Spatial Equalization – A Better Way to Tune Sound Systems

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Introduction

This document describes Spatial Equalization, a new feature for EAW Adaptive Systems. Spatial Equalization requires EAW Resolution 2.3.0.123 and Anna firmware 1.0.18.0 or Anya firmware 1.0.44.1 or higher. Spatial Equalization is available only on Anna and Anya and through the use of EAW Resolution software for prediction, control and monitoring.

Spatial Equalization allows Adaptive Systems users to simply select a part of the audience where a tonal change is desired and apply the target EQ. Adaptive Systems then determine the changes necessary to implement it and do so in real time. **For the first time, users can truly EQ the room instead of the sound system.**

The Case for Spatial EQ:
A Better Way than 'Turning Knobs'

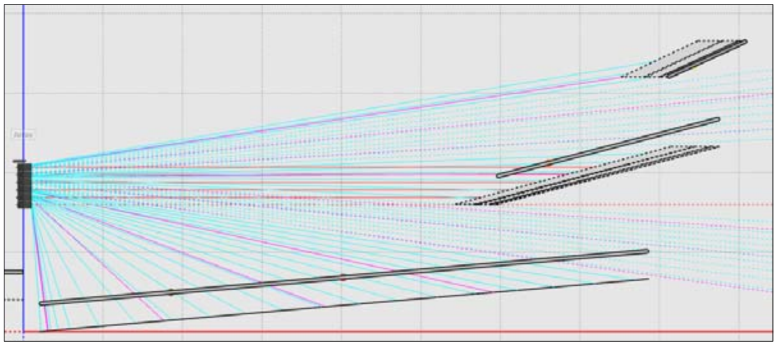
It is almost always the case that once a system is installed (temporarily or permanently) in a venue, adjustments must be made to equalization in certain parts of the audience relative to others. This is necessary to compensate for phenomenon such as low-frequency buildup due to the proximity of the sound system to nearby surfaces, local resonances (i.e. under a balcony), atmospheric air loss over distance and other phenomena. It is a fact of life in the world of the system engineer or designer and the process of 'tuning' a system can be very time-consuming, in large part because it is not simply a question of what to adjust, but also how to adjust it. It is often the "how" that takes the most time.

It is generally not a challenge to establish where, in a given venue, a frequency response anomaly exists. This evaluation is often by simply walking the venue or by using a measurement system and moving a calibrated microphone around. However, even after the user identifies the adjustment they want to make, traditional mechanically-articulated line array systems offer limited options to make those adjustments. It is necessary for system engineers to determine what part of the system is contributing most to that area, attempt to isolate it (which may or may not be possible depending on splay, frequency and amplification), make adjustments and then determine:

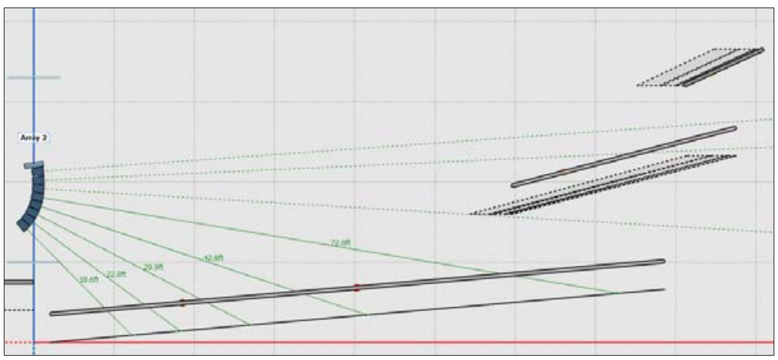
a) Whether the adjustments have been effective in the targeted area and
b) If the adjustments have had negative effects elsewhere.
c) If (b) is found to be true, what further adjustments can be made to reduce negative effects.

Additionally, with mechanically-articulated line array systems the 'spatial resolution' of the system is very coarse. Each module covers a large section of audience, and so even if the operator is able to control each array module individually, the affected area is large.

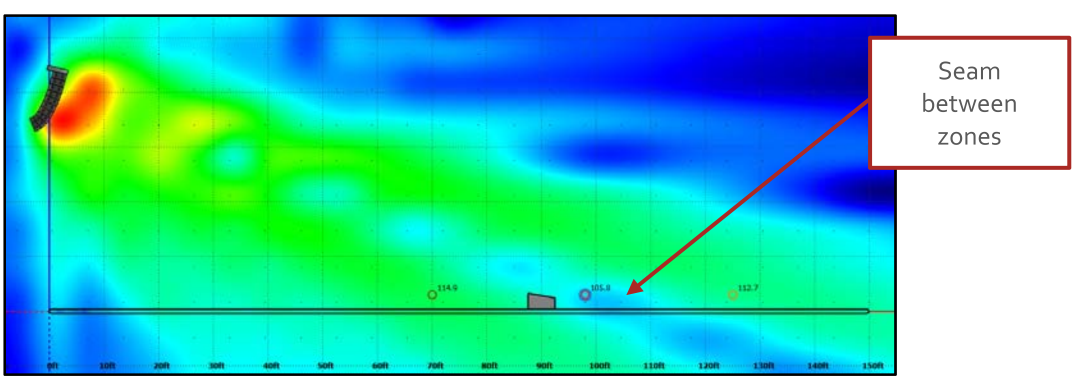
Even a compact Adaptive array includes nearly 50 high-frequency cells, allowing for very precise aiming across a venue. Each cell therefore addresses a very small area of the venue, allowing very precise control:



Whereas with a traditional mechanically-articulated line array, only a smaller number of cells (equal to the quantity of array modules) must be distributed across the entire seating cross-section. The array addressed by each cell, therefore, is very large:



Another problem with this approach is that, because a traditional array has relatively few cells, the adjustment to each module is large, and so the difference in processing from one module to another is large (one module may have no equalization adjustment, whereas the next has the adjustment. There is no ‘in-between’ state). This opens up ‘seams’ as the listener moves from the coverage of one module to that of the next in the array because of the amplitude and phase differences as the listener transitions from the area served by one module versus another, as shown below:



Overall, applying different processing to different parts of a traditional line array will always trade favorable results in some places and unfavorable results in others.

The Process with Spatial EQ: Select Audience Area, Specify Desired Change, Done.

The introduction of Spatial Equalization drastically simplifies the process that users undergo to make adjustments to their system. Users simply select a column covering the portion of audience they wish to apply the adjustment to, specify a 'start' and 'end' to the zone, and apply a parametric equalization filter. Resolution will, based on the user's input, determine what part of the array is serving the indicated zone and apply filtering in such a way that only that zone is affected.

Resolution will, based on the array's coverage and audience geometry, also automatically indicate the area that will actually be affected by their change, in real time. This helps users quickly understand the smallest zone they can affect based on the venue geometry, array size and allocation.

Below, the traditional and new processes are compared:

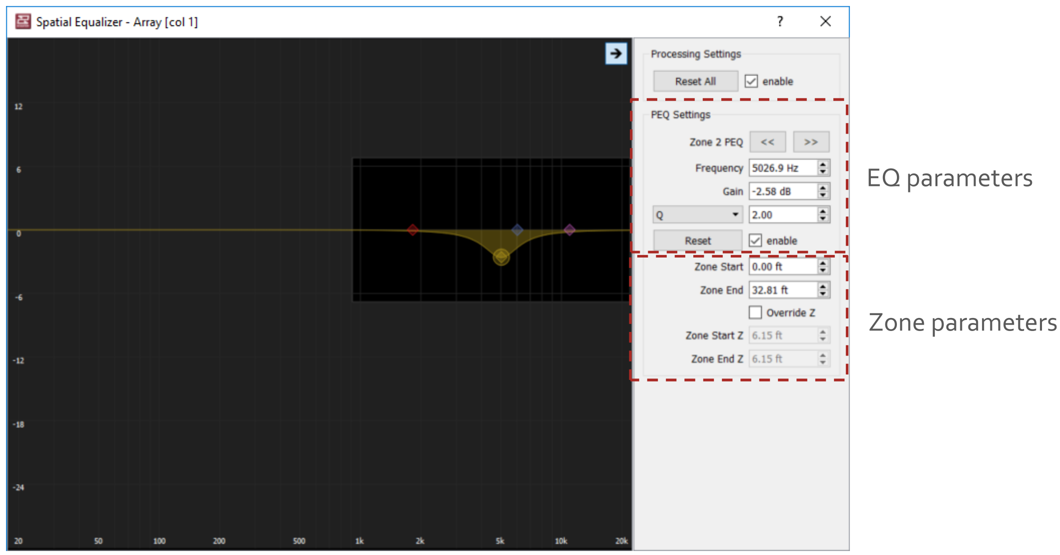
Step	Traditional System	Adaptive System with Spatial EQ
1	Install system.	Install system.
2	Survey venue (by ear or with measurement tool). Identify problem areas.	Survey venue (by ear or with measurement tool). Identify problem areas.
3	Determine what part of sound system serves problem areas.	Not necessary.
4	Based on system design, isolate part of system serving problem area.	Not necessary.
5	Make adjustment to part of the system serving problem area.	Select area and make adjustment.
6	Re-survey venue to identify if problem is corrected, or if new problems exist.	Not necessary.
7	If correction has caused new problems, go back to step 3 and make further adjustments.	Not necessary.
8	Use system.	Use system.

Using Spatial EQ, the user can both:

a) Achieve a much better result than would be possibly with a traditional system
b) Accomplish this goal much more quickly than would otherwise be possible.

How to Use Spatial Equalization

The Spatial EQ window functions like a normal equalizer window, except that the user can specify the bounds of the area they wish to affect. "Start" and "Stop" function just like coverage, in that they specify the audience areas by their x-axis value (moving towards or away from the array). The user can also use the 'Z override' function to limit the affected area based on their z value (height) in the venue; this can be useful in selecting a balcony or floor below a balcony that are the same horizontal distance away from the area.



Once the area has been specified and the filter, gain and bandwidth entered, the user can view the resultant affected area in the Venue view. The target area is indicated as a solid line, while the anticipated affected area is indicated by a dashed line.

The difference between the target area and the expanded area is determined by the array size, desired equalization frequency, and allocation of array resources within the venue. This is visible in both the Side View and Free View. This feedback step is crucial in helping the user to decide what equalization to apply. Using Spatial EQ however, the change is not only more precise with respect to affected area, but the user can also identify the total affected area in advance of making the change. This saves the time-consuming steps of re-measuring, making further adjustments, etc. as would be required for a traditional line array.

Once the user has selected their zone and entered the equalization parameters, the change will be live. If online with a system, the equalization will be applied to the output of the system. No parameter upload or additional calculations are necessary. Additionally, the effect of the Spatial EQ on the audience area SPL and frequency response will be recalculated and displayed.

Generally, higher trim heights and longer arrays will result in greater precision and the ability to apply Spatial EQ to smaller audience areas. The size of the affected area will adjust automatically when the frequency of the filter is adjusted. As one might expect, lower frequency adjustments will affect a greater area of the audience. In all cases, Resolution will determine the ideal parameter adjustments to minimize the affected area outside the target zone.

Frequently Asked Questions about Spatial Equalization

Will Spatial EQ affect the coverage of the array?
No. Unlike the traditional approach where standard parametric equalization is applied only to specific modules in the array in a trial-and-error fashion, Spatial EQ analyzes and applies processing such that the changes between cells are very small. Additionally, the filter implementation used to apply Spatial EQ was selected specifically with consideration to phase linearity. Thus, the coverage pattern is unaffected. It would not be possible to accomplish this in any other way.

How long does Spatial EQ take to calculate?
No acoustical model recalculation is necessary. Thus, the calculation takes only seconds to complete and upload to the array (if online with a system).

What's the smallest area I can affect?
This depends on the venue geometry and array size. With more modules, the minimum area that can be affected gets smaller because the area that each module covers gets smaller. In all cases, Resolution will always indicate the expected affected area based on the user's target zone start and stop. At a glance, users will know the impact of the adjustment they are making without needing to re-measure and verify.

Why does my affected area change with frequency?
As a fundamental law of acoustics, wavelength dictates everything. Lower frequencies, with their larger wavelengths, make the smallest area in which a Spatial EQ change is possible larger than higher frequencies with smaller associated wavelengths. As array length grows, the affected area for a given zone and frequency will become smaller.

What do current Adaptive system owners need to do to get Spatial EQ?
First upgrade Resolution. A firmware update is required, and this is performed through the Firmware Manager in Resolution. No additional downloads are necessary.

On what products is Spatial EQ available?
Spatial EQ is available on Anya and Anna.

What is the range of frequencies over which Spatial Equalization can be applied?
Spatial EQ filters are available from 1 kHz and higher. Filter gains can range from +6 to -6 dB, but it is expected that in almost all cases, the range of adjustment needed by users will be much less than +/- 6 dB.

Can I segment an array myself and apply equalization? Will it be the same?
No! Spatial EQ filters are not traditional EQ filters and are not applied traditionally. Manually applying equalization to different parts of an Adaptive array will adversely affect the performance of the array and will not

yield the same results.

Do any other products on the market offer anything like Spatial EQ?
No. This technology is unique to EAW, and to Adaptive Systems. It is only possible through the combination of many disciplines – including software, acoustics, mechanical and electronics – working together for the best possible result.