HARMAN
A SAMSUNG COMPANY

JBL COLUMNS SERIES DESIGN GUIDE

AKG AMX BSS crown dbx JBL PROFESSIONAL Lexicon Martin Soundcraft

INTRODUCTION

Choosing the correct loudspeaker for a given application is not as straightforward as it first seems. There are many factors to consider, from budget to aesthetics and positioning. Thankfully JBL offers a large 'toolbox' of loudspeakers for practically every audio application. This document will take a brief look at some of the considerations involved in sound system specification, such as loudspeaker types, acoustic space challenges and will explore using specialist loudspeakers such as column arrays to overcome certain challenges.

How you design and optimize a speaker will affect how it performs in an acoustic space. The output can be influenced by the cabinet, waveguides and internal electronics when constructing a loudspeaker, as well as the eventual placement. Each of these factors can have a profound effect on the eventual performance.

This guide is designed to highlight some of the acoustical challenges you may encounter and introduce you to a handy 'array' of solutions.

EXAMINING SPACE CHALLENGES

When considering the requirements of the sound system, many people can tell you the intended application (for example, speech, live music, or DJ purposes), but they are unable to quantify, or often overlook, the characteristics of the space in which the sound system will be used. When we talk about 'good sound' one factor that is regularly overlooked is the necessity for high intelligibility. The acoustic environment of the space is commonly the most important factor in determining how intelligible any system will be.

Simply choosing a system that sounds good in one space doesn't mean it will perform the same way in another.

A simple, practical tip for ascertaining the characteristics of a space is to clap your hands, once, and listen to the sound echo back to you. This is a very organic way of producing an instantaneous burst of noise, and if you listen back, each environment will be different from the next; results will even change depending on where you are positioned in the space.

The acoustics of a space varies with dimensions, material composition, geometry, and many other factors. As this is a complex subject, many audio companies employ the use of trained acousticians, who are experienced in measuring and consequently determining which products will be best suited to the space. Having a basic grasp of the acoustics of the space is a prerequisite to designing and installing a sound system.

Imagine you're in a cathedral or large church setting. The dense, reflective stone interior combined with high ceilings and opposing hard surfaces creates a rich environment for long reverberation times. Reverb time is usually measured as an RT_{60} value. RT_{60} is the time for the sound energy to attenuate by 60 dB from the initial impulse of sound.

Likewise, in a small office containing chairs, desks, bookshelves, and other surfaces that the sound will interact with, the RT_{60} will be short, but could still have some undesirable acoustic characteristics.

Both examples will have many more factors than just the acoustics which determine the most suitable loudspeaker choice. A combination of sound system application (for example speech, background music, or sound reinforcement) and physical limitations such as mounting and infrastructure options, indoor/outdoor use, sightlines etc. will determine what type of loudspeaker is most appropriate for the project.

Often people will describe an event as having 'good' or 'bad' sound, yet the reality is the space, application and the sound system all interact, contributing equally to the perceived quality of the system. When choosing a loudspeaker, we sometimes look at what other systems have been installed in places we associate with a good experience, but the performance won't necessarily equate to the same outcome in a different acoustic environment.

Point source loudspeakers lose 2x the energy over the given distance compared with a line source loudspeaker

PERFORMANCE CHARACTERISTICS

The most typical type of loudspeaker is a point source design. This is where a single loudspeaker emits its sound energy similarly in the horizontal and vertical plane. Multiple drivers in a column speaker allow it to act more like a line source than a traditional point source. The limited vertical dispersion means that sound pressure levels start to decrease at a rate of 3 dB per doubling of distance, rather than 6 dB like one would expect form a point source design.

Point source loudspeakers do a tremendous job in an enormous variety of situations and use various techniques to direct the sound in a predictable manner. Typically, a good sound system design aims to direct sound towards listeners rather than having it bounce off walls and ceilings.

For a cabinet to be considered full range it is often necessary to employ two or more loudspeaker drivers within the design. In most cases, loudspeakers will utilize a waveguide on the tweeter which helps to increase directionality. The bass driver will behave more omnidirectionally due to the compact dimensions of the cabinet relative to the long wavelengths of bass frequency sounds.

At low frequencies, due to the relatively low directivity of a point source loudspeaker, a considerable amount of sound pressure is lost as we move away from it. If you are trying to cover a long distance you may encounter problems; by attempting to get sound to propagate to the back of the room, we will need to produce a level of output which may be too loud for people at the front.

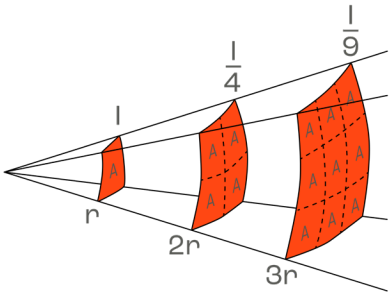


Figure A: *typical point source dispersion. The energy twice as far from the source is spread over four times the area, hence one-fourth the intensity*

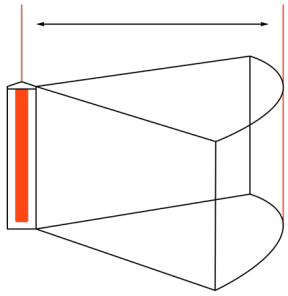
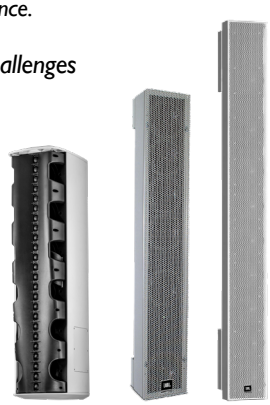


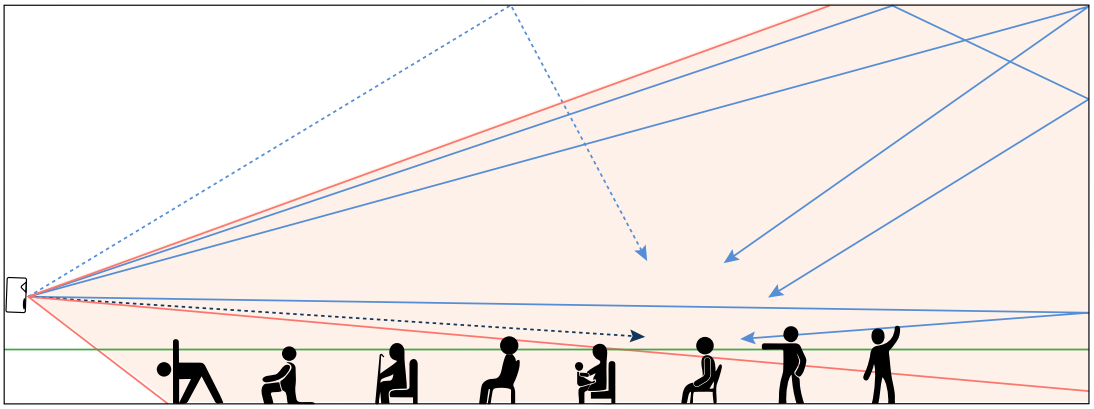
Figure B: *typical line source dispersion. Dispersion is controlled vertically so less energy is lost over distance.*

Column loudspeakers were invented as means to overcome these two audio design challenges

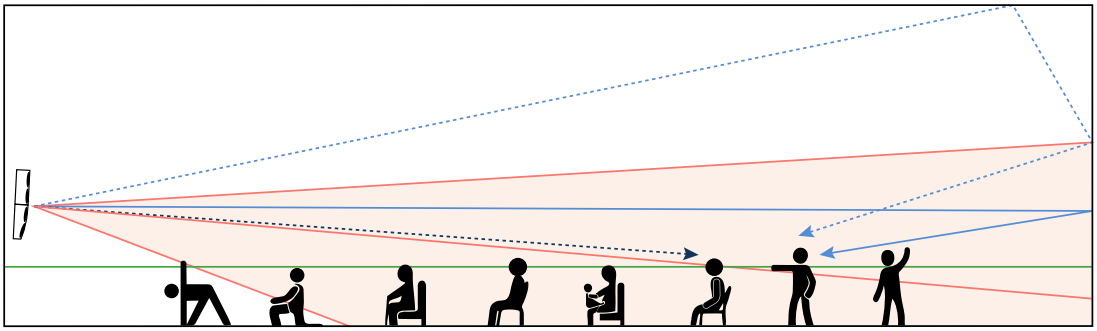
Line array loudspeakers work by using a series of drivers that are mounted vertically above each other. The drivers are arranged so that their combined output interacts and sums together to produce sound waves that propagate in a line rather than an arc, producing a tight vertical coverage pattern which can then be aimed towards the audience. This has the added benefit of reducing the amount of energy lost to the reverberant field, thereby improving speech intelligibility.



Conventional point source energy dispersion



Line array energy dispersion



Column or line array?

Line Array has been a buzzword in audio for the past thirty years. Essentially all column loudspeakers are line arrays, despite people often describing 'line arrays' as those being made up of separate elements like those used at concerts, and 'column arrays' as a single unit filled with many drivers. However, the principles are the same, and when designed correctly the performance is too.

No matter which style of array used, there are fundamentals that apply to all. The longer the array, the greater the throw and control capability you will have over the lower frequencies – which have longer wavelengths – therefore the array needs to be physically long to control the low end. In a particularly reverberant space, we want to use this control to help reduce the reverberant field and increase the direct sound from the loudspeaker, which in turn helps to increase intelligibility.

Beam Forming

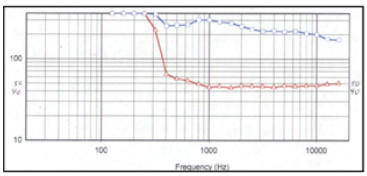
Beam forming is the phenomenon of using phase, delay and attenuation of multiple drivers in a coupled array to direct radiating sound into a tight beam. This beam can then be aimed electronically to cover the audience without the need for physical aiming. This also significantly reduces the amount of energy propagating where we don't want it i.e., on to the building structure, thereby causing echoes and reverberation which will impact intelligibility.

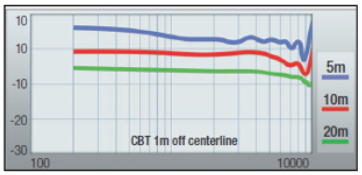
Whether a highly configurable active design or a performance audio design, JBL's wide range of columns has got you covered

Active or passive?

Passive column arrays are used in much the same way as a conventional point source speaker. They are powered by an external amplifier and the sound beam is controlled using the physical layout of the drivers, waveguides, and any passive internal electronics.

All interactions between multiple drivers will have some positive and some negative interference. JBL's patented Constant Beamwidth Technology (CBT) has been developed to mitigate the undesirable characteristics such as lobing and the widening and narrowing of beamwidth at different frequencies. CBT passive columns have the power and performance characteristics of a high quality professional PA speaker but with the benefits of beam steered line array coverage.



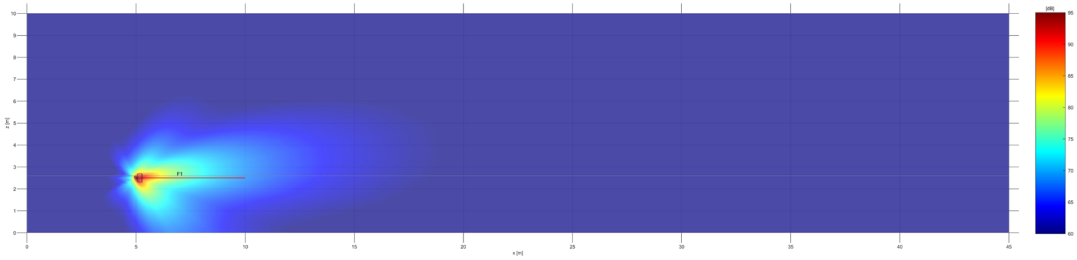


Active column arrays also contain many drivers, but additionally feature multiple channels of amplification and digital signal processing. This allows the interaction between the transducers to be manipulated electronically using specialist control software. This provides the installer the opportunity to optimize the coverage of the column to meet the exact requirements of the job.

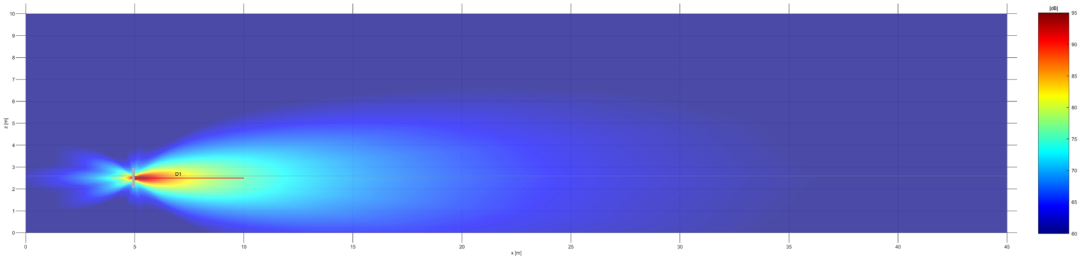
Typically, active columns such as JBL's Intellivox range allow users to create a beam shape with very tight vertical dispersion, concentrating the sound energy into a much smaller area with a very even distribution of power from the front to the back of the audience. This has the added advantage of substantially reducing the amount of sound pressure loss as you move further from the loudspeaker. As such, these taller active column designs are ideal for long throw applications such as houses of worship and transportation hubs.

The following examples illustrate the characteristics of each type of loudspeaker at 2 kHz:

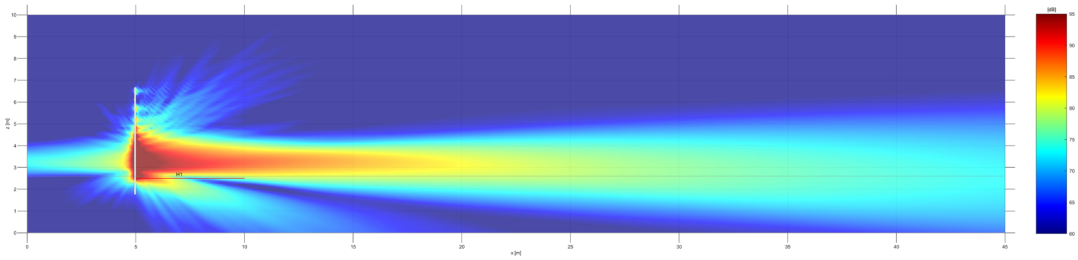
Column loudspeakers offer minimal visual impact and are sympathetic to architectural aesthetics



Point Source - (JBL Control 28-1) This shows a typical point source cabinet which exhibits good control of the high frequencies; however, energy is concentrated near to the speaker and drops off rapidly with distance.



Passive Column - (JBL CBT 100LA) This shows the improvement in directivity that a passive column can offer, better directing sound at the listener. It can also 'throw' a longer distance with a good level of energy.



Active Column - (JBL Intellivox DS500) The beam of this large column can be shaped and controlled electronically creating a precise coverage pattern to cover much longer distances.

WHERE BEST TO USE A COLUMN LOUDSPEAKER?

Column speakers lend themselves best to applications where limited placement options can impact desired coverage, in areas or zones where direct sound is significantly affected by reverberance, or where the presence of point source boxes is not in line with the aesthetics of a space.

By definition, column loudspeakers are tall and narrow so they can be mounted very discreetly.

They can be used in a variety of applications ranging from retail, AV, auditoria, transportation hubs and houses of worship.

Good examples in transportation are in train stations, where public address/voice alarm systems need to cover the whole length of a platform. Running extra cable out to multiple point source loudspeakers will increase installation cost, may not provide the required coverage, and may not even be physically possible.

Column speakers also work very well in house of worship environments, where the use of stone and hard finishes typically give long reverberation times. Evenly distributing a series of column speakers can provide a given area with a greater direct-to-reverberant sound ratio compared to a point source system. By keeping the distributed, direct sound level low, less excitation of the room occurs. This improves intelligibility.

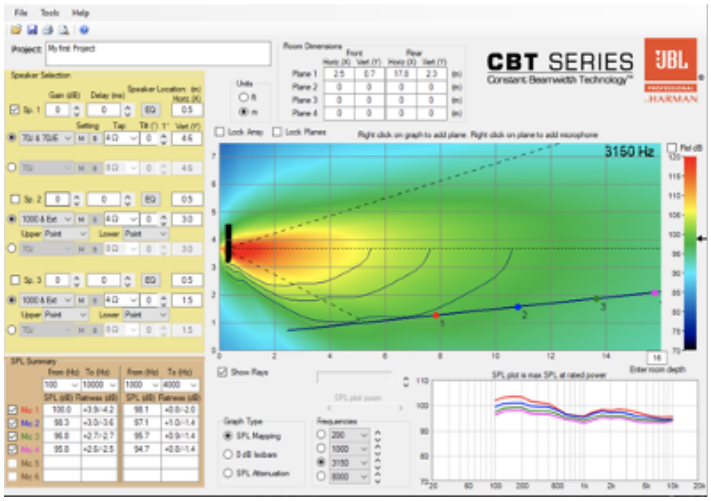
Architecturally sensitive spaces

Care and attention will have been given to the design and aesthetics of the space in which you need to install a loudspeaker system. The column loudspeaker can be a useful tool with its naturally small footprint, allowing for discreet mounting. It is also possible to recess and paint the loudspeakers to help further reduce the visual impact on their surroundings.

DESIGN TOOLS AVAILABLE

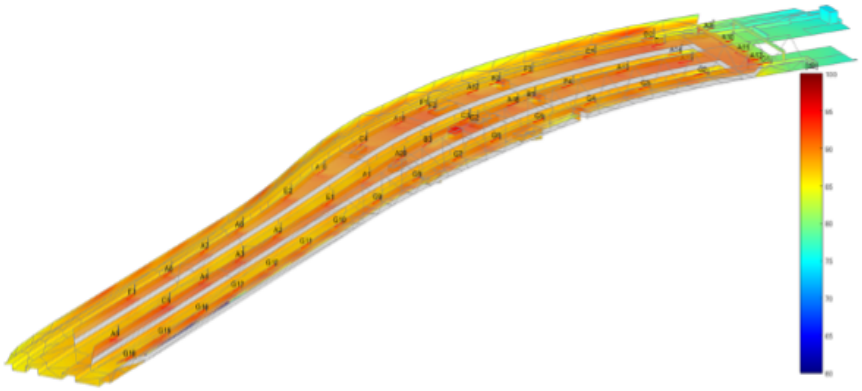
JBL offers software tools to assist sound system designers in system optimization. Array calculators are very helpful in determining mounting positions and selecting the most appropriate product for the space. These proprietary tools are available online, along with additional EASE and CLF files for third-party modelling suites.

CBT Line Array Calculator



Digital Directivity Analysis and WinControl™

DDA offers 3D modelling support for all JBL point source loudspeakers with CLF data and all JBL Intellivox products.



DDA software direct sound coverage visualization. Platforms 20-24, Waterloo Station, London.

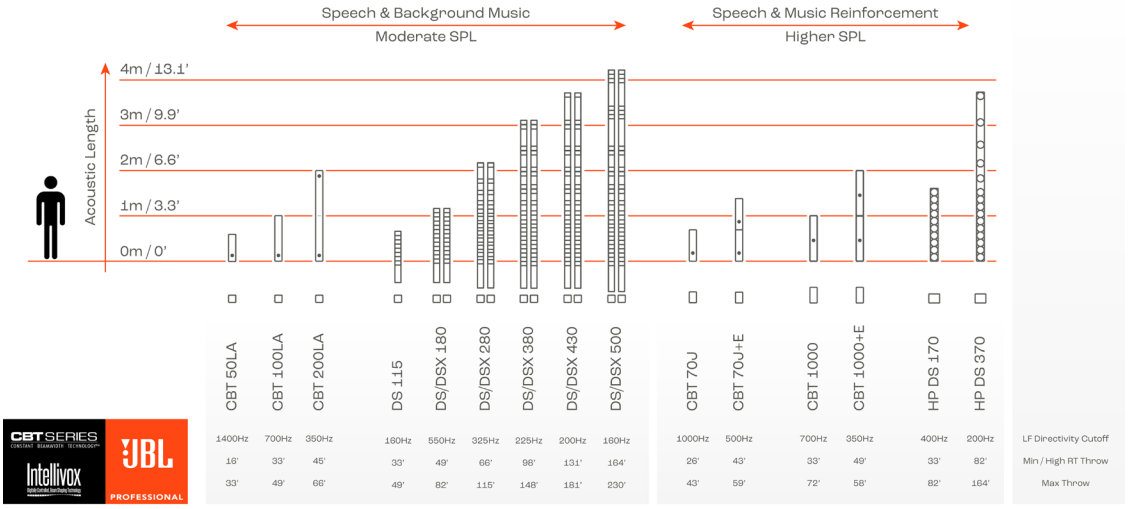
Intellivox makes use of JBL's advanced beam shaping (DDS - Digital Directivity Synthesis) technologies. Within the DDA software, the radiation pattern of JBL Intellivox loudspeaker arrays can be controlled precisely and tailored to the shape and the acoustics of the space. In addition, DDA offers various tools to reduce design time and help to optimize system performance. For installation and commissioning purposes DDA can also generate FIR output filters which can be uploaded to supported DDS-controlled loudspeaker arrays using the JBL WinControl™ software.

Where to find assistance

JBL and our distribution partners have teams of highly experienced engineers ready to support your project, please contact us for advice and design support.

Product name	Description	Type	Typical uses/USPs	EN 54-24
CBT 50, 100	Slimline Column Line Array	Passive	Short-mid throw AV/House of Worship	Available
CBT 200	Slimline Column Line Array	Passive	Mid-long throw AV/House of Worship	N/A
CBT 70	High-performance Column Line Array	Passive	Mid-throw AV/HOW/ Foreground audio	N/A
CBT 1000	Very High-performance Column Line Array	Passive	Long-throw AV/HOW/ Foreground and Performance audio	N/A
Intellivox ADC	Fixed, Steered Column Line Array	Passive	Short-mid throw PA/VA systems	Yes
Intellivox DS and DSX	Custom Beam-Shaping Column Line Array	Active	Long throw and challenging acoustic environments	N/A
Intellivox HPDS	High Power Custom Beam-Shaping Column Line Array	Active	Long throw and challenging acoustic environments IP55 rated	N/A

Column Array Overview



CBT 50, 100 and 200

The Constant Beamwidth Technology™ range represents a breakthrough in pattern control, utilizing analog delay beam-forming and amplitude tapering to accomplish consistent vertical coverage without the narrow vertical beaming and out-of-coverage lobing typical of straight form-factor passive column speakers. Ideal for speech and full-range background music.

Learn more on our website

CBT 70

Incorporating CBT in a larger form factor, the 70J-1 is capable of producing spectacular high fidelity audio in spaces.

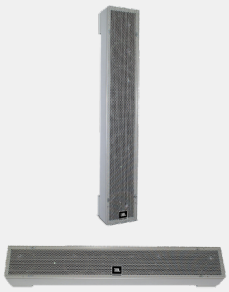
Additional low frequency extension down to 45Hz is also possible with the addition of a CBT 70JE- 1 to the array, making it suitable for use in a variety of applications.

Learn more on our website

CBT 1000

The most powerful array in the CBT range, the 1000 and 1000E low frequency extension also feature asymmetrical vertical coverage control and tapered horizontal waveguiding to increase the versatility of loudspeaker coverage across a wide variety of listening areas whilst matching the power output of the SRX and VRX high performance ranges.

Learn more on our website



Intellivox ADC range

At home in Public Address and Voice Alarm (PA/VA) systems, the ADC range adopts a set of analogue passive filters precisely transferred from the Digital Directivity Control realm. These column arrays can be adopted in 70/100V line systems, making them at home in transport hubs and museums where high intelligibility is appreciated.

Learn more on our website

Intellivox DS and DSX range

Active beam shaping featured in these ranges offers bespoke coverage control for applications requiring more accuracy in directing sound propagation. There's an Intellivox DS or DSX for spaces of any size; intelligibility can be achieved in smaller, less reverberant environments, whilst the larger sized units can cover areas up to 70m. The DSX variant range has dome tweeters which improve horizontal coverage and enhance subjective sound quality for both speech and music.

Learn more on our website

Intellivox HPDS

The active beam shaping, self-powered HP-DS range is just as at home outdoors as it is indoors; durability against the elements is proven with IP55 rating. The High Power range has been designed specifically to solve the problems of speech intelligibility and musical reinforcement in large highly reverberant spaces including houses of worship, theaters, transportation halls and more. The slim profile also helps it to fit unobtrusively into spaces with challenging architectural and acoustical factors.

Learn more on our website

About HARMAN Professional Solutions

HARMAN Professional Solutions (harmanpro.com) is the world's largest provider of professional audio, lighting, video and control products. HARMAN's best-in-class integrated solutions help customers to deliver the highest-quality results for concert tours, cinema, retail, corporate, government, education, large venues, hospitality and more. With brands that include AKG®, AMX®, BSS Audio®, Crown International®, dbx Professional®, JBL Professional®, Lexicon Pro®, Martin®, and Soundcraft®, HARMAN Professional Solutions offers the most proven, innovative, and comprehensive solutions for the entertainment and enterprise markets. For more information, visit http://pro.harman.com/.