StepArray

manual

audio

L'acoustique active

Contents

Foreword

StepArray is a versatile line-array system designed for speech reinforcement in large spaces. It offers excellent sound intelligibility, slim design, external electronics, security systems compatibility and more.

This reference manual is intended to be a user manual for StepArray based systems, as well as a complete reference with all the technical specifications and details about the StepArray system.

How to use this manual

This reference manual is divided in two parts:

- The first part is a **tutorial for recommandation**. It deals with StepArray design and principles, introducing the acoustic background necessary to understand sound reinforcement in large space, and how StepArray can help to achieve good intelligibility in these places.
- The second part is a **technical reference** describing the full range of StepArray products. It covers installation, wiring, maintenance, and tuning. Extensive technical data is found there.

Part I

StepArray: tutorial for recommandation

Table of Contents

Introduction

This is a tutorial for StepArray recommandation.

Section 1 presents general issues about public address in large spaces (1.1) and explains how loudspeaker arrays can be a good solution to these issues (1.2). StepArray is introduced as the last point of this section (1.3).

The following parts are a step by step introduction to the StepArray system:

- Section 3 explains the rules to follow when designing a StepArray system,
- Column positionning is described in section 4,
- NUT control software, serving both as a simulation and tuning software, is described in section 5,
- CAD modeling tools are presented in section 6.

1 Sound reinforcement in large spaces

1.1 General issues with public address in large spaces

Speech reinforcement in large and reverberant rooms is made difficult by several causes, namely **reverberation**, **ambient noise**, and **architectural constraints**.

Reverberation

In all rooms, sound transmission from a loudspeaker to a listener can be divided in two parts (figure 1):

- Direct sound, which depends on the loudspeaker-to-listener distance and on the loudspeaker directivity.
- Reverberated sound, which depends on the geometry of the room, and the acoustical properties of the walls. In large spaces (church, railway station), the reverberation can be very important and plays a negative role on speech intelligibility (Note that the energy of the reverberated sound is constant throughout the room).

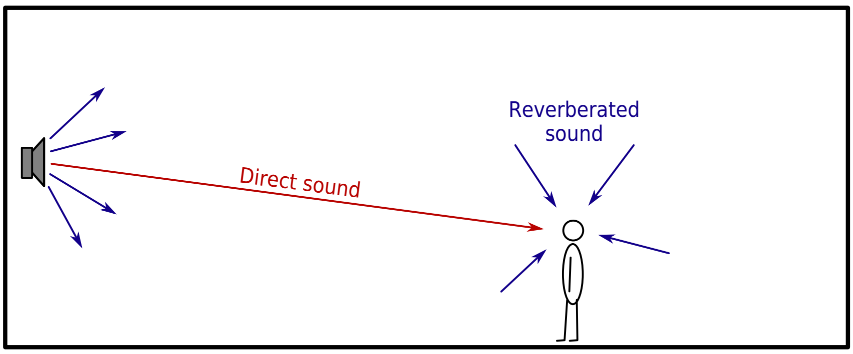


Figure 1: Direct sound increases speech intelligibility, reverberated sound impairs it.

Intelligibility rule #1:
Direct sound increases speech intelligibility, reverberated sound impairs it.

Ambient noise

Ambiant noise reduces intelligibility. For example, the loud noise produced by trains in railway stations could prevent the listener from understanding a message properly. Also, the noise level can change drastically over time: in this case, the public address system must adjust its diffusion level according to the noise level.

> *Intelligibility rule #2:*
> The public address sound system should emit at least $10dB$ above the ambient noise level.

Architectural constraints

Loudspeakers positionning is often restricted by architectural or practical constraints. Because loudspeakers are not always welcome in places where aesthetics are important, they should be made discreet and as few as possible should be used.

Speech intelligibility in large spaces

As seen above, speech intelligibility[1] depends on:

- Reverberation time. This is a caracteristic of the room acoustics and depends on the material of the wall and the geometry of the room.
- $\frac{\text{Direct Sound}}{\text{Reverberated Sound}}$ energy ratio. This depends on reverberation time, room volume[2], loudspeaker to listener distance, and **loudspeaker directivity.**
- $\frac{\text{Signal}}{\text{Noise}}$ ratio. This depends on the ability of the sound system to emit enough energy to «cover the noise».

In large spaces, changing the reverberation time involves changing a significant portion of the wall material, and most of the time, this is not possible.

Providing a strong signal to noise ratio is also important, but it is not enough to ensure intelligibility.

Therefore, in large and reverberant rooms, the most important parameter the public address must affect is the $\frac{\text{Direct Sound}}{\text{Reverberated Sound}}$ ratio. It is necessary to privilege the direct sound energy and avoid putting energy in the reverberated part of sound. This can be achieved either by moving the loudspeaker close to the listener, or by using highly directional loudspeakers.

> In a large and highly reverberant room, **it is necessary to privilege the direct sound energy** for good intelligibility results.

In large spaces, if the loudspeakers are to be placed close to the listeners, many loudspeakers are required. This is not practical in such places because fixing loudspeakers can be difficult (very high ceiling, etc). Also, in many cases, this will not give good intelligibility results because only the loudspeakers close to the listener contribute to the direct sound, while all the loudspeakers contribute equally to the reverberated sound.

[1] Several indexes have been proposed to measure speech intelligibility. The most widely used of them is the Speech Transmission Index (STI). Value 0 corresponds to extremely poor intelligibility, and value 1 corresponds to perfect intelligibility. It is generally considered that intelligibility is correct above STI=0.55.

[2] Energy of the reverberated field is proportionnal to the ratio $\frac{\text{Reverberation time}}{\text{Room volume}}$.

Using many non-directional loudspeakers often leads to poor intelligibility: all loudspeakers contribute to the reverberation, while only a few contribute to direct sound.

Using highly directionnal loudspeakers is an easier solution in large spaces because only few diffusers are needed. In addition to improved acoustic performance and reduced cost, it minimizes the aesthetical impact of the public address system.

Sound quality

Intelligibility is not enough for good perceived sound quality. Another very important aspect is that every listener has an adequate sound pressure level (SPL), which implies that the public address system provides an even coverage of the audience area. This can be acheived with an accurate control of the loudspeaker directivity.

Acoustic comfort also implies a wide frequency bandwidth and low harmonic distortion.

The most important goal of a public address system is to provide a strong and constant direct sound over the entire audience area, and minimize the energy emitted elsewhere.

1.2 Loudspeaker arrays

Loudspeaker arrays are often the best solution to providing strong and constant direct sound over the audience. Indeed, although a distributed public address system might yield a relatively constant SPL over the audience using a large number of loudspeakers, it is usually not able to provide satisfactory speech intelligibility when reverberation in the room is high. In addition, it usually has a rather negative impact on the visual aspect of the room.

In contrast, high speech intelligibility can be obtained with a limited number of loudspeaker arrays (often only 1 or 2) in a large and highly reverberant room with minimum impact on the aesthetics of the room.

It is easy to calculate the shape of the wave front that should be radiated by a loudspeaker array in order to yield constant SPL over the entire audience area, and minimize sound energy emitted elsewhere. A J-shape wave front is obtained, in which the local curvature depends on the focal distance, as illustrated on figure 2. In order to generate such a wave front, one can align loudspeakers along the J-shape as in **geometric arrays** (figure 3a on the following page) [C-HEIL], or place loudspeakers on a vertical line and rely on the filtering of each individual loudspeaker as in **electronic arrays** (figure 3b on the next page) [DSP directivity]. The latter case corresponds to column loudspeakers, which can be flush mounted on a wall. Advantages and disadvantages of both array types are discussed in [DGRC-Arrays].

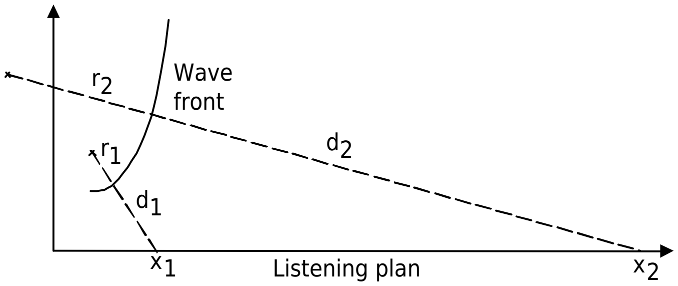
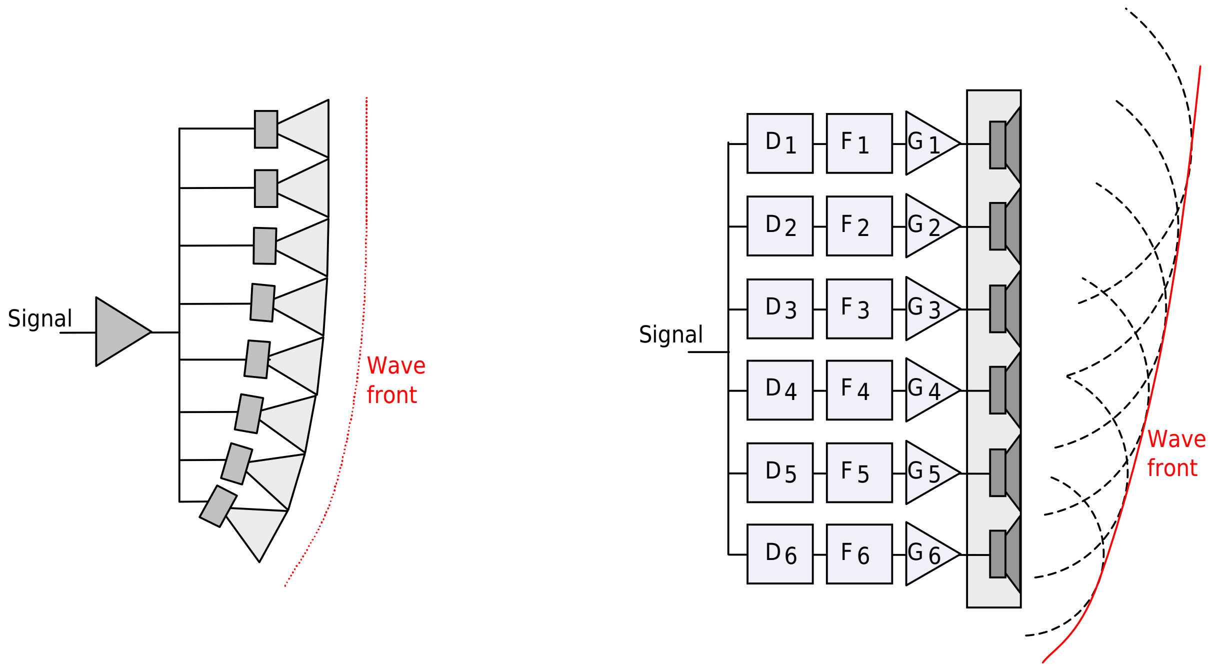


Figure 2: J-shape wave front required in order to radiate constant SPL over the listening plan.

The main characteristic of an array is its **range**, which corresponds to the minimum and maximum distance (from the column) where the SPL is constant (with a given tolerance). The range of a column is proportional to its height. Another important characteristic of an array is the spacing between loudspeakers. Good rejection of secondary lobes at high frequencies is obtained with a short spacing. At high frequencies, geometric arrays generally use waveguides that radiates like an isophase vertical slit. Aligning several of these waveguides yields a semi-continuous “line source”, which greatly reduces undesired secondary lobes.



(a) In a geometric array, loudspeakers are aligned along the shape of the wave front to be generated, usually a J shape.

(b) In an electronic array, loudspeakers are aligned vertically, and the wave front is synthesized by adequate filtering by filters F_i, delays D_i, and gain G_i associated to each loudspeaker.

Figure 3: Electronic and geometric arrays

1.3 DGRC: The StepArray system

The StepArray columns implement the DGRC line-array principle (Digital and Geometric Radiation Control) which is a synthesis of geometric and electronic arrays patented by Active Audio. The principle is illustrated in figure 4 on the facing page.

The key idea is to split the desired wave-front into sections and move them back on a vertical line, much like what is done in the Fresnel lenses used in optics. Then electronic delays are used to compensate sound propagation delay between the sections. It was shown in [DGRC-Arrays] that with this delay setting there is no diffraction at the edges of the saw-tooth shape. As a result of this principle, the number of DSP and amplification channels is independent of the number of loudspeakers, so that a dramatically reduced number of channels is achieved.

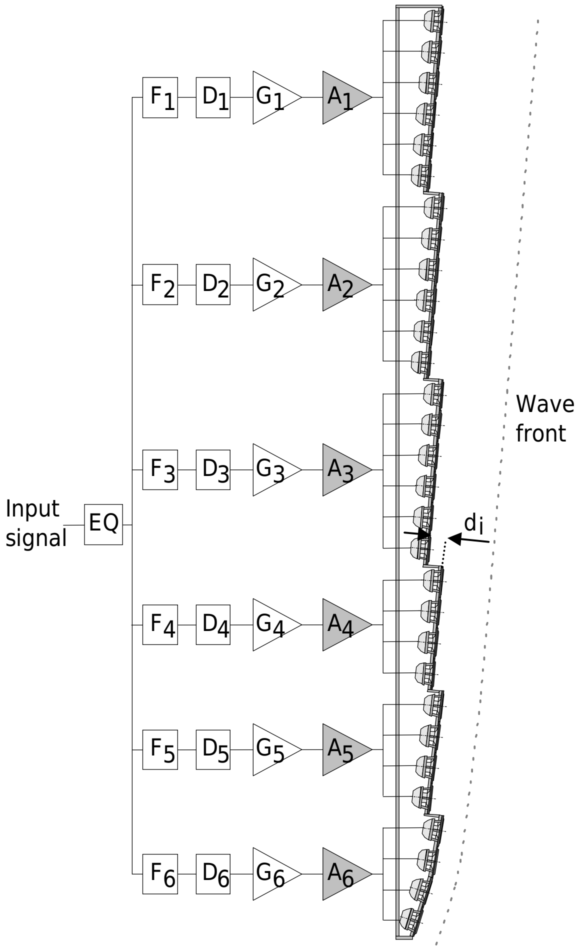


Figure 4: The DGRC principle used by StepArray columns. The wave front is controlled both by the positioning and orientation of the loudspeakers, and by filters F_i, delays D_i, and gain G_i of each channel.

The main advantages brought by the DGRC principle used in StepArray columns are:

- The column is vertical and can be fitted close to the wall.
- Reduced number of electronic channels, both for DSP and amplifiers. For example, model SA250P which is $2.5m$ high uses only 6 channels for 30 loudspeakers. This can make a big cost difference.
- Power is uniformly distributed to all loudspeakers. This way they can all be used at their maximum capabilities, enhancing overall performance and sound pressure level.
- The number of channels does not depend on the number of loudspeakers. Therefore, many small full-range loudspeakers can be used to obtain perfect sound quality in the treble range and reduce secondary lobes at higher frequencies.

2 Overview of the StepArray system

The StepArray range consists of several column models dedicated to speech diffusion and to mid-power music diffusion in large and/or reverberant enclosed spaces. The different models allow coverage of flat or tilted audience area ranging from 15m to 68m with perfect speech intelligibility and high sound quality.

StepArray columns use **external electronics**. They are controlled by the **NUT** digital signal processor (DSP) and powered by the **MPA6150** 6-channel amplifier. Having external electronics has the following advantages:

- Possibility to use a **single NUT processor controling several columns**, yielding a large cost reduction (see section 2.3 on the next page).
- Possibility to use several amplifiers for a single column in order to **increase security**: failure of one amplifier would only affect some of the channels, but the column continues to diffuse messages. For example, when using 2 columns and 2 amplifiers, amplifier 1 can be connected to channels 1, 3, 5 of both columns, and amplifier 2 to channels 2, 4, 6 of both columns.
- Easier maintenance: all electronics can be **easily accessed** in the technical room.
- Electronics can be placed in a fireproof room, with uninterruptible power supply (UPS).

The operating parameters of the NUT processors are tuned with the **NUT control** software. NUT processors feature filtering functions such as the control of directivity, equalization, delay, and high level functions.

2.1 StepArray system example

Figure 5 is an example of a complete StepArray installation.

The audio signal is fed into the NUT processors which then supply DGRC compatible signals to the MPA6150 amplifiers driving StepArray columns. A NUT processor also provides sub-bass output for an active subwoofer. The settings are made with the NUT control software through an Ethernet cable here, but a USB connexion is also available.

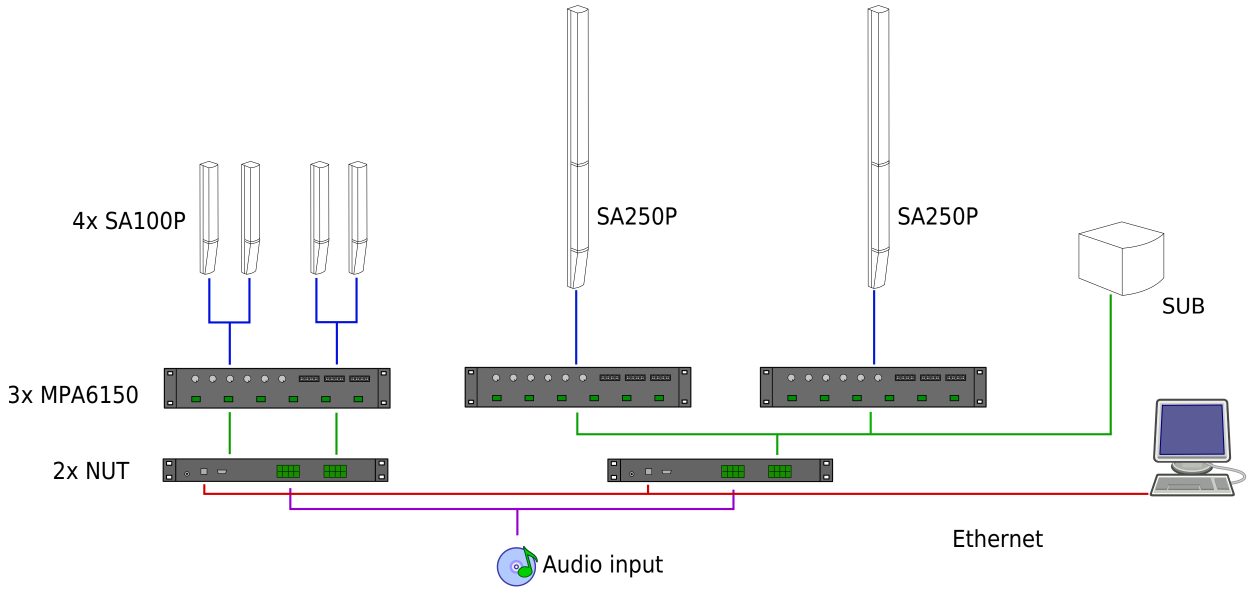


Figure 5: Example of StepArray system

2.2 StepArray column models

Table 1 on page 12 and table 2 on page 13 give an overview of the StepArray models characteristics. A complete description of the technical characteristics can be found in sections 12 and 13.

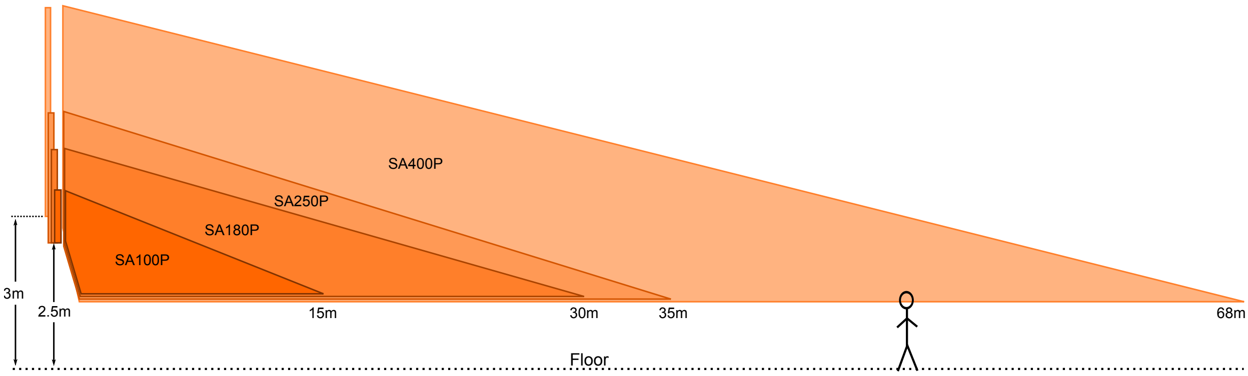


Figure 6: Listening zones (P-models)

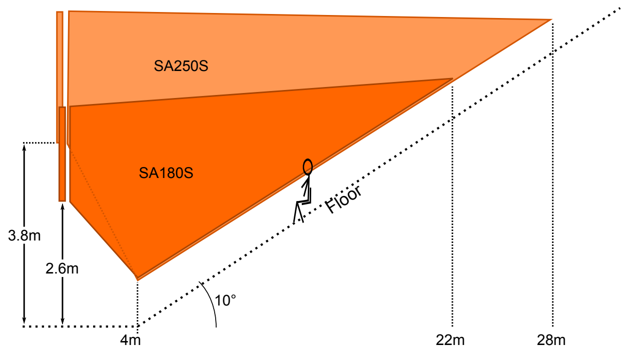


Figure 7: Listening zones (S-models)

Columns whose name ends with a «P» (SA100P for example) are designed for **horizontal audience areas**, whereas column whose name ends with a «S» are designed for **tilted audience areas** (or with balcony).

2.3 StepArray specificity: shared electronics

One of the advantages of using external electronics is that several columns can be connected (via their amplifier) to the same NUT processor.

A NUT processor features 8 analog symmetrical outputs. Therefore a single NUT processor can be used to deliver signals for:

- a 6 channel column,
- one or two 3 channel columns.

Moreover, a NUT processor can be connected to one or several StepArray amplifiers (to feed several columns with the same signal). In this case, the inputs are simply daisy chained to the amplifiers (see section 8.1 on page 21).

In the example installation figure 8 on the following page, three independant rooms are equipped with StepArray columns. Each room receives its own signal and can have independant parameters. For a total of 6 columns, only 2 processors and 3 amplifiers are needed!

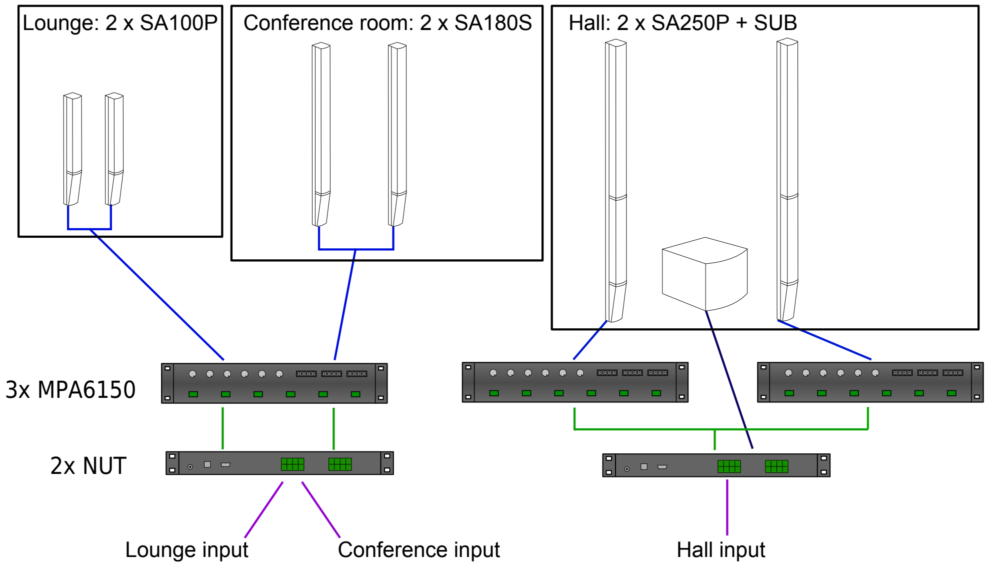


Figure 8: Shared electronics example

3 Choosing the right installation set-up

3.1 Columns

All StepArray columns feature a large frequency bandwidth and a wide horizontal opening angle[3]. The columns are **mounted vertically** using the supplied square brackets. The columns are available in standard RAL colors RAL9016 and RAL9005, but any other RAL color is available with the COL option. Table 1 sums up these characteristics.

Max SPL	Hor. opening	Bandwidth	Mounting	Colors
$95dB_{SPL}$ (pink noise, in listening area)	180° (-6dB)	135Hz-17kHz (-3dB) 110Hz-19kHz (-10dB)	***Vertical*** (supplied square brackets)	White RAL9016 Black RAL9005 Any RAL (COL option)

Table 1: General characteristics of StepArray columns.

StepArray columns do not use opening angle and tilting angle to tune directivity. Instead, StepArray use the **listening area** definition to automatically adjust themselves as to fit the requirements to the best.

StepArray columns use the **listening area** definition to automatically adjust themselves.

The StepArray range provides a full set of listening ranges[4] and audience tilting angles to suit any public address situation. The listening areas, as described on figure 9 on the facing page, are listed on table 2 on the next page. The nominal situation corresponds to the conditions for which the column has been designed. By specifying the

[3]The horizontal opening angle corresponds to a 6dB attenuation for the average of the 1 kHz and 2 kHz octaves.

[4]The range of a column is defined as the maximum distance from the column for which the mean sound level for the octaves 500Hz, 1 kHz, and 2 kHz remains within $\pm 3dB$ or $\pm 5dB$.

effective positioning of the column and the shape of the listening area in the *StepArray* bloc of the *NUT control* software, the DSP filtering parameters are automatically adjusted to the situation.

Choose the column which covers the most of the listening area.

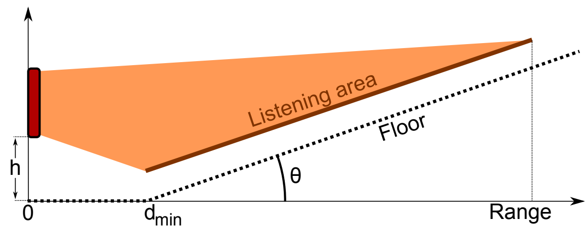


Figure 9: Listening area definition

Model	Height	Nominal altitude h (standing/seated audience)	Audience angle (θ)	Range 500Hz-2kHz ($\pm$3dB / $\pm$5dB)	Min. distance (d_{min})	Channel count
SA100P	1m	2.5m / 2.1m	Flat (0-5°)	15m / 21m	1m	3
SA180P	1.8m	2.5m / 2.1m	Flat (0-5°)	30m / 40m	1m	3
SA250P	2.5m	2.5m / 2.1m	Flat (0-5°)	35m / 45m	1m	6
SA400P	4m	3.0m / 2.6m	Flat (0-3°)	68m / 90m	1m	6
SA180S	1.8m	3.0m / 2.6m	Tilted (5-20°)	22m / 29m	4m	3
SA250S	2.5m	4.2m / 3.8m	Tilted (5-20°)	28m / 36m	4m	6

Table 2: Specific characteristics of StepArray column models.

3.2 NUT processor

The NUT processor has 8 output channels, therefore it can deliver signals for two *3 channel* columns, or one *6 channel* column.

It is also possible to connect two *3 channel* columns with different signals on the same processor to obtain a stereo sound. Independent settings are available for directivity, equalization, and delays. All these settings can be saved and recalled remotely thanks to presets.

More details on wiring can be found in section 8.1.

3.3 MPA6150 amplifier

The MPA6150 amplifier can deliver 6×150 watts under 4Ω load, or 6×100 watts under 8Ω loads. It is the standard amplifier used to drive StepArray columns, but any other amplifier with similar power capabilities can be used with StepArray columns.

More details on wiring can be found in section 8.1.

3.4 Cables

Cable lengths detailed in table 3 correspond to the maximum lengths recommended for the amplifier to column cable[5].

Cable length	Wire diameter
$< 300m$	$1.5mm^2$
$< 500m$	$2.5mm^2$

Table 3: Wiring recommendations for StepArray columns.

For distances exceeding the maximum cable length mentioned in table 3, please contact Active Audio.

- 3 channel columns need a 4 wire cable.
- 6 channel columns need a 7 wire cable.

3.5 Subwoofers

In cases where the StepArray system diffuses music, the sound fidelity will be better if a subwoofer and its associated amplifier are added. This option is not necessary for installations aimed at vocal diffusion since the human voice hardly has component frequencies in the bass range below 150 Hz.

The subwoofer signal is delivered by the NUT processor with appropriate filtering.

4 Column positionning rules

When choosing a StepArray setup, the goals are:

- Ensuring proper SPL coverage,
- Delivering satisfying intelligibility of vocal messages,
- Avoiding echoes and feedback effects,
- Giving the feeling that the sound comes from the speaker.

The positioning of columns should follow a few basic rules:

- Use as few columns as possible: choose the column covering as much of the listening area at once.
- Add more columns only if necessary. Beware: intelligibility could be impaired if there are too many columns.
- Columns should be placed so as to obtain the most homogeneous sound level over the audience area.
- For complex cases, it is highly recommended to use CAD software which will take into account the acoustics of the room. CAD tools are presented in section 6.

[5]These maximum cable lengths correspond to a sound level loss of 3dB.

- Place the columns as close as possible to the nominal altitude (see table 2 on the preceding page). When placing columns at non nominal altitude, use NUT control software to check that column emission will be acceptable.

When dealing with several columns, the differences of propagation distances[6] for columns covering **the same listening area** should be less than **20m**. so as to avoid possible echoes for certain sections of the audience. See figure 10.

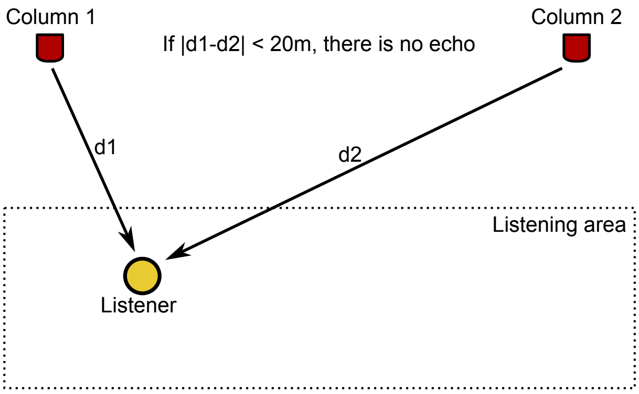


Figure 10: Interferences between columns

Also, consider microphones and stage:

- the speaker must be placed at less than 15 m from the columns, otherwise he will hear the echo of his own voice.
- the audience must feel that the sound comes from the speaker. This is achieved by fitting a column on each side of the stage so as to «re-centre» the sound. A single column can be used but in this case it has to be close to the zone to be covered.
- Prevent the feedback effect: there should never be a microphone aiming at a column; this could generate a feedback problem.

The impact of the room acoustics on the sound level within the covered zone is relatively low [a], since the fundamental aim of the StepArray columns is to provide a strong direct sound in order to ensure high intelligibility, even in reverberant spaces.

[a] SPL reinforcement by reverberation can be higher close to walls.

[6] In this context, propagation distance is the column to listener distance.

5 NUT processor and control software

The NUT audio processor performs the digital signal processing needed to control the directivity of StepArray columns.

The *NUT control* software is used to tune the NUT audio processor. It is available as free download on Active Audio's web site:
http://www.activeaudio.fr/en/public-address-sound-reinforcement/digital-signal-processor-nut

The NUT processor is very flexible in its usage, it gives access to a full range of functions including equalization, delay, compressor, automixer, feedback-fighter, presets, and directivity control.

The directivity control block allows the user to change the radiation pattern of StepArray columns in real-time. This block is presented in figure 11.

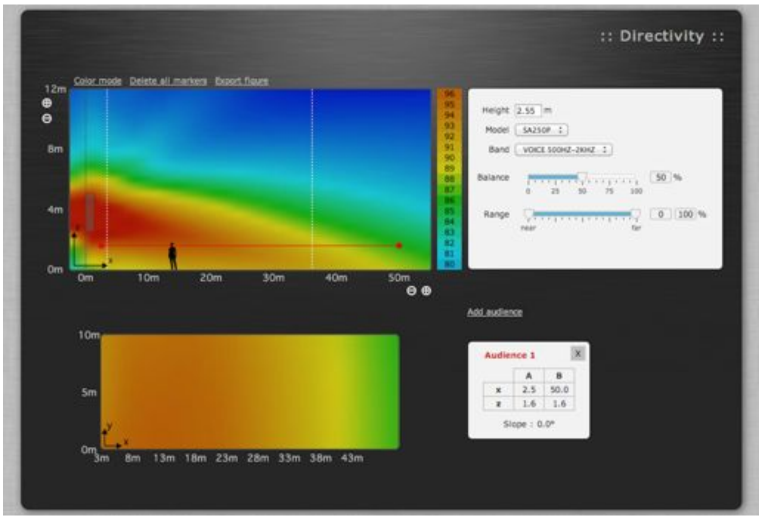


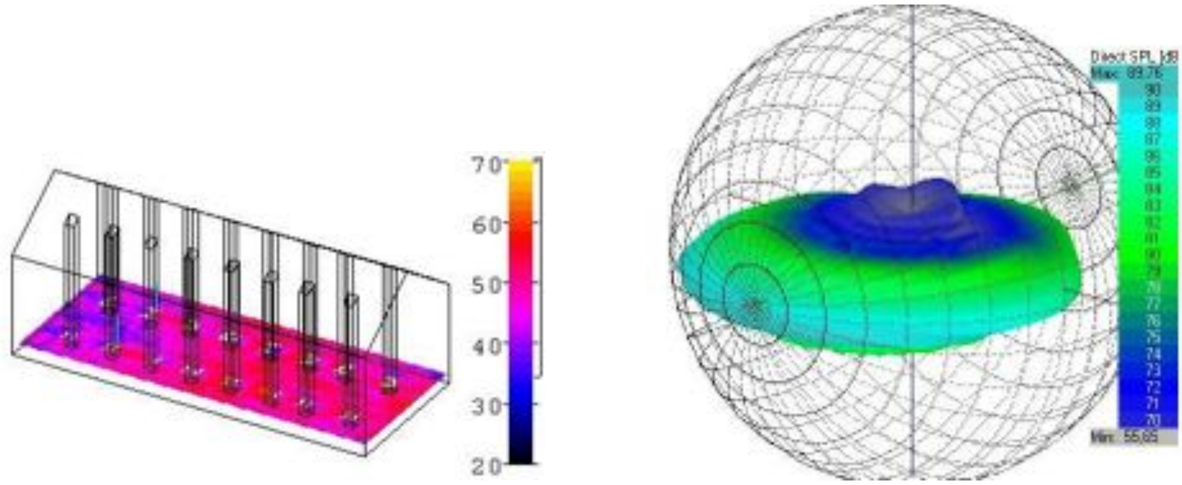
Figure 11: StepArray directivity control with the NUT software

6 CAD modeling

There are powerful CAD software tools that can predict the acoustics of a room and accurately model the radiation of loudspeaker arrays. These tools can calculate various acoustic index, such as reverberation time, sound pressure level, STI. . .

In a loudspeaker array, all loudspeakers operate in a coherent way. This must be taken into account in the modeling. To do so, software modules which enables the CAD tools to properly model the StepArray columns are included in CATT-Acoustic and EASE.

Figure 12 on the next page shows examples of a modeling results for CATT-Acoustic and EASE.



(a) Example of RASTI modeling using software CATT-Acoustic®.

(b) Balloon plot of SPL radiated in octave 1 kHz by column SA250S. Simulation with EASE®.

Figure 12: Examples of a CAD modeling results.

References

[DGRC-Arrays] X. Meynial, *«DGRC arrays : A synthesis of geometric and electronic loudspeaker arrays»*, AES 120th Convention. Preprint 6786, Paris May 2006.

[C-HEIL] *«Sound Wave Guide»*, US Patent # 5,163,167, Inventor : C. Heil, nov 10 1992.

[DSP directivity] G.W.J. van Beuningen; E.W. Start; *«Optimizing Directivity Properties of DSP Controlled Loudspeaker Arrays»*, Reproduced Sound 16 Conference, Stratford (UK) 17-19 Nov 2000, Institute of Acoustics.

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Part II

StepArray technical reference

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7 Installation of the columns

StepArray columns are mounted verticaly, usually on a wall, using the supplied brackets. Figure 13 illustrates the steps to follow for column mounting. See also figure 18 on page 27 for technical drawings of the brackets.

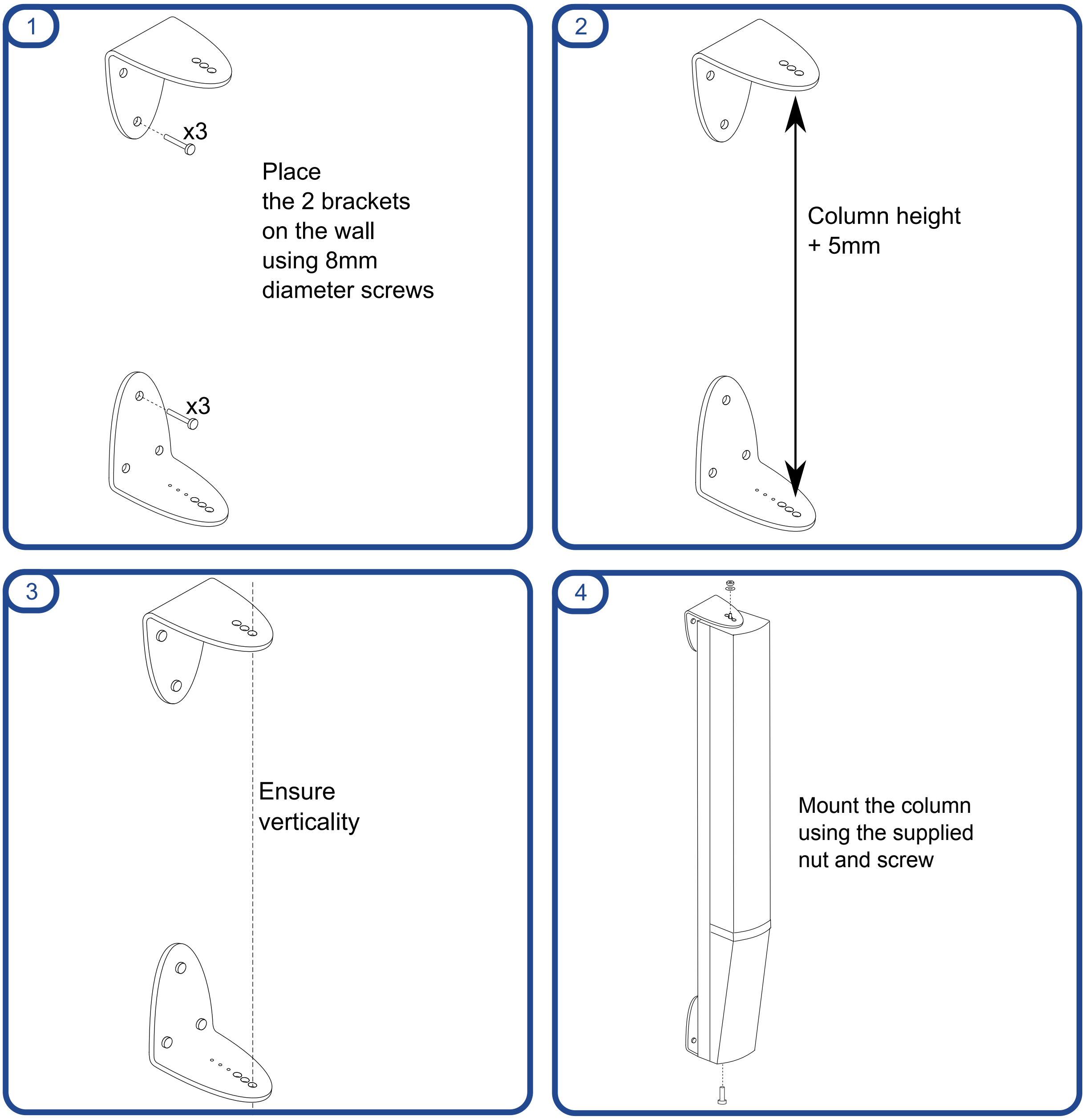


Figure 13: Column mounting on a wall

It is important to **ensure verticality** when mounting StepArray columns.

8 Wiring

8.1 NUT processor to MPA6150 amplifier

A NUT processor can be connected to one or several StepArray columns via amplifiers (see figure 14). When a NUT is used with several amplifiers (to feed several columns with the same signal), the inputs are simply daisy chained (see figure 14b).

(a) Direct wiring (b) Daisy chain wiring

Figure 14: NUT to MPA6150 wiring

8.2 MPA6150 amplifier setup

MPA6150 amplifiers should be tuned with **all gains to max**, and microswitches set for **independent channels**, as described in figure 15.

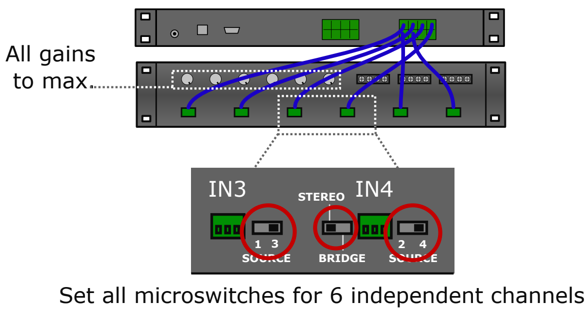


Figure 15: MPA6150 amplifier set-up

8.3 Wiring amplifiers to columns

Wiring amplifiers to columns is straightforward: simply connect each channel of the MPA6150 amplifier to the corresponding channel of the column and provide a common ground, as illustrated by figure 16.

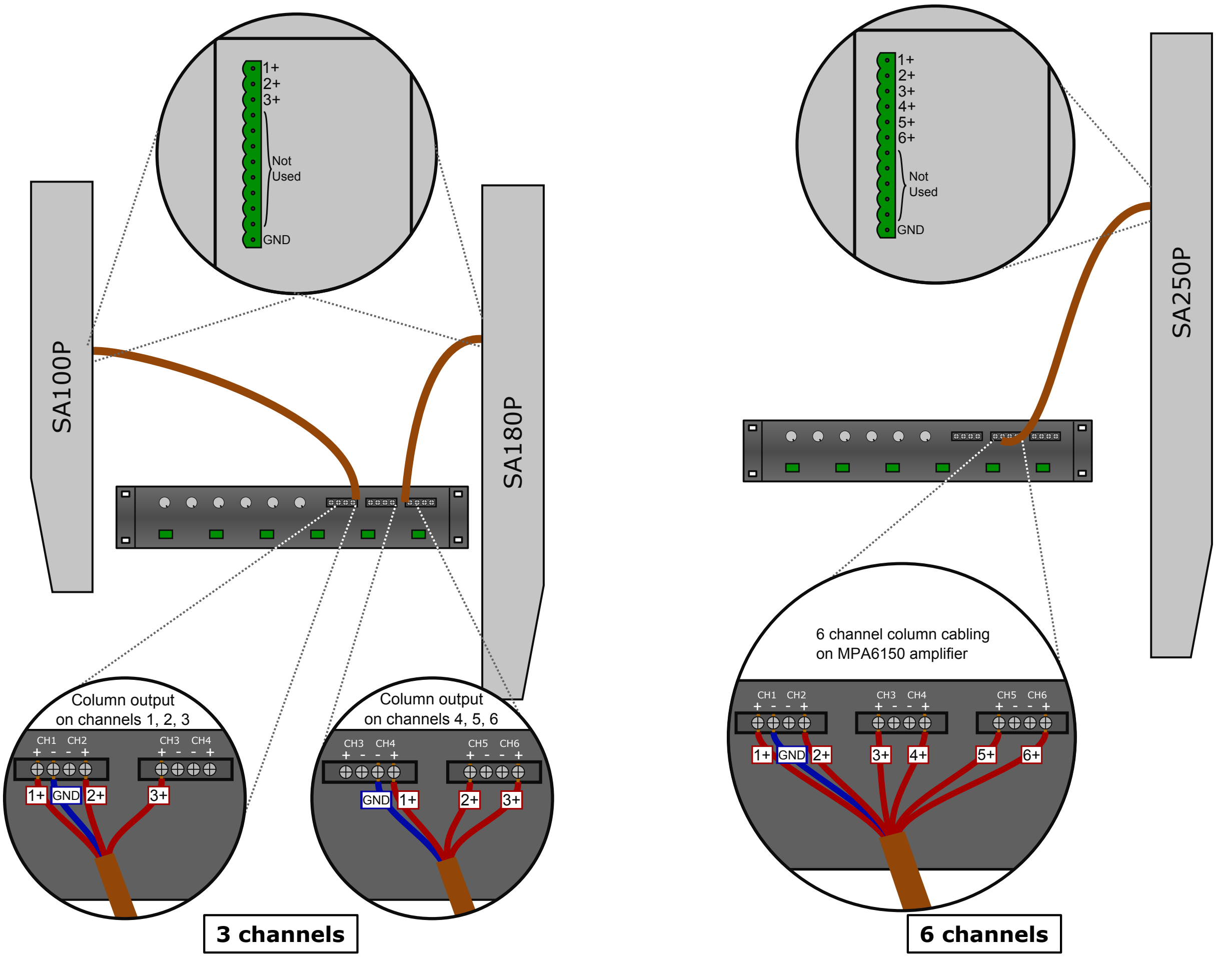


Figure 16: MPA6150 to column wiring

9 Test before powering up

Before powering up an installation, it is good practice to ensure that the column cable is properly connected to the column. Therefore, the electrical resistance of each channel of the column must be controlled at the end of the cable connected to the amplifier side. The measured electrical resistances values must correspond to the values below.

Channel	1	2	3	4	5	6
SA100P	6.6Ω	6.6Ω	6.6Ω	-	-	-
SA180P	6.6Ω	6.6Ω	6.6Ω	-	-	-
SA250P	6.6Ω	6.6Ω	6.6Ω	4.4Ω	4.4Ω	4.4Ω
SA400P	6.6Ω	6.6Ω	6.6Ω	6.6Ω	6.6Ω	6.6Ω
SA180S	6.6Ω	6.6Ω	6.6Ω	-	-	-
SA250S	3.3Ω	6.6Ω	6.6Ω	4.4Ω	4.4Ω	3.3Ω

For details on connector pin assignement, see figure 16 on the facing page.

When measuring the electrical resistance, the cable resistance must be taken into account (about 1.3Ω for 100 meters of $1.5mm^2$; 0.7Ω for 100 meters of $2.5mm^2$).

10 *NUT control* software

The *NUT control* software is used to tune the filtering and directivity parameters of StepArray columns, it is available as free download on Active Audio's web site:
http://www.activeaudio.fr/en/public-address-sound-reinforcement/digital-signal-processor-nut

11 Troubleshooting

Symptom	Possible cause	Solution
The power LED of the NUT processor is not ON	A fuse burned	Replace inside the NUT processor (1A delayed fuse)
The sound is not homogeneous or distorted	Amplifier to column connection is incorrect	Make sure columns are properly connected, as described in section 9 on the preceding page.
	Input signal level is too high	Reduce input signal level (Max signal input is $\pm 8Vrms$ as described in 12.1 on the following page).
	Filtering parameters are wrong	Reduce the gain (Mixer Block). Correct the equalization.
	There is a wiring problem.	Make sure the wiring is correct (see 9 on the preceding page).
	The parameters of the *StepArray* block are wrong	Check that the parameters in the *StepArray* block of *NUT control* are correct (see figure 9 on page 13).
	The column model of the *StepArray* block in *NUT control* doesn't match the real column model.	Correct the column model in the *StepArray* block.

12 Hardware specifications

12.1 NUT processor

Audio data	
Inputs	8 symetrical analog inputs, Euroblock connectors Max input voltage: $8Vrms$ (+20dBU) Phantom power ON/OFF on each input Selectable line/mic level for each input
Outputs	8 symetrical analog outputs, Euroblock connectors Max output voltage: $8Vrms$ (+20dBU)
Dynamic range	114dB
Processing	28bits / 48kHz à 192kHz
General data	
Communication	Ethernet 10/100MB USB (no driver needed) RS232 for remote control
Mains	24V DC. 230V/50Hz power supply included.
Power consumption	< 10W
Dimensions	$480 \times 44 \times 251mm$ (Rack 19" - 1U)
Color	Black
Weight	3.5kg

12.2 MPA6150 amplifier

Audio data	
Operating modes	6 independent channels 3 independent channels (bridged) 2 x 3 channels (in1→out 1,2,3 ; in2→ out 4,5,6)
Power	6 x 100 W under 8Ω, 6 x 150W under 4Ω 3 x 300W under 8Ω (bridged)
Power consumption	Typical: 100W ; Max 1kW.
Analog inputs	6 symmetrical analog inputs. Phoenix connectors
Outputs	6 outputs on screw terminals
Frequency response	20Hz - 20kHz @ 1W $\pm$1dB
Input Impedance	$10k\Omega$unbalanced, $20k\Omega$ balanced
Sensitivity	$1V_{eff}$
Signal-to-noise ratio	$95dB$
Damping factor	> 300
Gain	Adjustable with 6 knobs on rear panel. Max voltage gain: $28dB$.
Harmonic Distortion	THD : 0,1 % @ 1kHz

General data	
Cooling	Variable speed fan
Protection	Protection against overload and overheat
Indicators	Clip and Protect LEDs
Dimensions	$483 \times 88 \times 420mm$ (Rack 19" – 2U)
Weight	$12.3kg$

For further information, see the MPA6150 owner's manual.

12.3 Columns characteristics

12.3.1 Electrical characteristics of StepArray columns

Channel	1	2	3	4	5	6
SA100P	6.6Ω	6.6Ω	6.6Ω	-	-	-
SA180P	6.6Ω	6.6Ω	6.6Ω	-	-	-
SA250P	6.6Ω	6.6Ω	6.6Ω	4.4Ω	4.4Ω	4.4Ω
SA400P	6.6Ω	6.6Ω	6.6Ω	6.6Ω	6.6Ω	6.6Ω
SA180S	6.6Ω	6.6Ω	6.6Ω	-	-	-
SA250S	3.3Ω	6.6Ω	6.6Ω	4.4Ω	4.4Ω	3.3Ω

Table 5: DC resistance of StepArray columns.

For details on connector pin assignement, see figure 16 on page 22 in section 8.3.

12.3.2 Mechanical characteristics of StepArray columns

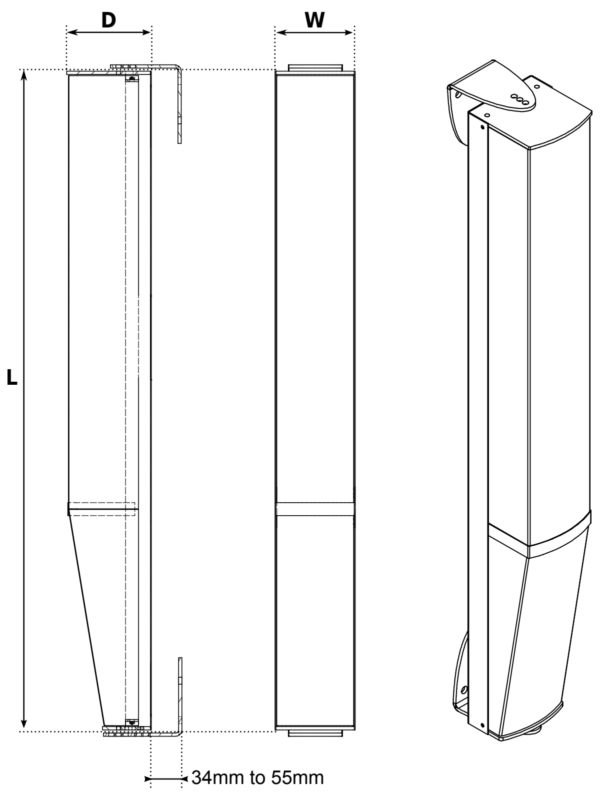


Figure 17: StepArray column dimensions

Model	Dimensions (L×W×D mm)	Weight (net/shipping)	Cable
SA100P	1024 × 124 × 131	9kg / 12kg	4G
SA180P	1840 × 124 × 135	17kg / 21kg	4G
SA180S	1840 × 124 × 135	17kg / 21kg	4G
SA250P	2505 × 124 × 159	24kg / 29kg	7G
SA250S	2505 × 124 × 159	24kg / 29kg	7G
SA400P	4096 × 124 × 135	39kg / 46kg	7G

Table 6: Mechanical and electrical characteristics of StepArray columns

More precise schematics are available on Active Audio's website in several formats:
http://www.activeaudio.fr/en/gamme-steparray/catalogue-et-telechargements

12.3.3 Fixing brackets

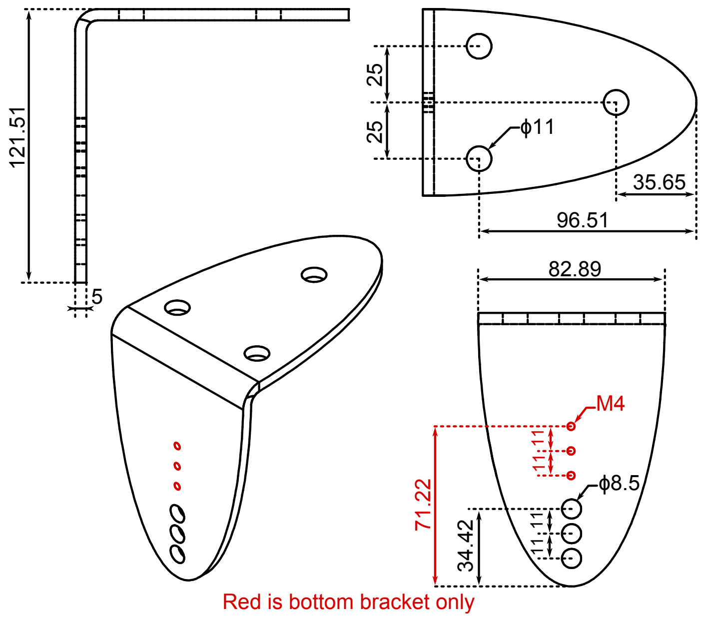


Figure 18: Fixing brackets for wall mounting of StepArray columns.

13 Acoustical data

All data presented below is obtained with columns in their nominal position and using nominal DSP filtering parameters (flat EQ, etc).

13.1 Common data

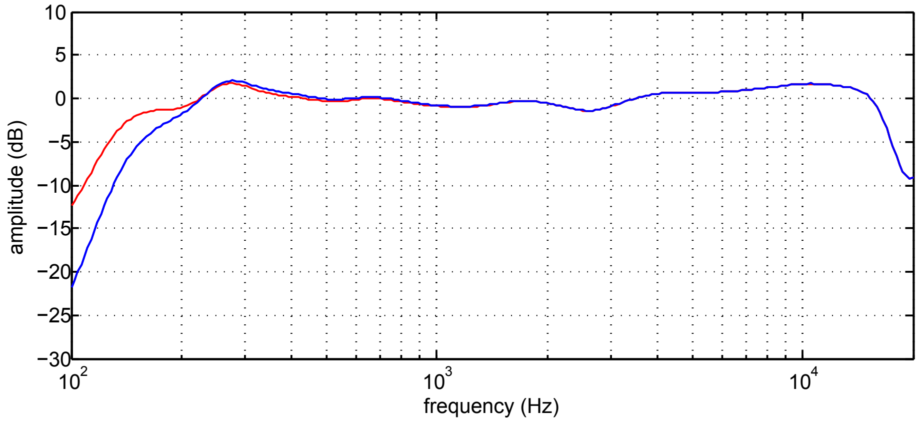


Figure 19: Frequency response (column SA250P). Average of the mesurements at 7, 10, 15, 20, 25, and 30m. In red: with bass high-pass on position «100Hz», in blue: with bass high-pass on position «200Hz».

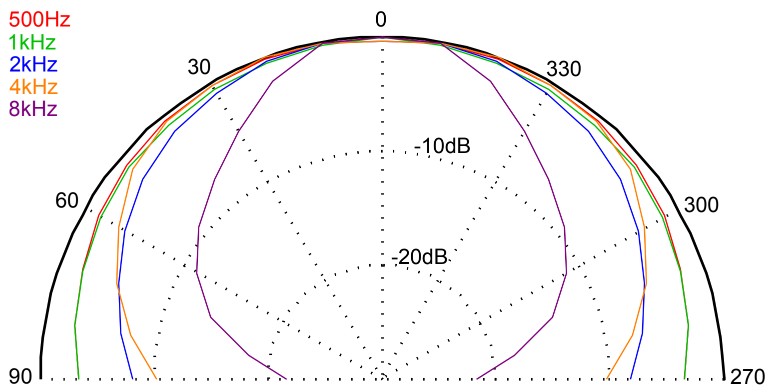
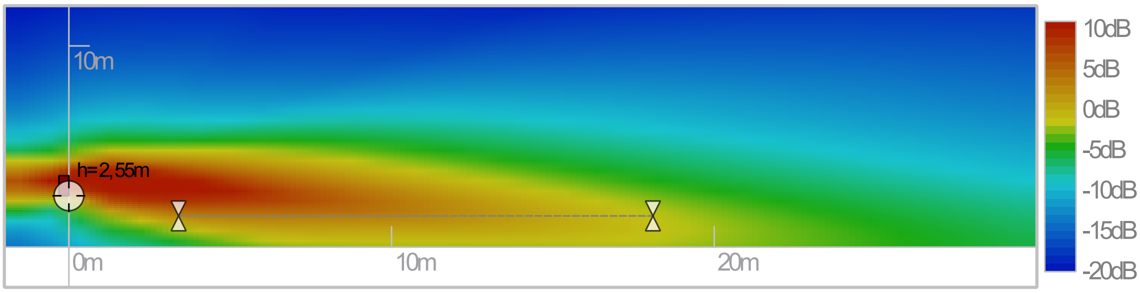
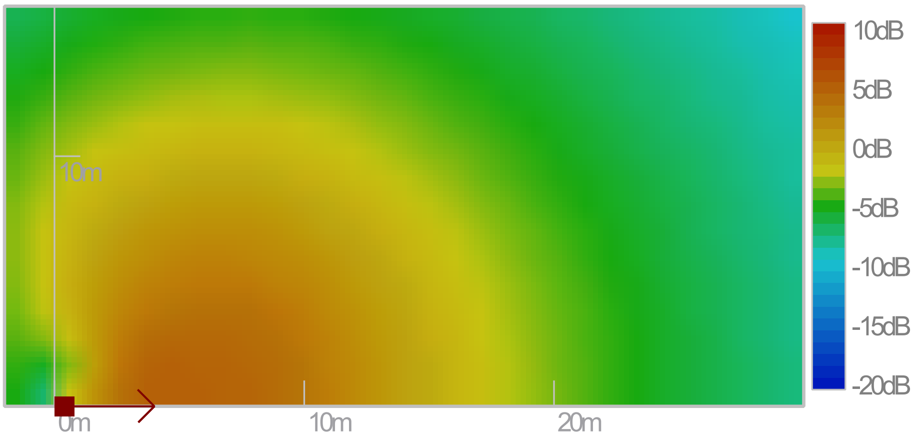


Figure 20: Horizontal directivity (column SA250P)

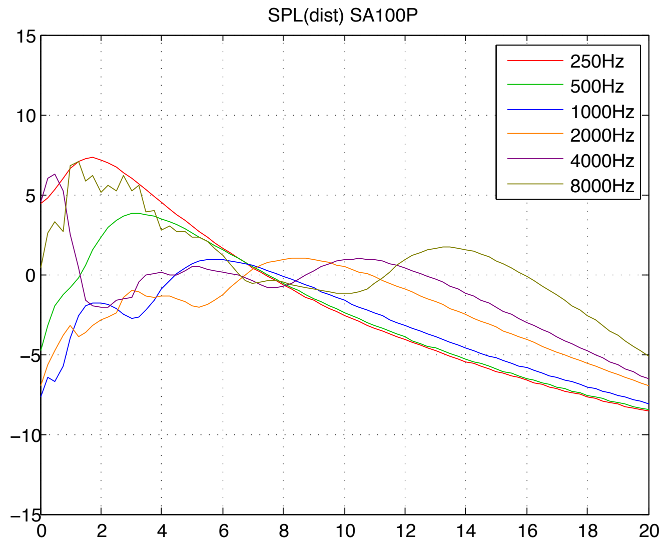
13.2 SA100P acoustical data[7]



(a) SA100P vertical directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) in the vertical median plane.



(b) SA100P horizontal directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) on the listening plane.

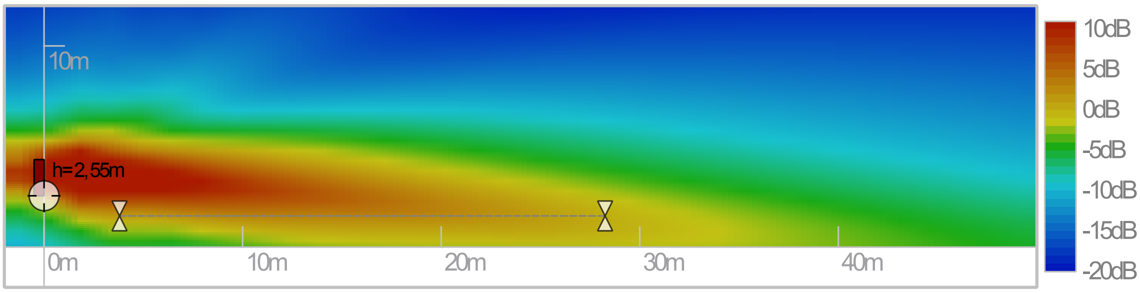


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

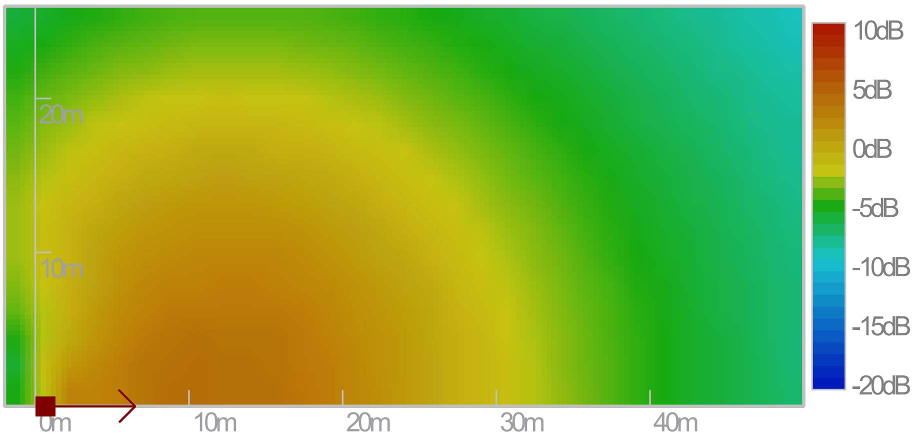
Figure 21: SA100P acoustical data.

[7]Column is in nominal position. Levels are referenced to the mean SPL on the listening area.

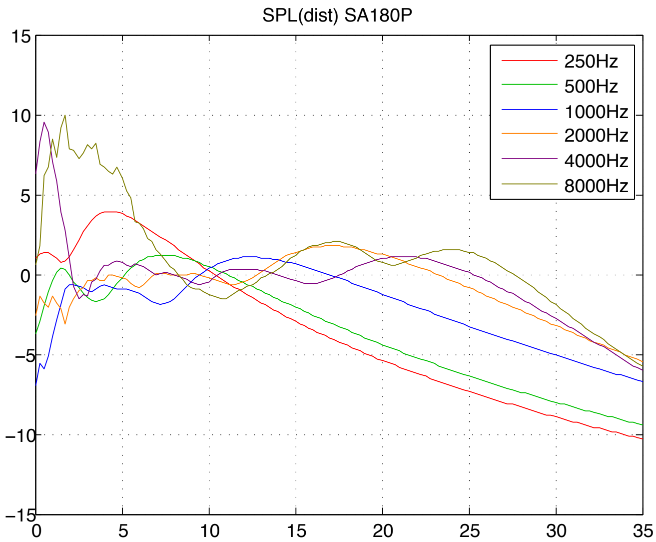
13.3 SA180P acoustical data[8]



(a) SA180P vertical directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) in the vertical median plane.



(b) SA180P horizontal directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) on the listening plane.

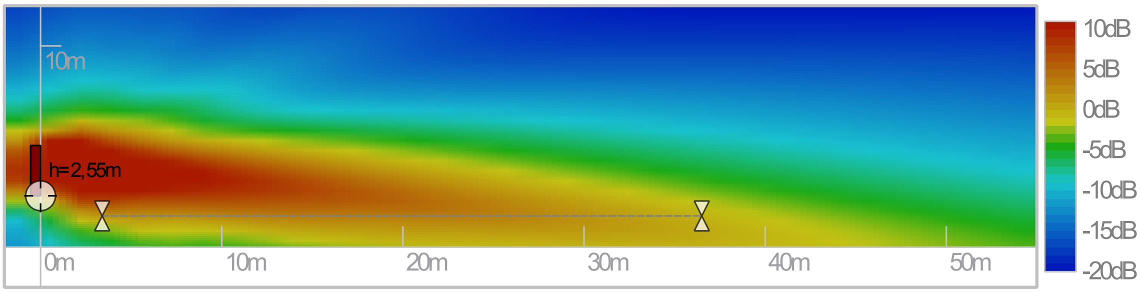


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

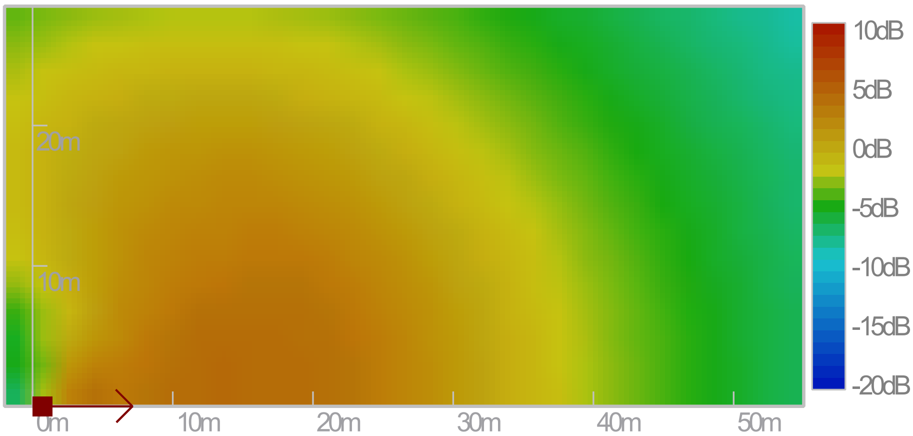
Figure 22: SA180P acoustical data.

[8]Column is in nominal position. Levels are referenced to the mean SPL on the listening area.

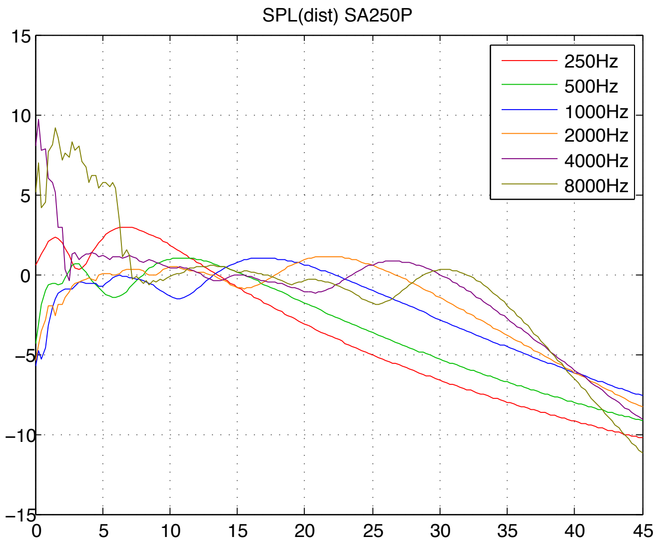
13.4 SA250P acoustical data[9]



(a) SA250P vertical directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) in the vertical median plane.



(b) SA250P horizontal directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) on the listening plane.

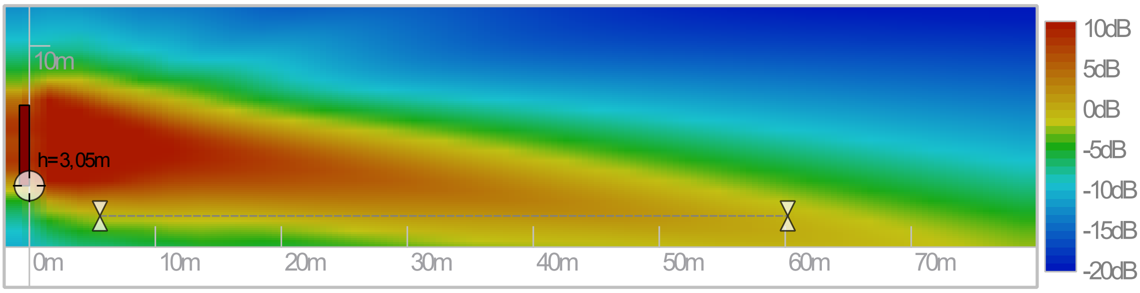


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

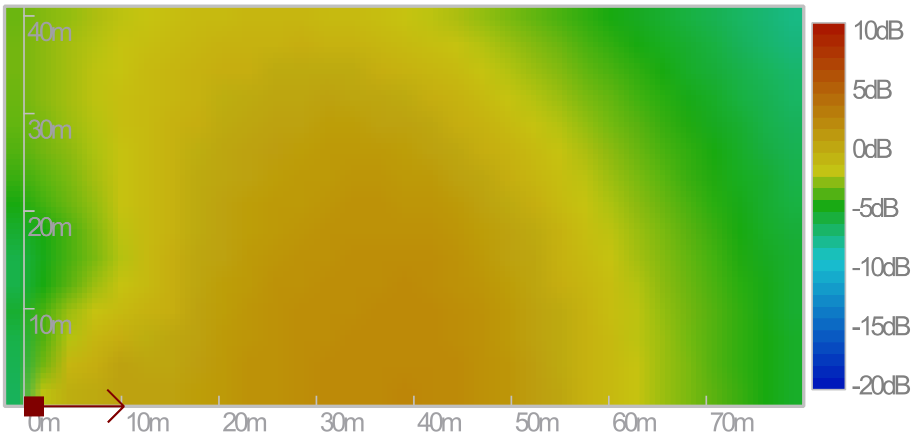
Figure 23: SA250P acoustical data.

[9] Column is in nominal position. Levels are referenced to the mean SPL on the listening area.

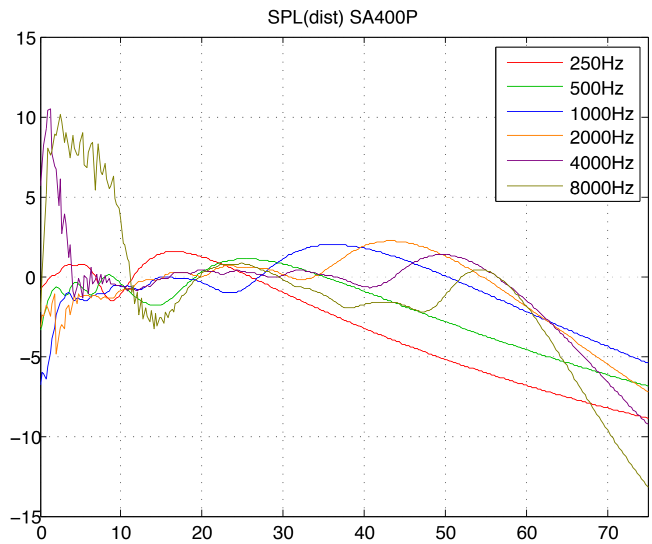
13.5 SA400P acoustical data[10]



(a) SA400P vertical directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) in the vertical median plane.



(b) SA400P horizontal directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) on the listening plane.

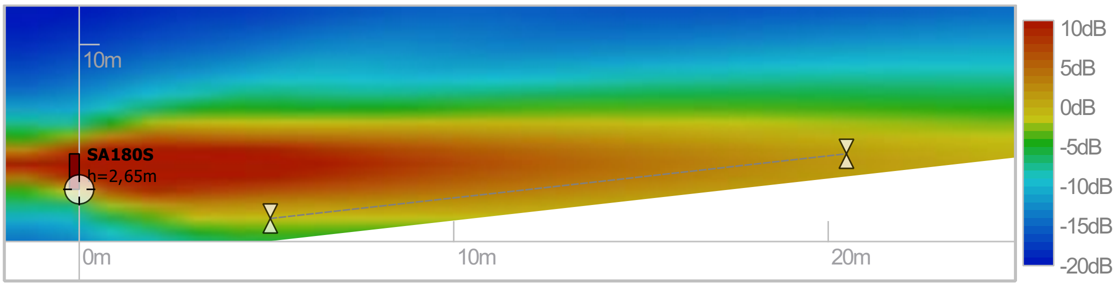


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

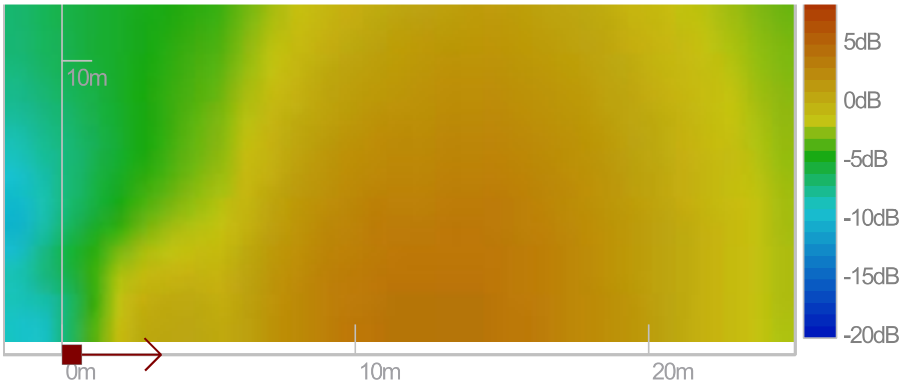
Figure 24: SA400P acoustical data.

[10] Column is in nominal position. Levels are referenced to the mean SPL on the listening area.

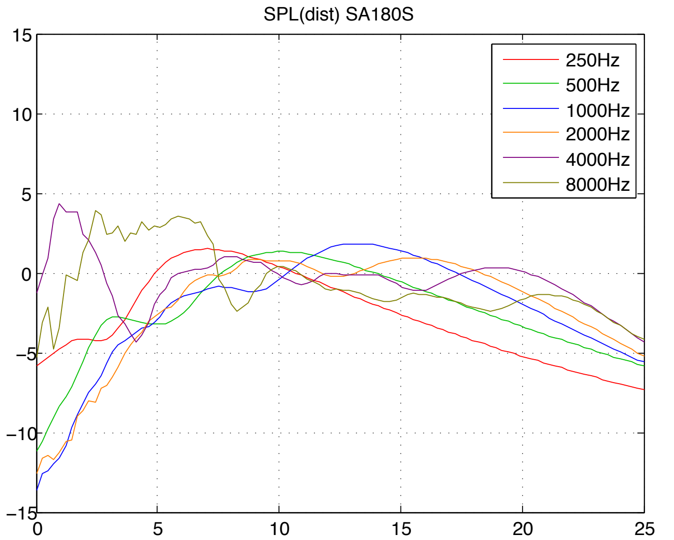
13.6 SA180S acoustical data[11]



(a) SA180S vertical directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) in the vertical median plane.



(b) SA180S horizontal directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) on the listening plane.

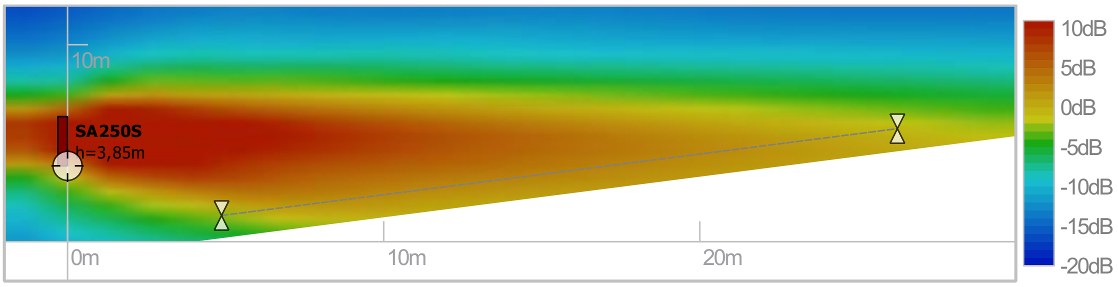


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

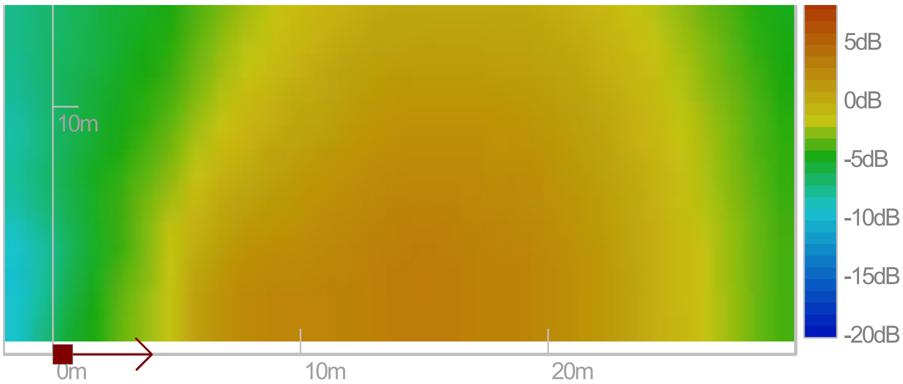
Figure 25: SA180S acoustical data.

[11] Column is in nominal position. Levels are referenced to the mean SPL on the listening area.

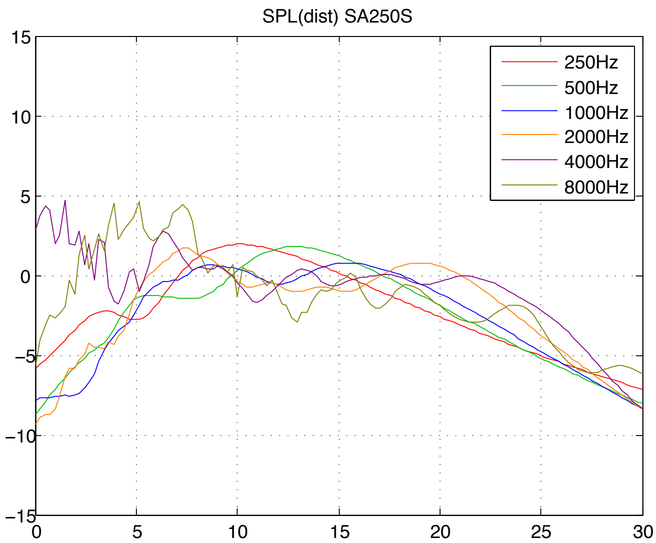
13.7 SA250S acoustical data[12]



(a) SA250S vertical directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) in the vertical median plane.



(b) SA250S horizontal directivity: sound level for the voice octaves (500Hz,1kHz,2kHz) on the listening plane.



(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

Figure 26: SA250S acoustical data.

[12] Column is in nominal position. Levels are referenced to the mean SPL on the listening area.

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