

The Sheikh Zayed Grand Mosque in Abu Dhabi demands a sound reinforcement system for the indoor venue and the outdoor areas. The system shall achieve high quality and intelligibility to carry the vocal energy in various prayer halls and outdoor audience considering the acoustic criteria condition and the architecture. So, considering these requirements, we have proposed the full solution based on the selection of particular loudspeakers answering these criteria; the indoor and outdoor areas system design approach is based on different loudspeaker technologies but keeping a similar sonic impression throughout the entire audience. Generally, our scope of work for the proposed solution covers the following areas:

- Main Haram Prayer Hall and Haram Main Entrance
- Covered Prayer Halls North and South
- VIP Majlis
- Minarets
- Arcades and Main Courtyard Entrance

Indoor System Approach

The proposed solution for the prayer halls is based on Active Audio steerable array powered speakers with built-in DSP; loudspeakers will ensure proper sound coverage and are distributed as following:

- Main Haram Prayer Hall and Haram Main Entrance:
 - (2) numbers of SA450P+
 - (4) numbers SA300P+
 - (18) numbers SA230P+
 - (4) numbers SB115 Subwoofer
- Covered Prayer Hall North:
 - (4) numbers SA230P+
- Covered Prayer Hall South:
 - (4) numbers SA230P+
- Haram Entrance Prayer Hall North:
 - (2) numbers SA230P+
- Haram Entrance Prayer Hall North:
 - (2) numbers SA230P+

These self-powered digitally steerable column loudspeakers incorporate Dante™ and designed for horizontal seating spaces for up to 68m with a uniform coverage of $\pm 3\text{dB}$. StepArray Plus column speakers enjoy the benefits of the two main current technologies for directivity control by implementing a hybrid principle patented by Active Audio: DGRC, Digital and Geometric Radiation Control. Additional

15" subwoofers ensured the enhancement of the frequency bandwidth down to 100Hz; 4x units model

SB115 Dual interactive chamber were installed at the main prayer hall.

Minarets System Approach

The proposed solution is based on Electro-Voice EVH series; it is a high power, 2-way Horn loaded coaxial loudspeaker system, wide bandwidth directivity control, and high efficiency performance.

The selected models are EVH-1152S/64 FGW and EVH-1152S/64 FGW; both models utilize 1x ND2B and

1x SMX2151. The ND2B is a high output 2" titanium compression driver, coupled to a rotatable 12" x 12"

Constant Directivity™ waveguide, 40° x 30° on EVH-1152S/64 FGW model and 60° x 40° on EVH-1152S/64 FGW. The SMX2151 is a high output, low distortion 15" woofer.

Both types feature a trapezoidal enclosure and constructed out of 13 ply, 18mm birch, and coated with

Fiber Glass in white color for maximum protection for the elements and the recommended model is FG permanent outdoor with IP 55 that uses a stainless-steel grill grille backed with multiple material layers to prevent weather or humidity ingress. Total of 34 units were used at minarets.

Power amplifiers model used for minarets is TG-5 with RCM-28 module.

Courtyard and Arcades System Approach

The proposed solution for the courtyard and arcades is based on Electro-Voice XLD line array system to cover the courtyard outdoor large area while the arcades will be covered by MC2C weatherized speaker from Active Audio.

The XLD281 is a 3-way design using CCT (Coverage Control Technology) to control horizontal coverage to

250 Hz. It uses an 8" neodymium LF transducer, an 8" neodymium LF/MB transducer, and two neodymium 2" voice coil compression drivers combining through 2 hydra plane wave generators into a

120° x 10° waveguide. CCT uses both 8" transducers to provide maximum low frequency output and operating bandwidth while controlling horizontal beam width to 250 Hz by using DSP. The XLD281 is used in bi-amp using its built-in internal passive network. Four arrays will cover all the outdoor area: 1)

Central left and right arrays each with (14) elements, 2) Side left and right each with (8) elements; these arrays will deliver full bandwidth audio with precise, predictable coverage control. Integrated rigging with hinge points located correctly between array elements is simple to use and quickly provides uncompromised line array performance. These arrays are weatherized type for permanent outdoor install delivered in white color to match the existing color of the wall.

Power amplifiers model used for XLD's is TG-5 with RCM-28 module.

The Active Audio MC2C is column shape model for fixed installation using the d'Appolito baffle optimized for dual 6.5" transducers. The unit has been developed for no-compromise

reproduction of the mid frequency range and especially the human voice, offering maximum clarity and intelligibility.

Thanks to the d'Appolito's baffle, the directivity is controlled in the mid-range and makes the MC2C a perfect loudspeaker for high intelligibility vocal reproduction up to 25 meters outdoors. A total of 16 units are used at the arcades for optimum coverage. Power amplifiers model used for CPS4.10 with RCM-810 module.

Audio Network System

The Digital Matrix Processor provided by Electro-Voice N-8000; it is a modular, network-compatible and freely configurable audio system with which complete system solutions can be constructed. The system provided all components ranging from the matrix to the speakers including Dante™ boards and other system control and monitoring in a common audio platform. The configuration, operation and monitoring of the system is controlled through the IRIS-Net control software protocol. The system provides comprehensive built in supervision functions to monitor and report failures in all aspects of the systems functions.

A total of 16 racks are distributed at the mosque in different locations providing audio signals; the core network is provided by ELC Ethernet switches using two buses for redundant Dante™ audio network. A total of 40x units ELC DLS8GB have been used to secure the proper network operation.

The main audio console is provided by Yamaha model CL3 along with Dante stage boxes; 2x Rio1608-D +

4x Ri8-D + 4x Ro8-D have been used to ensure the distribution of inputs and outputs within the complex.

Wireless Microphone System

The wireless microphone system is provided by Sennheiser 2000 series; a total of eight channels are provided with both handhelds and belt packs in use. The handhelds are furnished with e965 capsule while HSP4 has proved to be the best choice for vocals in such venue. The system is controlled and monitored by the WMS application provided by Sennheiser and the coverage is optimized by the 2x AD3700 directional antenna throughout all prayer halls.

Another set of eight (8) e965 condenser microphone is provided to ensure high quality audio reproduction were the unit switches between gentle cardioid and more direct super-cardioid polar patterns.