HK AUDIO ELEMENTS IN PRACTICAL APPLICATION (1)

Brought in Line

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The Workshop

This workshop series focuses on how line-source PA systems work using HK Audio Elements as an example. One special feature of this system is its modular setup, which adapts to suit different venues. The insights gained in this workshop may be applied to other line-source systems.

This installment covers the technical background of line array systems, describes how they work and discusses their typical directional characteristics.

Henry Ford was said to have asked his contemporaries about their expectations for future mobility. The answer was: „faster horses.“ This very human attitude towards innovation is typical. So what‘s the alternative? Leave the beaten path, pursue a brilliant idea and overcome challenges in order to offer genuine added value to the user – these are all driving forces behind the art of real engineering.

Modern line-source PA systems like HK Audio‘s Elements prove this point. For one, they offer the typical benefits of a line source: They are not too loud in front of the speakers and not too soft far out in the room. What‘s more, the Elements system is modular in design. The manufacturer was doubly well prepared to develop a compact, scalable line array system – for one, because of the company‘s many years experience with large line array systems, and for other, because of the LUCAS compact satellite systems, a successful design aimed at musicians who tote their own PA to the venue..

Line-source in, monitor out

A scalable sound system designed as a line-source PA has several obvious benefits for the user: Less bulk and weight to be transported, easier handling and faster setup. The e-Connect coupler – a special feature of HK Audio‘s Elements – provides a signal path through the column so a lot less effort goes to plugging in cords. And most important, the system‘s coherent wave (see box) is projected further into the room with less energy invested. This means the signal is not too loud at the front of the stage and reaches further into the room. What‘s more, there is no need for delay lines to amplify the signal further in deeper venues.

A nice side effect: This kind of system looks rather more elegant than a hulking tower of cabinets, and its unobtrusive visuals suggest moderate volume. Audiences more often accost purveyors of light entertainment with questions about turning it down, and these musicians benefit from this psychological effect more than their harder rocking colleagues. Another advantage: The line-source system offers lots of gain before feedback and is therefore safer to use. It enables musicians to place their microphones within the field of throw. Like the audience, the band is in front of the PA system without requiring any monitoring.

This revolutionizes the interaction between musicians and the sound system in the best sense of the word. Chances are all musicians have asked themselves what the sound is like „out there“ during a performance with monitors on stage. Now they can answer that question because they enjoy an audio experience that has eluded musicians since separate PAs and monitoring systems first surfaced.

Limited speaker size

Aligning the same speakers in a line-source system creates a small line array modeled on those known from large stages. But there is a lot more to the development effort than that. The size of each speaker dictates the maximum coupling frequency because the spacing between the speakers‘ acoustic centers is determined by their diameter.

A frequency of 800 Hertz, for example, has a wavelength (λ = lambda) of around 43 centimeters.

This means we can use speakers with a radius no larger than 21.5 centimeters (see the diagram) for the distance equal to half a wavelength (λ/2). This would typically be an 8“ speaker. Larger speakers can no longer be fully coupled at this frequency because their acoustic centers would be further than a half wavelength apart. Also, practical applications have shown that the coupling effect is not interrupted at a frequency of lambda/half, but that it works smoothly up to around the frequency corresponding to the full wavelength.

In search of the middle ground

The maximum coupling frequency produced by the smallest possible individual speakers is not the only consideration that has to be taken into account. Such a speaker should also have the ability to render lower midrange frequencies. Relatively small speakers are progressively less able to do this with decreasing cone surface area. .

This is where developers began searching for the middle ground. The speakers used in Elements units measure 3.5 inches; the maximum frequency to form a coherent wave in a line of 3.5“ speakers is calculated at 1,700 Hertz. In practical experience, however, the coherent wave works up to about 3.4 kHz.

At first glance, this would appear to limit the high frequencies. Even if we consider PA systems‘ usable sound pressure ranging up to 12 to 14 kHz in the high frequency range to be sufficient, 3.4 kHz seems somewhat low for decent high-frequency performance. So how do you solve that problem?

IIn most large array systems equipped with 8“ speakers, the frequency range is generally extended upward with additional HF drivers. They are coupled at a frequency of around 2 kHz. Crossovers serve this purpose; they use filters to control the crossover frequency. However, the prerequisite for this is that coupling is even possible for the HF drivers‘ speakers. This means there has to be another line for the high-frequency range (the diagram on page 93) in addition to the speakers for the midrange. The challenges of generating a coherent wave for the frequency range in the harmonic spectrum are even greater than for the midrange. A slim column such as Elements would also get a bit fatter

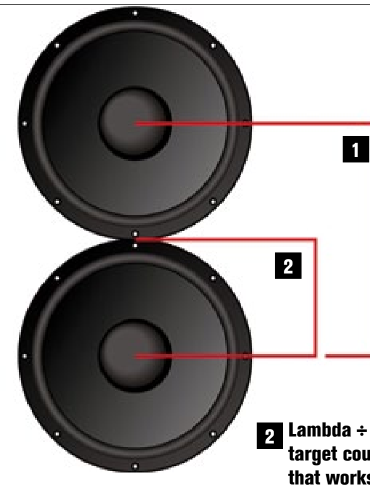
Large array systems‘ frequency range is generally extended upward with additional HF drivers. This is why a second line for the high-frequency range is added to the line of speakers for the midrange. This setup makes the system scalable.

TECHNIK-TIPP

What is a coherent wave?

A coherent wave is created when the acoustic centers of several identical speakers are arrayed so waves are coupled and they in turn create a cylindrical wave. This achieves a three decibel reduction in level rather than six decibels as the distance doubles when sound is dispersed through the air. The human ear perceives ten decibels as being twice as loud, so this effect already makes quite a difference at a medium distance of eight to ten meters. These ideas and their practical implementation date back to the middle of the last century. The outcome of this research is a speaker with great reach that is not too loud at short distances and whose sonic image does not change excessively over the entire range. In other words, the signals timbre or tonal texture is conveyed stably over a greater distance.

This rendering of overtone oscillations on a speaker cone looks like a floral pattern. Given carefully selected material, surfaces and specific vibration properties, this can serve to extend the useful range of a loudspeaker. That's why Elements works even without additional HF drivers.



1 Distance between the acoustic centers = lambda

2 Lambda ÷ 2 = target coupling that works flawlessly up to this wavelength

with a properly constructed, additional high-frequency line.

Overtime in the laboratory

Scalability – that is, the ability to adapt the system to varying requirements – was a fundamental design specification for the Elements system. In terms of hardware, this means the extensible l would have to accommodate as many Elements mid/high units as needed for the given room and music. This would rule out columns with tweeters and midrange woofers combined in a single line because a combination of different speakers does not bring the benefits of acoustic coupling to bear. The outcome would be a conventional PA cabinet with spherical directivity lacking scalability in any practical sense.

It is also important to avoid potentially adverse phase shifting and interference induced by a crossover. Consequently, a different approach had to be taken to resolve the tweeter issue even though this added around one and a half years to the time taken to develop Elements.

Your friend, the overtone

Every loudspeaker behaves like any vibrating string or membrane in that it produces partials in addition to its fundamental vibrations. The partials of a musical instrument are also called harmonics or overtones.

A vibrating string on a guitar, for example, produces a fundamental frequency such as E and always also its octave, fifth, third and so on in the form of overtones. These partials are selectively attenuated by the cones of a guitar cabinet to improve the tone and limit the upper end of its frequency range. An electric guitar signal rendered by a cabinet typically ranges up to around 6.5 kilohertz. If this were not the case, an overdriven guitar, especially, would sound unpleasantly piercing as an attempt to install a PA speaker in a guitar cabinet will confirm.

GHowever, if you carefully select the material, surface and vibration properties so as to allow specific overtones to oscillate, then you can extend the speaker's useful range. Think of the partials of a 3.5" speaker in the Elements aggregate as little tweeters on the cones of a single speaker as pictured in the illustration.

If the maximum usable coupling frequency for a 3.5" speaker is given at around 3.4 kHz, then the partials' acoustic coupling extends far beyond this into the high-frequency range. The range of the cylindrical wave increases with increasing line length and frequency. To compensate for this effect, there are filter presets on board with settings that adapt the Elements system's response to the number of mid/high units used.

The next installment is all about the components of the Elements system. It shows some examples where the focus is on music and musicians – which is exactly what its developers intended. tw

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