

## Vertical AND Horizontal

L-ACOUSTICS KUDO designed for both planes

By Paul D. Bauman

*This Factory Direct was submitted by L-Acoustics. Live Sound makes every effort to eliminate any use of marketing inspired hyperbole.*

The working concept of the new L-ACOUSTICS KUDO line source array began with the goal of offering a higher degree of flexibility. Specifically, we were seeking to offer our patented Wavefront Sculpture Technology (WST) in both vertical and horizontal planes, and further, to make this coverage adjustable to fit a wide range of applications.

Sound reinforcement for venues such as theatres, concert halls, houses of worship and arenas were identified as the target applications for KUDO, as well as regional sound companies for touring and/or corporate applications. Coverage requirements for these venues were carefully studied in order to determine performance specifications in terms of directivity and the necessary flexibility required to cover typical audience geometries.

Average throw distances and sound pressure level (SPL) expectations were also important considerations, leading to the selection of an active three-way enclosure format. For improved handling and speed of installation in touring rigging situations, a convenient captive rigging system was engineered.

Specifically, two proprietary DOSC waveguides are incorporated in KUDO. In parallel, coverage pattern adjustment is available in the perpendicular plane using patent-pending K-Louver technology. This mechanically adjustable approach provides directivity control of the mid/high section (above 800 Hz) and allows KUDO to be reconfigured with four different coverage pattern settings.

KUDO combines the functions of a variable-curvature vertical line source array (like V-DOSC) and a constant-curvature horizontal line source array (like ARCS). When used as a vertical line source array, inter-enclosure angles are 0 to 10 degrees at 1-degree



*KUDO can be configured both ways.*

resolution and the horizontal directivity can be configured as 50 degrees (symmetric); 110 degrees (symmetric); 25 degrees by 55 degrees (asymmetric) or 55 degrees by 25 degrees (asymmetric).

Within the same vertical array, individual enclosures can also be configured with different horizontal directivity depending on the shape, width and reverberation properties of the venue, offering flexibility with respect to audience geometry matching.

When installed horizontally as a constant curvature line source array, 10-degree inter-enclosure angles are employed and the horizontal coverage is 10 degrees by N (where N is the number of enclosures). Vertical directivity can then be configured as 55 degrees (symmetric); 110 degrees (symmetric); 25 degrees by 55 degrees (asymmetric – for upfill) or 55 degrees by 25 degrees (asymmetric – for downfill).

Given the choice of four directivity settings and two orientation possibili-

ties, KUDO provides the performance equivalent of eight different loudspeakers.

WST criteria provided the scientific basis for the design of KUDO by defining the conditions that need to be satisfied in order to create a properly functioning line source array. (For more about WST, see "Wavefront Sculpture Technology," *AES Journal*, Volume 51, Number 10, October 2003.)

In addition to R&D, design specifications for KUDO were determined based on our cumulative experience with V-DOSC, dV-DOSC and ARCS over the past decade. L-ACOUSTICS' overall philosophy is to offer strategic, complementary sound design tools that are application-oriented.

### DIMENSIONAL ACCURACY

The custom dual DOSC waveguide module was specifically designed for KUDO using CAD/CAM techniques in order to ensure dimensional accuracy and precise manufacturing tolerances. Extensive prototyping and testing



*The dual DOSC waveguide designed specifically for KUDO.*

were then conducted to optimize KUDO – particularly the mid/high section and the unique variable directivity aspects of the enclosure.

KUDO incorporates proprietary



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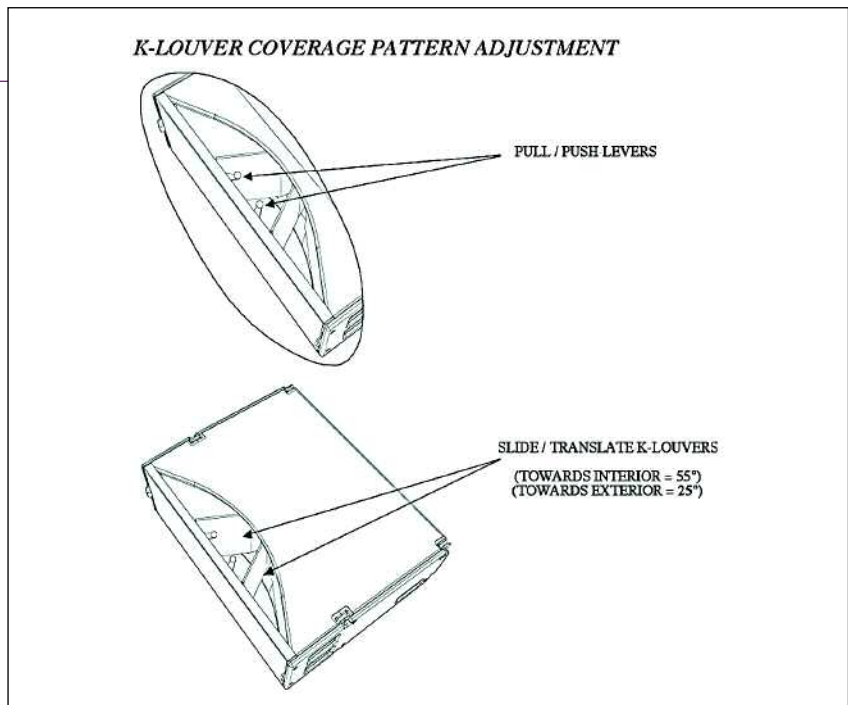
# Factory Direct

OEM components and transducers. The enclosure is an active three-way design with two direct radiating, bass reflex-loaded 12-inch low frequency transducers, four high-efficiency five-inch midrange transducers mounted in a V-shaped configuration; and dual one-inch high frequency compression drivers that are coupled to individual DOSC waveguides.

The 12-inch low-frequency transducers employed in KUDO offer a four-inch edge-wound copper voice coil on a fiberglass former and dual spider construction for long-term durability. Vented gap cooling increases power handling with reduced power compression, and the cone bodies are waterproof-treated on both sides for added reliability.

High-frequency compression drivers offer a neodymium magnet structure that boosts sensitivity and linear response up to 20 kHz. The 1.75-inch diameter voice coil employs copper-clad aluminium wire wound on the inside (and outside) of the kapton former for better heat dissipation and reliability in addition to reduced power compression.

Crossover points are 300 Hz between low and mid sections and 2 kHz between mid and high sections, with 24 dB-per-octave Linkwitz-Riley characteristics. As a full range system, frequency response is meas-



Detailed look at the K-Louver system that allows precise coverage pattern adjustment.

ured as 50 Hz to 18 kHz with less than  $\pm 3$  dB variation, and the usable bandwidth has been evaluated as 40 Hz to 20 kHz (-10 dB).

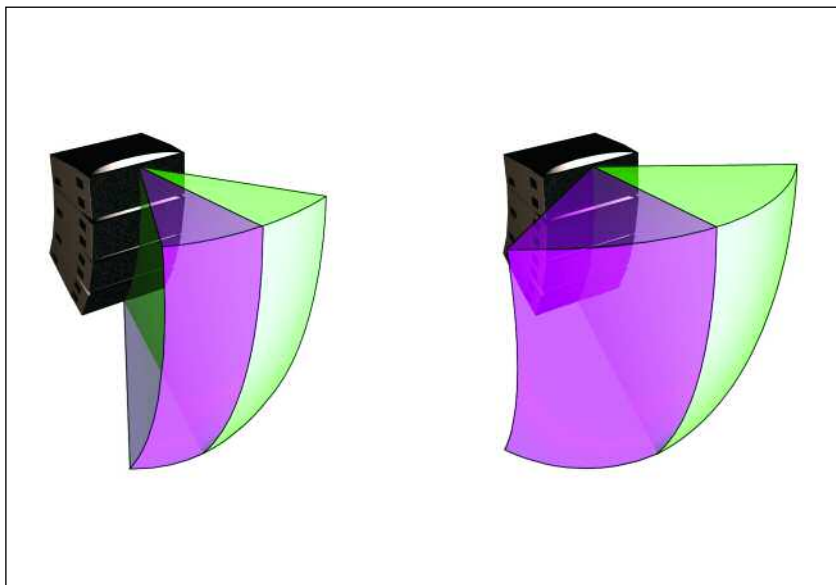
When arrayed vertically or horizontally, multiple KUDO loudspeakers function according to the principles of WST with either the separation between acoustic centers of components less than half the wavelength at the highest frequency of their operating bandwidth or the sum of the individual areas of the radiat-

ing enclosures greater than 80 percent of the target radiating area. In addition, the radiated wavefront of a KUDO array has less than 5 mm of variation with respect to the target wavefront – whether flat or at maximum 10-degree curvature.

The configuration of transducers in KUDO is symmetrical with respect to the plane of propagation of the wave, i.e., the plane bisecting the main axis of the coverage angle. High frequency transducers are located in the middle, mid frequency transducers are on both sides of the high section, and low frequency transducers are laterally positioned on both ends.

Such a configuration is described as having coplanar symmetry and this arrangement of transducers provides natural polar symmetry, allowing the system to operate as a line source array over its entire operating bandwidth (50 Hz to 18 kHz).

Coplanar symmetry is the line source array equivalent of the coaxial loudspeaker configuration that is also found in the L-ACOUSTICS MTD and XT product ranges. Essentially, coplanar symmetry provides even coverage at any listening angle over a KUDO array's coverage pattern and eliminates off-axis acoustic cancellations at crossover frequencies. Psycho-acoustically, coplanar symmetry is largely responsible for the



Various vertical line source array patterns (symmetric and asymmetric) can be attained.

stereo imaging properties that are characteristic of KUDO.

Enclosures have a truncated trapezoidal shape with trapezoidal angles of 5 degrees top and bottom. Dimensions are 34.5 inches wide, 14 inches high and 27.1 inches deep. Enclosure weight is 191.4 pounds.

### FLYING MANEUVERS

The captive rigging system offers separate rigging bumpers for either vertical or horizontal orientations. In the vertical orientation, up to 21 KUDO enclosures can be flown using the K-BUMP rigging bumper with inter-enclosure angular spacing between 0 degrees to 10 degrees, in increments of 1 degree. In the horizontal orientation, up to four KUDO enclosures can be flown per K-LIFT liftbar with constant inter-enclosure angles of 10 degrees.

The horizontal (or vertical) pattern of KUDO can be adapted to the required width (or vertical elevation) of a venue/coverage area. When used as a vertical line source array, the same KUDO enclosure offers two symmetrical directivity patterns of 50 degrees or 110 degrees and two asymmetrical patterns of 80 degrees left or 80 degrees right by making a simple mechanical change to the internal K-Louver orientation. Within the same array, individual KUDO enclosures can also be configured with different horizontal coverage patterns depending on the shape, width and reverberation properties of the venue.

When used as a horizontal line source array, KUDO is a constant curvature single row array with fixed, modular 10-degree inter-enclosure angular spacing. As a result, six enclosures are necessary to cover a 60-degree area, while 36 enclosures can be installed as a center cluster for full 360-degree arena coverage. The variable directivity of the enclosures is then used in the vertical plane to optimize both coverage and SPL distribution over a given audience geometry, i.e., symmetrical 50-degree or 110-degree coverage vertically or asymmetric 80 degrees up or down.

### POWER IT UP

Long-term power handling is two by 425 watts for the dual-12-inch low-frequency section, 400 watts for the four

5-inch midrange transducers and 85 watts for the two one-inch high-frequency compression drivers (all RMS ratings). Lows are powered individually at a nominal 8-ohm impedance, mids are connected in series/parallel at a nominal 8-ohm impedance, and highs are connected in parallel for a nominal 8-ohm impedance. Connection to the loudspeaker is made via two parallel Neutrik NL8 Speakon connectors.

L-ACOUSTICS RK122K and RK124K power amplifier racks are supplied "amplifier ready" and can be loaded with L-ACOUSTICS LA24a or LA48a power amplifiers, depending on the number of KUDO enclosures to be operated in parallel. We recommend the LA48a power amplifier as being optimum for three KUDO enclosures in parallel, while the LA24a power amplifier is suitable for two enclosures in parallel.

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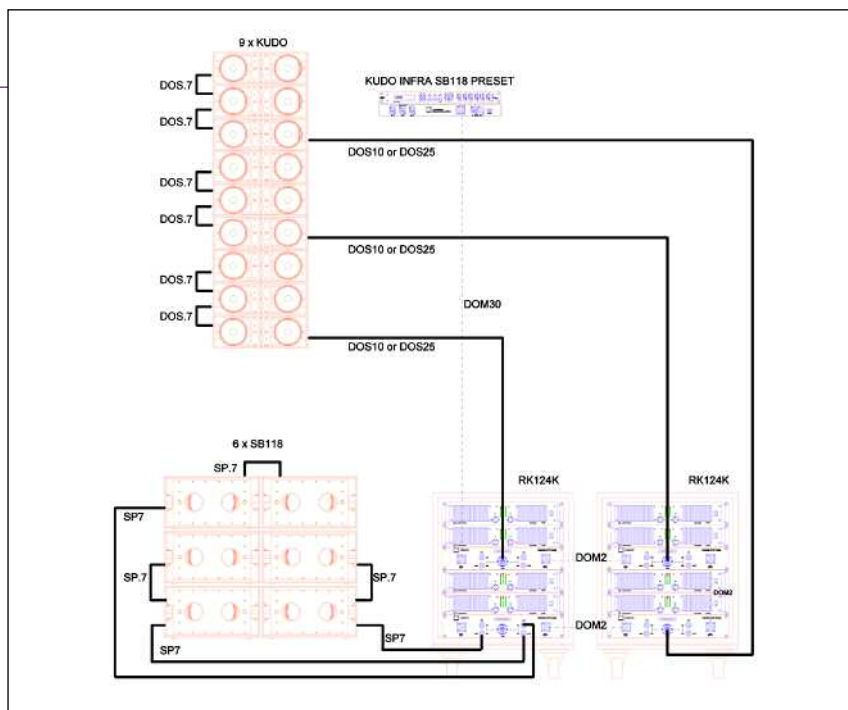
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The PADO2K amplifier patch panel allows for connection of loudspeakers, input signal and output signal loop through. The panel has two 19-pin male CA-COM connectors for input signal connection (six channels) and linking to other amplifier racks and a single female Neutrik NL8 Speakon connector for loudspeaker connection (wired in parallel with four Neutrik NL4 Speakon connectors).

For the CA-COM connectors, line 1 is reserved for subwoofer drive; lines 2, 3 and 4 are for KUDO low, mid and high, respectively; lines 5 and 6 are for two-way fill (low and high, respectively). The 37-pin D-SUB connector is wired in parallel with the CA-COM connectors and works in conjunction with two-way, three-way or sub COMB connectors, allowing the user to assign desired signal lines to amplifier inputs and conveniently reconfigure amplifier racks without rewiring the amplifier racks internally.

The CO6 Control Output panel is



A sample system configuration including KUDO as well as other L-ACOUSTICS components.

intended for use with a single two-input (or three-input) by six-output digital signal processor (DSP) for the creation of a modular drive rack or for stand-

alone master amplifier rack packaging.

DSP outputs are connected to the 6x female XLR patch bay on the rear side of the CO6 panel, and these outputs are in turn assigned to the front panel 19-pin CA-COM connector. This provides a six-channel multi-core return snake system when used with a standard 30-meter DOM30 cable. For longer cable runs, multiple DOM30 cables can be extended using the DOMP adapter (19-pin male-male CA-COM adapter).

The CO6 Control Output panel allows for maximum flexibility while providing a scaleable architecture that can be used for small, medium and even large system applications since it is compatible with current L-ACOUSTICS signal distribution and cabling/connector standards.

Fixed horizontal directivity has been one of the few critiques of line arrays over the past few years and with the release of KUDO, L-ACOUSTICS has attempted to address this. The added capability of being able to fly the system horizontally (with accompanying variable vertical directivity) opens up many possibilities for creative sound design. ■

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