ArrayCalc simulation software V8
ArrayProcessing feature, technical white paper

d&b audiotechnik

Contents

1. Introduction

This Technical white paper describes ArrayProcessing, a feature that enhances the performance of d&b line arrays. This feature is contained in d&b ArrayCalc V8.0, requires d&b R1 Remote control software V2.8 and the latest generation of d&b amplifiers and their firmware 1.10. It can be applied to d&b loudspeakers from the J-Series, V-Series and Y-Series.

2. ArrayCalc simulation software

The d&b ArrayCalc simulation software is the tool for planning system configurations of d&b line array, column and point source loudspeakers, as well as subwoofers. A comprehensive toolbox for all tasks associated with electroacoustic design, performance prediction, alignment, rigging and safety parameters. For both acoustical and safety reasons d&b line arrays must be designed using the d&b ArrayCalc simulation software. This includes defining the quantity and optimum aiming of loudspeakers, calculating subwoofer arrays and the time alignment of these to the main arrays, documenting weights and overall dimensions of arrays as well as producing printable rigging plots and parts lists.

ArrayCalc enables precise simulations when planning any type of installed or mobile systems, significantly reducing setup and tuning time in touring applications. Listening planes can be defined to create three-dimensional representations of the audience areas in a venue. Special functions assist in obtaining accurate dimensions with laser distance finders and inclinometers. Acoustic obstacles, such as arena video scoreboards, can be added to a model. d&b ArrayCalc is available as a native stand-alone application for both Microsoft Windows (Win7 or higher) and Mac OS X (10.6 or higher) operating systems.

Complete details of the system simulated in ArrayCalc are generated, including loudspeakers, amplifiers, remote IDs, groups and all configuration information. In combination with the d&b Remote network, the d&b workflow sequence transfers system data from ArrayCalc to the R1 Remote control software program, which in turn installs this data to the d&b amplifiers, without any further manual input.

ArrayCalc provides the following features:

- Editing of listening planes to create audience areas within three-dimensional venue models.
- Help functions to obtain venue dimensions using laser distance finders and inclinometers.
- Placing d&b Loudspeakers (line arrays, point sources and subwoofers) in the application and setting their configuration.
- Calculation of the level distribution over all defined areas displayed in three-dimensional format for selectable frequency bands from 63 Hz to 8 kHz.
- Calculation of absolute sound pressure levels in audience areas, including system headroom supervision for different input signals.
- Combination of up to 14 different array pairs distributed across the venue, plus ground stacked subwoofers in Left / Right combinations, or arranged as follows:
- As a SUB array with up to 51 positions with a steerable horizontal dispersion option
- Flown subwoofers integrated into the line arrays or suspended as separate columns.
- Analysis and setting of the time alignment of all sources of the system

3. ArrayProcessing

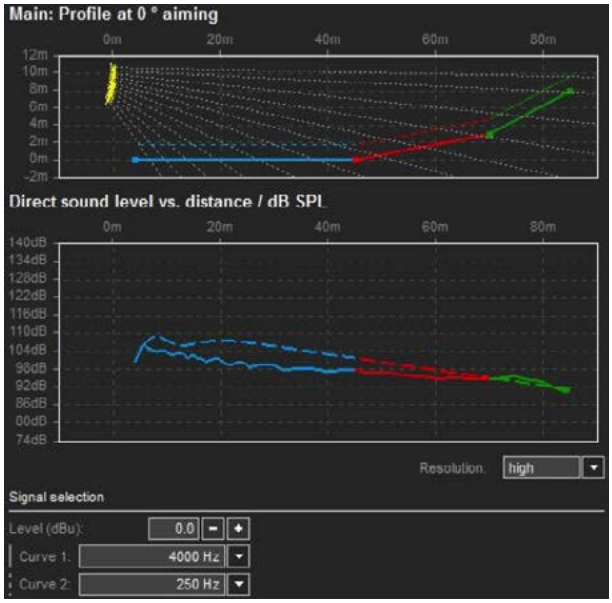
ArrayProcessing (AP) is a feature to calculate and design the holistic behaviour of a line array. It is an additional feature to enhance the performance of d&b J-Series, V-Series and Y-Series line array systems when powered by the latest generation of d&b amplifiers.
Physically, ArrayProcessing employs a conventional line array setup that is properly designed and positioned. The array must provide the required vertical dispersion and sufficient acoustic output to cover the audience areas effectively. Within one array it is possible to combine loudspeakers with different horizontal dispersions, for example J12s below J8 loudspeakers.
ArrayProcessing creates individual sets of FIR and IIR filters for every single cabinet of the array, each of which requires a dedicated amplifier channel. These filters shape the sound generated by the array to precisely match a user defined level distribution and obtain a uniform frequency response over a given audience geometry.
In addition to individual amplification for each

loudspeaker in an array, ArrayProcessing requires OCA Ethernet remote control for these amplifiers. The use of ArrayProcessing is optional, meaning the function can be applied for specific applications or not, as and when required.
ArrayProcessing adds 5.9 msec of latency, this is in addition to the 0.3 msec of the d&b amplifiers, arriving at a total of only 6.2 msec.

3.1 Motivation and benefits

Spectral differences in audience areas

Typically, a line array setup for a given situation is planned in a way that optimizes the level distribution over distance in the high-mid frequency range (2 kHz to 4 kHz). This requires a specific vertical aiming for the individual cabinets that is defined by the splay angles between them. However, the array dispersion at lower frequencies (100 Hz to 1000 Hz, depending on the array length) is a direct result of the total array curvature created by the splay settings (and not the individual aiming of a cabinet). This often creates a different level over distance distribution to that in the high-mid range.



Typical level/distance high-mid vs. low-mid: Changing tonal balance over distance with progressive curvature.

This effect is well known and has been a cause for criticism from the very beginning of line array usage in modern sound reinforcement. The result is an uneven spatial balance and spectral response from the front of a venue to the back – a rich and (too) warm sound close to the array, which then becomes thin and almost aggressive in remote areas.
Another well-known example is the difference in spectral response when covering steep seating areas with a strongly curved array, as it is often used in outfill and 270° applications for tiers or balconies. In the highest seats it sounds very thin, in the seats around the middle there is a strong and annoying midrange beam, which disappears again when approaching the stage. In these situations it can often be perceived that the lower midrange dispersion does not follow the array shape.

Typical level/distance high-mid vs. low-mid: Changing tonal balance over distance with constant curvature.

ArrayProcessing can eliminate these issues by providing a consistent frequency response throughout all listening positions. The resulting effect is that what you hear at FoH is what you will hear everywhere else. The mix is valid for everyone.

Compensating air absorption effects

ArrayProcessing includes air absorption effects in its calculations and provides a precise and seamless correction for all relevant cabinets. This not only provides a more consistent sound balance over distance, in applications where the system has sufficient headroom, its throw can be extended and the need for delay systems greatly reduced.

Flexibility
The level distribution in the audience area can be modified and tailored to reduce the level towards the front of the audience area and modify the level drop over distance over the audience area. Different ArrayProcessing settings for the array can be compared at a mouse click.

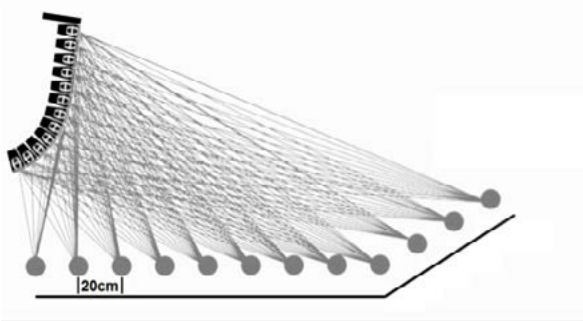
Intelligibility
In many applications, achieving a more accurate directivity control causes less stimulus to the reverberant field and leads to improved intelligibility.

Health & safety
Using ArrayProcessing, the level increase towards the front of the venue can be adjusted. Reducing it may help avoiding harmful sound pressure at the front while keeping the desired level for the rest of the audience.

3.2 How does it work?

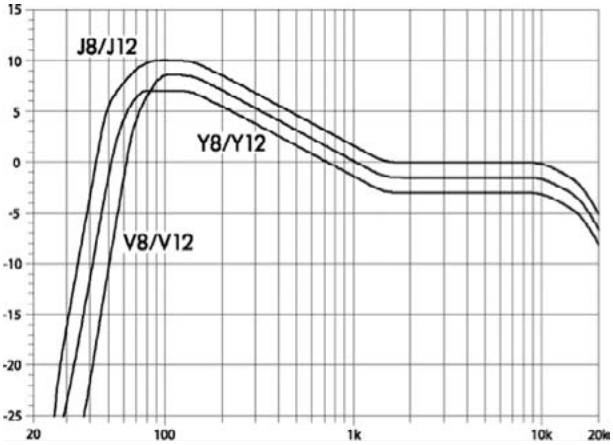
With the introduction of ArrayProcessing, for speaker simulation a completely new unified, more accurate and adaptive speaker model was developed and implemented. This speaker model provides exactly the necessary degree of detail for the type, size and the frequency range of each source – the highest resolution to provide a precise description of the behaviour of a line array's sharp HF dispersion, a medium resolution to cover the dispersion characteristics of point sources and directional subwoofers or a rather coarse resolution for omnidirectional subwoofers.
The ArrayProcessing algorithm also considers and corrects diffraction effects produced by neighbouring cabinets.

Target points are distributed along the listening area profile with a 20 cm spacing (along the intersection of the array profile with all matching listening planes). When ArrayProcessing is enabled it first calculates the contribution of each individual source to each listening position using a high spectral resolution of 24 frequencies per octave, making a total of 240 individual frequencies per target point over the entire ten octave audio band.



The resulting data are stored in a matrix and serves as a basis for all further calculations.

The ArrayProcessing optimization routine will then create a unified / standardized frequency response at all these points. This target frequency response is exactly the reference response that is initially defined when tuning and voicing the controller setups for the d&b line arrays in conventional (unprocessed) setups. This response is identical for all systems above approximately 140 Hz, below that frequency each system has its own individual LF extension, depending on the specific cabinet design.



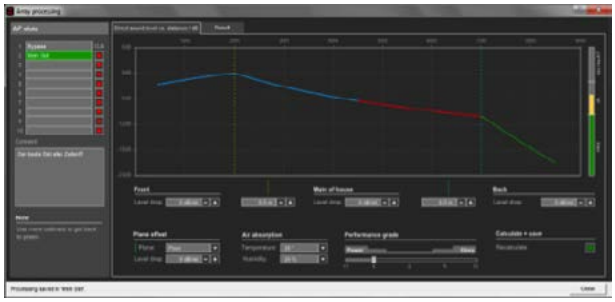
Target frequency responses for J-Series, V-Series and Y-Series 'TOP' loudspeakers

Please note that the response created by the ArrayProcessing algorithm is independent of array length, curvature and system type. Any ArrayProcessing line array design will provide the same sonic characteristics. Any combination using multiple columns of ArrayProcessing line arrays

(rear fills, outfills, delays, etc.) does not require individual tuning and maintains this uniform sonic footprint.
Any further adjustment to the system response, either by using the CPL (Coupling) function or by applying master equalization is then carried out identically on the entire system for all listening areas.

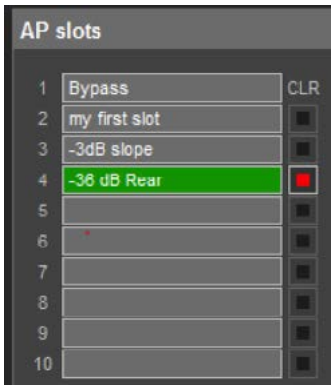
User parameters

The user can specify a desired level distribution along the listening profile. This is done in a simple way by specifying the level drop (in dB per doubling of distance) for up to three different sections of the listening area profile (Front / Central / Rear). Additionally, a level offset can be applied to specific listening planes.



Furthermore there is another powerful parameter: the Power / Glory fader, this defines the processing emphasis. Special focus on either maximum SPL and system headroom (Power) or on a best match of the target level distribution and frequency responses (Glory) can be selected. The centre position usually provides a good balance between those parameters.

Up to ten different combinations of user parameter settings can be prepared and stored in the 'AP slots' of the amplifiers. These can be selected using the R1Remote control software. Switching between different AP slots is performed in near to real time, but as it will interrupt the audio program for some tenths of a second, switching is not recommended during a performance.



AP slot overview in AP dialog

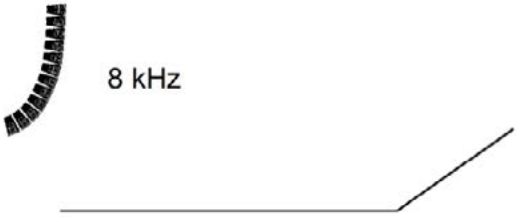
Keep it 'organic'

Individual FIR filtering for each line array element can easily destroy the sonic integrity of a system. The secret lies in useful constraints to the algorithm and all resulting transfer functions. Algorithm results for each frequency need to relate to the neighbouring frequencies to ensure a continuous filter response. System efficiency, headroom and time correlation must be preserved.

Different strategies for different frequencies

For the lower frequency range, where all sources contribute to most listening positions, processing basically only modifies the time alignment, but keeps equal level for all sources. You can picture the result as a varying virtual curving of the array over frequency.

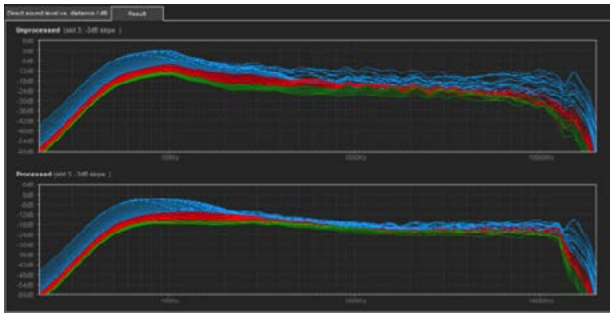
For higher frequencies, where the individual sources cover only a small part of the listening area, the algorithm gradually shifts towards individual magnitude equalization of the transfer functions.



The transition between these ranges is continuous, always considers coherence relations between all elements of an array, ensuring the acknowledged d&b sonic footprint.
Processing is precisely matched to compensate for the air absorption under the actual atmospheric conditions and geometric relations. This replaces the manual process of selecting specific HFC (High Frequency Compensation) settings for each loudspeaker.

Optimization result

The optimized results for frequency response and level distribution per slot are displayed after processing.



Unprocessed (top) and processed (bottom) frequency responses over distance

Subwoofers

ArrayProcessing is also available for flown J-Series, V-Series and Y-Series subwoofer arrays in mixed arrays with subwoofers at the top of the column. However, to preserve the latency of 5.9 msec, ArrayProcessing will not significantly modify the directivity of subwoofer columns, but rather ensures their time alignment and frequency response correctly matches line arrays.

Speed

For mobile applications, the speed of the calculation is an essential aspect. The user should always be able to immediately react on changing requirements (atmospheric conditions, audience attendance, level adjustments at the front or back). From ArrayProcessing initialization to the filter set being active in the amplifiers, the typical calculation time for a 20-deep array covering an audience profile of 100 m is in the range of one minute – on a standard laptop computer.

3.3 ArrayProcessing workflow

As part of ArrayCalc V8 software, ArrayProcessing integrates seamlessly into the d&b workflow without compromising the renowned d&b sonic character or ease of use.
The planning process starts in a well-known way; the array is positioned and splayed mechanically to achieve a useful level distribution for the 2 kHz and 4 kHz bands using the recommendation approach described in in chapter 10.7 of d&b TI 385, the d&b ArrayProcessing Tutorials from www.dbaudio.com and of during the various d&b training and workshop sessions.
Enabling the loudspeaker specific ArrayProcessing option in ArrayCalc / R1 Remote control software provides access to the additional processing functionality.
Settings for the array shape (Arc / Line) as well as for the compensation of air absorption (HFC) are not available as they are now embedded in the ArrayProcessing algorithm.
ArrayProcessing sets the target frequency response of the applied system to its original reference response. The optional CUT mode functions as usual: the low frequency level is reduced. The source is now configured for use with the system's dedicated subwoofers.
The CPL functionality is still available with ArrayProcessing being active. However, its traditional functionality of compensating for array length and curvature has been taken over by ArrayProcessing as it provides a uniform target frequency response for every array. With ArrayProcessing, CPL now provides an additional user parameter to adjust the system's tonal balance, for example to cater for the venue acoustics or individual taste. Its characteristics are identical for all ArrayProcessing line arrays. All ArrayProcessing line arrays used in a system should be set to the same CPL value.

Summary

The directivity control of d&b audiotechnik line array systems is extremely well behaved in the horizontal plane. This is achieved by a careful and exacting approach to the alignment of the internal elements to smoothly and effectively cover the operational bandwidth. With the inclusion of ArrayProcessing, the d&b ArrayCalc simulation software is able to achieve a similar alignment within the vertical directivity of line arrays. The

established approach to defining the mechanical array setup is combined with the ability to generate different processing settings for each loudspeaker using FIR and IIR filters, these settings are then installed into the individual amplifiers powering each array.

For consistent array performance, a fixed target frequency response is employed within ArrayProcessing. This achieves spectral continuity across multiple line arrays in projects, even when the setups differ mechanically, or include arrays from different d&b Series (J-Series, V-Series and Y-Series). This consistent spectral performance delivers the same sound balance throughout the entire listening environment, drastically reducing the time required to fine-tune the resulting systems.

The ArrayProcessing approach can adjust the level drop over distance for distinct areas within the vertical coverage angle of the array. Similarly it is also compensates for differing high frequency atmospheric absorption effects over distance.

ArrayProcessing is very quick and easy to employ, adding just 5.9 msec of system latency, while consistently achieving the same sound throughout audiences. It integrates the latest technology, adding a new dimension to the sonic integrity, simplicity and ease of use for which d&b systems are renowned worldwide.

d&b audiotechnik®

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