Line Array Calculator Software

JBL's Line Array Calculator is provided as a tool to enable you to perform pre-event model array configurations. to preview the acoustical performance characteristics of different arrays. Knowledge of the line array summation effect that governs the behavior of this type of loudspeaker system will give you some distinct advantages in understanding the directivity of different array configurations, and the management of array coverage areas.

JBL Engineering has made extensive measurements on multiple array configurations to confirm the predictive accuracy of the Line Array Calculator and its modeling functions.

Four VT4889 enclosures set up for measurement sessions. Here, groundplane data is being gathered. The four boxes are set on end, at 0° splay angles.

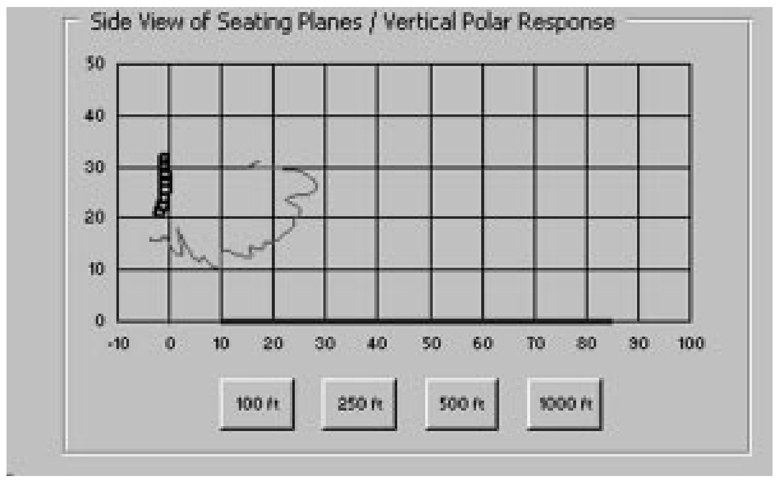
It is important to understand that the Line Array Calculator is not just a hypothetical prediction tool. The proprietary algorithms that calculate array performance and drive the graphic displays have been correlated with real-world measurements. Arrays of different sizes, with varying enclosure splay angles, have been measured under controlled conditions in both groundplane and free field setups. The results show the Line Array Calculator to be a unique and reliable tool for understanding how the VerTec system behaves in different array configurations.

Let's look at how the Line Array Calculator correlates to the measurements of actual VerTec speaker systems. Here is a typical, 8-box array. This graphic figure showing the enclosures is a 'predicted' array.

Computed polar response at 1 kHz: An 8-box array model created in the Line Array Calculator with splay angles set at:

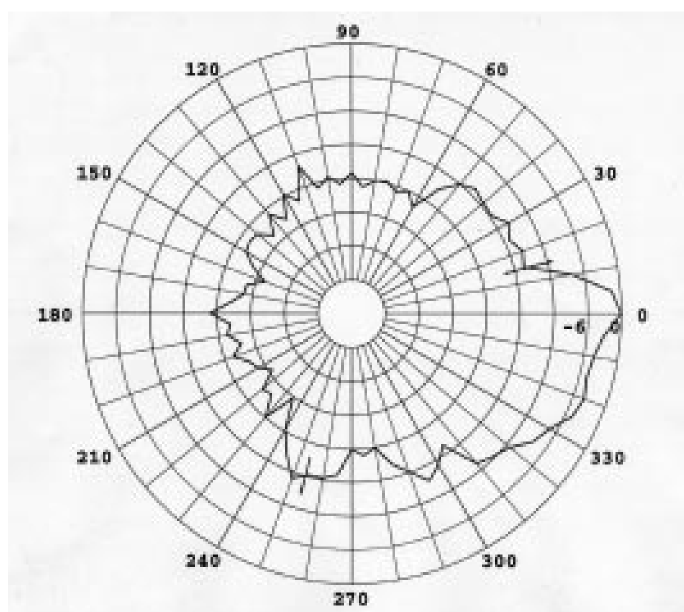
0+0+0+2+4+6+8+10

(creating an array baffle arc of 30°).



The polar plot shows this same array's actual acoustical performance, at a frequency of 1 kHz, as measured with a calibrated mic and data recording system from a distance of 20 meters. Note the good correlation between the imaginary array's predicted performance, and the real array's acoustical performance in a room space.

Measured polar response at 1 kHz (data gathered at 20 meters). The measured polar data are taken every 5 degrees, whereas the polar data produced by the design program are computed on one-degree increments.



For more information on the physical principles that govern line array performance, and how the Line Array Calculator can be used to work with them, see Chapter 1, "Vertical Technology Acoustical Principles".

You will want to learn to use the line array summation effect to your advantage, and the Line Array Calculator will help. It has a variety of features, and the information displayed is based upon data that you enter. This data falls into two categories: size and orientation of the audience seating area(s), and the array size, shape and placement that you may intend to set up and operate in a venue having those particular seating area characteristics.

The following reference guide, which is also supplied as a .PDF format file along with the Line Array Calculator software on the available VerTec CD-ROM, will get you started.

Quick Reference Guide

Introduction

The Line Array Calculator (LAC) is a Microsoft Excel Spreadsheet that gives you an easy to use, point-and-click way to gain significant understanding in the deployment of the JBL VerTec system. The graphical interface lets you input key dimensions of your venue's seating area and the array hanging plane. Afterwards, you can add boxes, change the trim height, and array geometry. Nearly instantly, the Line Array Calculator shows you the vertical polar pattern of the array and the predicted SPL at the audience seating plane.

What's needed

- Microsoft Excel95, or higher.
- A personal computer running Windows 95, 98, or 2000.
- About 1.85 megabytes of free space on the computer's hard drive.

Installation

1. Using Windows Explorer, make a new folder on your computer's hard disk. Give it a name that you can remember.
2. Copy the Line Array Calculator spreadsheet (filename: "JBL VerTec Line Array Calculator.xls") to this folder. This filename must be left as is; it may not be changed. (If you change the file name, some Macro functions may not work).
3. Double-click the resulting file icon.
4. Once Excel loads and the LAC displays:
    - Click Tools Add-Ins and ensure that Analysis ToolPak - VBA has been checked. (If this is not checked, your graphic displays may not function).
    - Excel may warn you that the LAC spreadsheet contains macros. Indeed the sheet does contain macros. Excel warns you about this because computer virus writers sometimes use Excel's macro language to spread their germs to your computer. Enabling the macros in the LAC does not expose your computer to virus threats (at least from the LAC spreadsheet).
    - Allow Excel to run the macros by clicking the Allow Macros button.
5. You are now ready to use the Line Array Calculator spreadsheet (File / Open).

Getting Started

Open the Line Array Calculator spreadsheet. Note the following points:

You can save any entered data (for a particular venue, array configuration, etc.) by creating a separate subdirectory (folder) for that instance and then using Excel's FileSaveAs dialog to save the spreadsheet in the new subdirectory. It is important to retain the same name.

Within the LAC spreadsheet, any values shown in blue may be changed. Any values shown in black are calculated by the LAC based on the values entered. Enter distances in feet (or meters if you have checked Metric in the Units box).

The small red triangles located near many of the data entry and display points denote hints. Move the cursor over one of these and watch what happens.

At the lower left, you should see a representation of the loudspeaker array and the seating planes. In red, the LAC shows the predicted vertical polar pattern of the array.

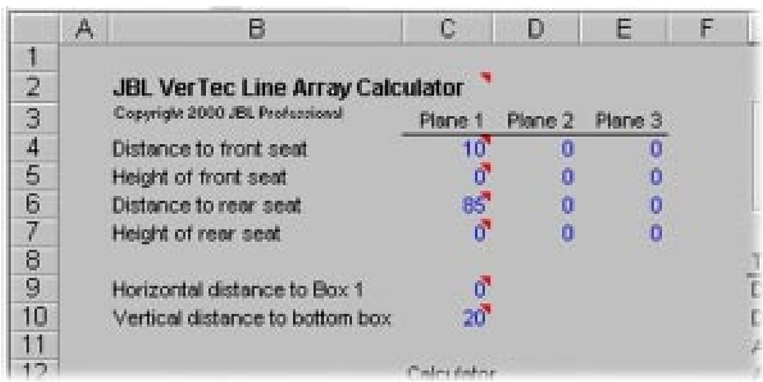
At the lower middle, the LAC shows the predicted relative SPL at the seating plane, plotted as a function of distance from the front of the seating plane. Note that this is not the frequency response.

At the upper left, you can enter values to locate up to three seating planes. Note the data for the seating planes are organized in columns. In the spreadsheet center, note the drop down menu to select the seating plane used for the relative SPL calculations. Just below the seating plane data you will find the array location data entry points. "Vertical distance to bottom box" is a key data point. This defines the distance from the floor or stage deck to the bottom of the loudspeaker array.

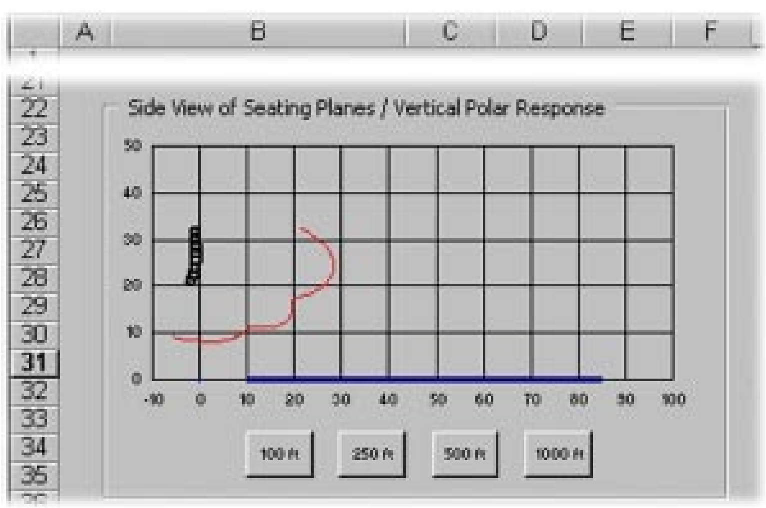
Once you have defined the seating plane(s) in the venue space under review, you can begin to experiment with different array sizes, vertical arc angles, and array locations.

- On the upper right, enter a box count for 'Number of Boxes'.
- Play with the hinge bar angles. Note the change in the polar pattern of the array as well as the elevation view of the array. Finally note the predicted relative SPL at the seating plane, plotted as a function of distance.
- At the middle left, locate and click the Auto Frequency button. Watch the polar response graph as well as the seating plane SPL graph. This button auto-steps the calculator through the speech range frequencies. You can select any single frequency via the dropdown menu located above the Auto Frequency button.

***Note**: The relative SPL plot does **NOT** take into account any shading caused by an adjacent seating plane.*



When you first open the Line Array Calculator, you will see that dimensional data has been entered for Plane 1 and Plane 2. This is where you enter data describing the seating areas in a particular venue. Note that in the opening example, Plane 3 has ‘0’ entered for all data points. If your venue plan has only one seating plane, enter ‘0’ for all data points on Plane 2 as well. Shown here, a simple flat seating plane with an eight box array (dimensional data has been entered for Plane 1 only.)

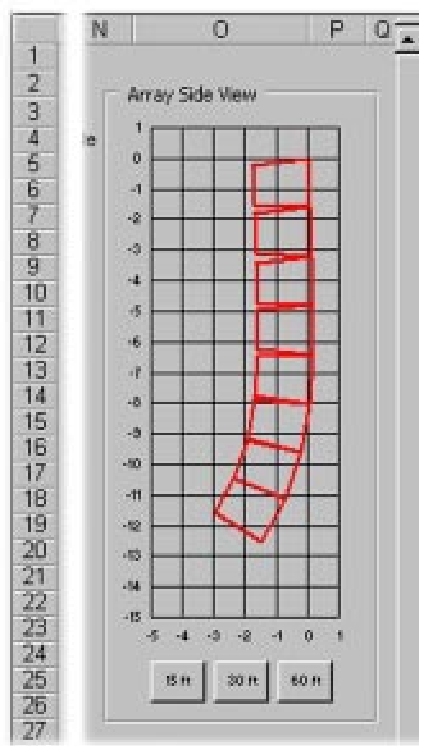


Be sure to start by selecting either ft/lb. or m/kg in the ‘Units’ box. As you work with different examples, note how the placement of the array and the seating planes are always referenced to the “0/0” point on the horizontal/vertical display grid.

When evaluating performance of an array, start by entering the number of boxes on the upper row of the data-entry section. When you first open the Line Array Calculator, it shows a 12-box array. Note that “Box 1 aiming angle” is the same as the Array Frame angle, since Box 1 in an array is set with its front baffle at 90 degrees to the plane of the Array Frame. Thus Box 1 is a ‘0’ degree array element.

	J	K	L
1			
2	Number of Boxes		8
3	Box 1 aiming angle		2
4			Hinge bar angle
5	Box 2	ON	0
6	Box 3	ON	0
7	Box 4	ON	2
8	Box 5	ON	4
9	Box 6	ON	6
10	Box 7	ON	8
11	Box 8	ON	10
12	Box 9	OFF	0
13	Box 10	OFF	0
14	Box 11	OFF	0
15	Box 12	OFF	0
16	Box 13	OFF	0
17	Box 14	OFF	0
18	Box 15	OFF	0
19	Box 16	OFF	0
20	Box 17	OFF	0
21	Box 18	OFF	0

The Array Side View shows the number of boxes you have selected, and the aiming angles they are set at. Note that when VT4889 rear hinge bars are set to 0 degrees (as box examples 2 and 3 here), the front baffle of the box is pointing straight ahead, following the plane of the Array Frame. When hinge bars are used to set box splay angles increasingly toward 10 degrees, the curvature of the array’s front baffle increases. Use the Vertical Scale buttons to adjust the relative size of the Array Side View.



Details

The following information describes the various data entry points.

Seating Plane data

These items describe the locations and elevations of the audience seating area. The program allows you to enter data for three different seating planes (for instance, main floor and 2 balconies, or a three-tiered stadium). Enter these data for each seating plane individually. . If you don't need to use one or two of the planes, just enter 0. Note that the program does not make any allowance for shading caused by an adjacent balcony.

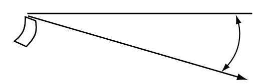
Item	What	Description	Notes
Distance to front seat	Insert value	Distance (horizontal) from the origin (0,0) to the front seat	Referenced to 0/0 point on the Side View of Seating Planes graphic display
Height of front seat	Insert value	Elevation of front seat.	
Distance to rear seat	Insert value	Horizontal distance from the origin to the rear seat.	
Height of rear seat	Insert value	Elevation of rear seat.	
Horizontal distance to Box 1	Insert value	Horizontal distance from the origin to the front of the top box (box 1).	
Vertical distance to bottom box	Insert value	Vertical distance from the origin to the bottom box in the array.	

Units

Select between metric and US/UK measurement systems. This alters the units used for distance and weight throughout the spreadsheet. Although this button alters the measurement system used, items entered in feet do not convert to meters when you change measurement systems. Try it. <u>When reading out data, you must remember which measurement system is currently in use.</u>

Calculator

The calculator section is a tool you may want to use to calculate unknown dimensions in a venue. It solves the equations for the sides of a right triangle given the hypotenuse and angle.

Item	**What**	**Description**	**Notes**
Diagonal distance	Input value	The length of the hypotenuse of a right triangle.	Useful for determining direct distance from array to front or rear of a seating plane.
Angle	Input value	The down angle between the hypotenuse and horizontal plane of a right triangle.	
Horizontal distance	Output value	Side opposite the angle. Base of the triangle.	
Height	Output value	Height of the triangle.	

Frequency

You can display array polar data and relative SPL at the target seating plane at any ISO one-third octave frequency between 100Hz and 20kHz. You can also step this display through the speech range frequencies.

Item	**What**	**Description**	**Notes**
Center Frequency	Drop down menu	Selects center frequency for polar response graph and SPL at seating plane.	ISO 1/3 octave frequency centers from 100Hz to 20kHz.
Auto Frequency	Button	Steps the LAC through the speech range frequencies.	ISO octave frequency centers from 250Hz to 4kHz.

Target Seating Plane

The LAC allows inputting data for up to three seating planes. This dropdown menu selects the seating plane used for the target plane data.

Item	What	Description	Notes
Target Seating Plane	Drop down menu	Select seating plane one, two or three.	No allowance made for shadowing caused by adjacent seating planes.
Target Plane Data			
Dist from top box to rear seat	Data output	Distance from top box of the array to the rear seat of target seating plane	
Dist from bottom box to front seat	Data output	Distance from the bottom box of the array to the front seat of the target seating plane	
Angle from top box to rear seat	Data output	The angle from the horizontal of a line drawn from the top box to the rear seat of the target seating plane.	The angle is presented as positive or negative relative to the horizontal (zero degrees). Negative values indicate down angle. Positive values indicate up angle.
Angle from bottom box to front seat	Data output	The angle from the horizontal of a line drawn from the bottom box to the front seat of the target seating plane.	The angle is presented as positive or negative relative to the horizontal (zero degrees). Negative values indicate down angle. Positive values indicate up angle.
Total included angle of target plane	Data output	Included angle from the top box to rear seat and bottom box to front seat.	
dB differential of plane	Data output	dB difference between the array and the rear seat of the target plane with respect to the front seat of the plane.	
Time differential (mSec)	Data output	The time difference of sound's arrival between the front seat and rear seat of the target plane.	May provide useful data when using signal-delayed arrays.

Array Data

Item	What	Description	Notes
Top box elevation	Data output	Distance from the floor to the top of box 1.	Array height, not including the array frame.
Bottom box sight angle	Data output	Angle from the horizontal plane to the bottom box center line.	
Distance to far field	Data output	Distance where inverse-square law attenuation . begins.	Approximation based on the array height and specific frequency.

Array Aiming

This area of the LAC lets you plug and play variations of array size and angles. The changes in system performance are displayed in the graphs located at the bottom of the screen.

Item	What	Description	Notes
Number of Boxes	Data input	Number of boxes in the array.	
Box 1 aiming angle	Data input	Aiming angle of box 1.	This is a combination of the hinge bar setting and the angle of the array frame. Positive angles are up angles, negative angles are down angles.
Hinge bar angle	Data input	Setting for the hinge bar	Input data for each box in the array.Hinge bar angles are one-degree increments from 0 to 10 degrees.

Array Side View

This is a side view of the array. You select the vertical scale used via the buttons located at the bottom of the box. Remember that this scale can be in feet or meters, depending on the setting of the Units switch.

Frame Options

This dropdown menu selects the array frames used to construct your array. The total weight of these components becomes part of the Array Weight computation in the next section of the LAC. The menu picks are either/or both the large frame and small frame, or no frame at all.

Array Mechanics

Item	What	Description	Notes
Array height	Data output	Overall height of the array taking into account any curvature.	
Array depth	Data output	Maximum depth of the array taking into account any curvature	
Array weight	Data output	Overall weight of the array, including the array frame.	Remember to select your Array Frame option via the Frame Options dropdown menu.