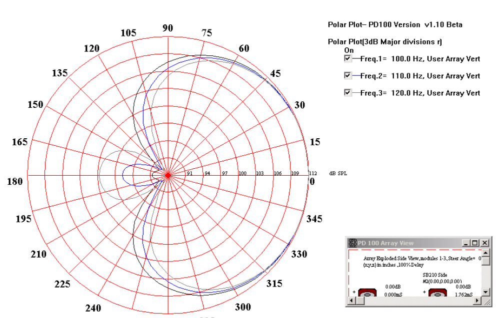
Pattern Control -- Pattern control, defined as minimum 6 dB rear attenuation, is effective from 60 Hz through 150 Hz.



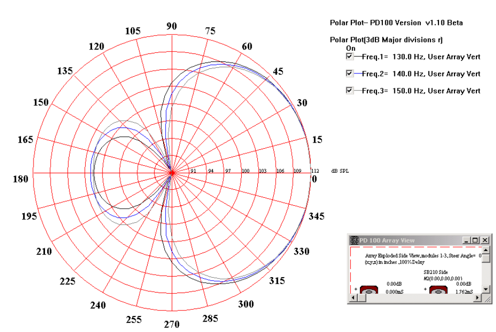
40 Hz, 50 Hz & 60 Hz



70 Hz, 80 Hz & 90 Hz



100 Hz, 110 Hz & 120 Hz



130 Hz, 140 Hz & 150 Hz

ARRAY 2
3 SPEAKERS 24" APART (On Center) with 130% Over-delay

Increasing the delay setting by 30% improves the rear attenuation below 100 Hz and narrows the coverage lobe, resulting in greater off-axis rejection. Following are the simulated coverage curves with delay times increased 30% over standard delay.

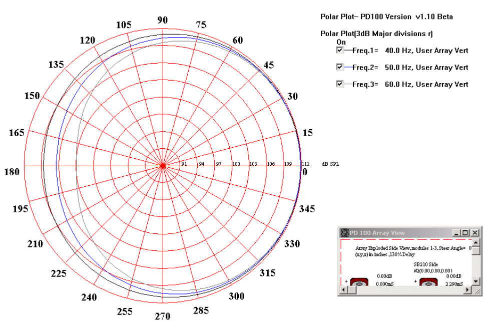
Delay Settings – The delay times are 2.29 mS to the 2nd speaker and 4.58 mS to the 3rd speaker.

Rear Attenuation – Compared to straight delay 40 Hz and 50 Hz show a slight improvement to 4 dB and 5 dB rear attenuation respectively. 60 Hz attenuation increases 50% to 9 dB.   70 Hz attenuation increases 60% to 15 dB. 80 Hz attenuation increases 70% to 25 dB. 90 Hz attenuation stays high at 25 dB. The rear lobes start showing up at 100 Hz attenuation which reduces 30% to 15 dB. Compared to 150% delay, rear attenuation is less at all frequencies except the top-end frequency of 100 Hz.

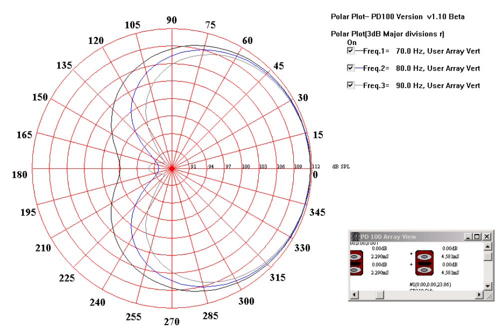
Rear Lobes -- Rear lobes start appearing at lower frequencies than with the straight delay but a higher frequency than with the 150% over-delay. Even when lobes appear, the rear attenuation is still excellent.

Pattern Control Range – The 130% over-delay extends the pattern control frequency down to 55 Hz.

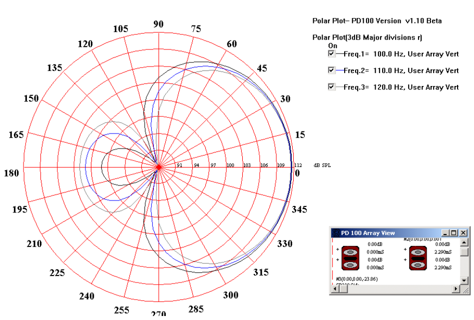
Width of Main Coverage Lobe – The 130% over-delay setting predictably results in coverage lobe widths narrower than with the straight delay, but not as narrow as with 150% over-delay.



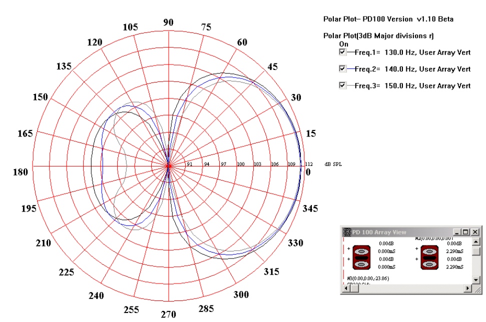
40 Hz, 50Hz & 60 Hz



70 Hz, 80Hz & 90 Hz



100 Hz, 110Hz & 120 Hz



130 Hz, 140Hz & 150 Hz

ARRAY 3
3 SPEAKERS 24" APART (On Center) with 150% Over-delay

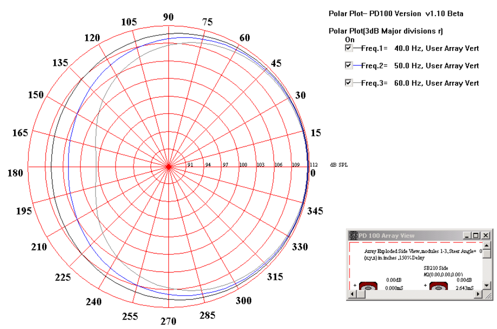
Following are coverage curves with delay times increased 50% over standard delay.

Delay Settings – The delay times are 2.64 mS to the 2nd speaker and 5.29 mS to the 3rd speaker.

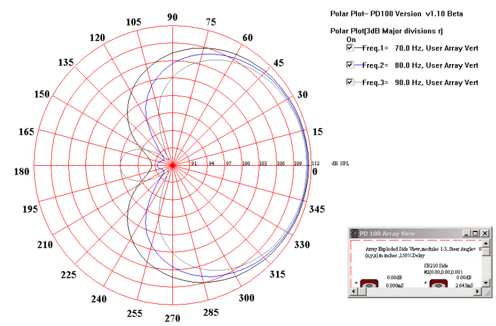
Rear Attenuation – Compared to the straight delay, 40 Hz shows a slightly higher 4 dB rear attenuation and 50 Hz shows a better 6 dB. 60 Hz attenuation doubles to 12 dB. 70 Hz attenuation almost doubles to 17 dB. 80 Hz attenuation increases 70% to 25 dB. A small rear lobe starts appearing at 90 Hz, lowering its attenuation to 15 dB. 100 Hz attenuation halves to 10 dB.

Rear Lobes -- Rear lobes start appearing at lower frequencies with the 150% over-delay, and while the lobes are slightly wider, they are the rear attenuation is considerably better.

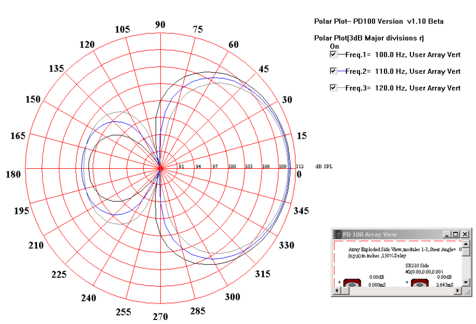
Pattern Control Range – The over-delay extends pattern control down to 50 Hz.



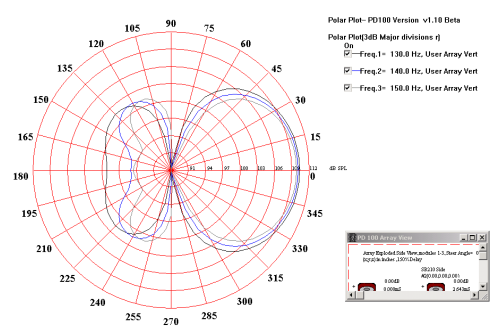
40 Hz, 50 Hz & 60 Hz



70 Hz, 80Hz & 90 Hz



100 Hz, 110Hz & 120 Hz



130 Hz, 140Hz & 150 Hz

SUMMARY

Width of Main Coverage Lobe

Over-delay narrows the coverage lobe and providing more defined coverage at all frequencies of interest. Below are coverage widths (defined as 6 dB down points).

Frequency	Coverage with Straight Delay (Array 1)	Coverage with 130% Over-delay (Array 2)	Coverage with 150% Over-delay (Array 3)
60 Hz	330°	270°	240°
70 Hz	270°	220°	200°
80 Hz	240°	200°	180°
90 Hz	210°	180°	150°
100 Hz	190°	160°	140°

Rear Attenuation

The frequency band of optimum control changes with the delay settings. For a low-pass crossover setting of 80 Hz, the 150% over-delay setting provides the best rear attenuation below 80 Hz. For a crossover setting of 100 Hz, the 150% setting starts loosing rear-attenuation at the higher frequencies, so the 130% over-delay setting if probably best. For crossover settings above 100 Hz, the straight delay setting may be an option if the objective is to provide best rear-attenuation in the 100 Hz to 120 Hz range.

Scenario →	Array 1	Array 2	Array 3
# of SB2210 Speakers	3	3	3
Description	3 speakers, straight delay	3 speakers, med over-delay	3 speakers, max over-delay
Spacing between speakers (on- center)	24”	24”	24”
Delay setting	Straight, 1.762 & 3.523 mS	130%, over-delay, 2.290 & 4.581 mS	150%, over-delay 2.643 & 5.285 mS

	Rear Attenuation in dB		
Scenario →	Array 1	Array 2	Array 3
40 Hz	3	4	4
50 Hz	4	**5**	6
60 Hz	6	**9**	12
70 Hz	9	**15**	17
80 Hz	15	**25**	25
90 Hz	21	**25**	14
100 Hz	21	**15**	10
110 Hz	16	11	11
120 Hz	12	10	10
130 Hz	11	16	17
140 Hz	10	13	17
150 Hz	10	10	13

Primary Band of Interest (50 Hz – 100 Hz)

Maximum SPL Capability

This "Forward Steered Array" method allows for complete coherent summation in the steered direction. Unlike some other methods (ie, cardioid subwoofers, etc) none of the sound in the direction of travel is cancelled. Therefore, full coherent summation of the multiple cabinets is achieved, providing for extremely high SPL capability.

Qty of SB2210s	Maximum Continuous On-Axis SPL
3 SB2210s	124 dB *(Peak of 130 dBr)*