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,
- The different options are described in section 5,
- SAdrive software, serving both as a simulation and tuning software, is described in section 6,
- CAD modeling tools are presented in section 7.

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).

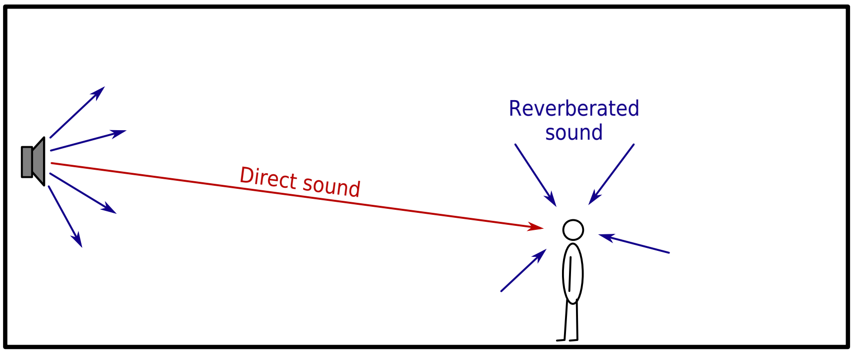


Figure 1: Direct sound increases speech intelligibility, reverberated sound impairs it.

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].

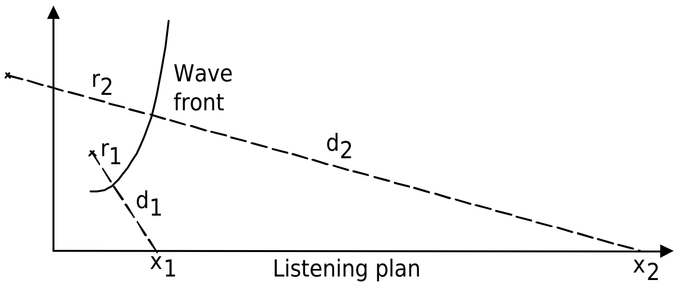
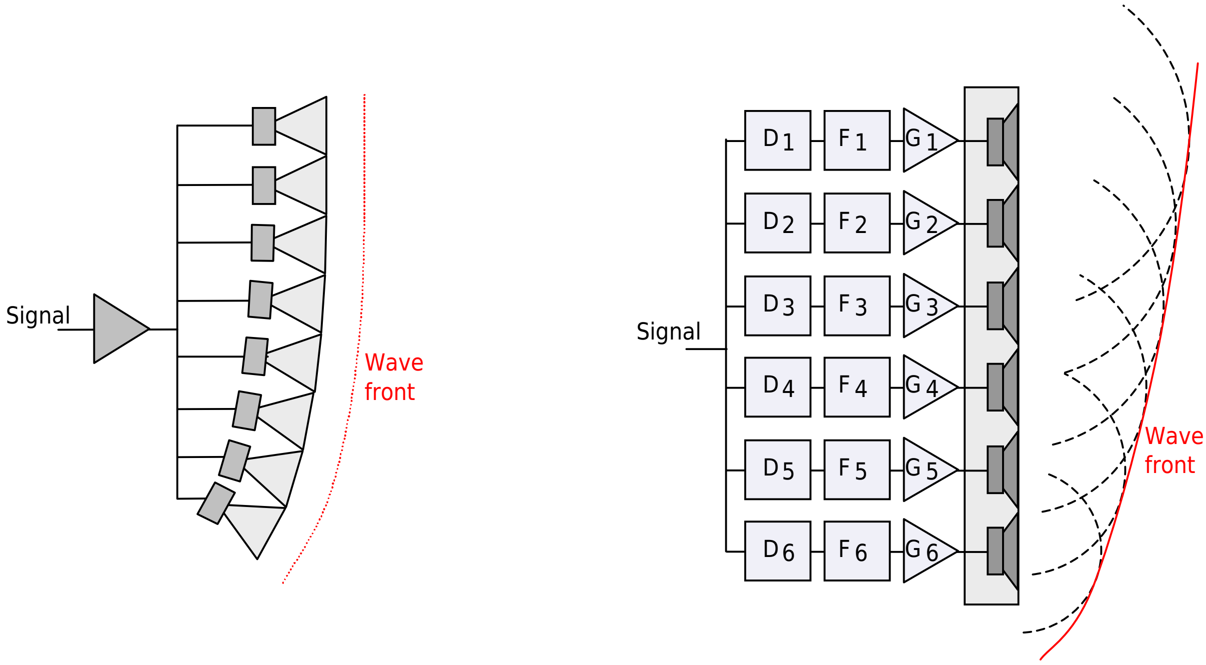


Figure 2: J-shape wave front required in order to radiate constant SPL over the listening plan.

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.

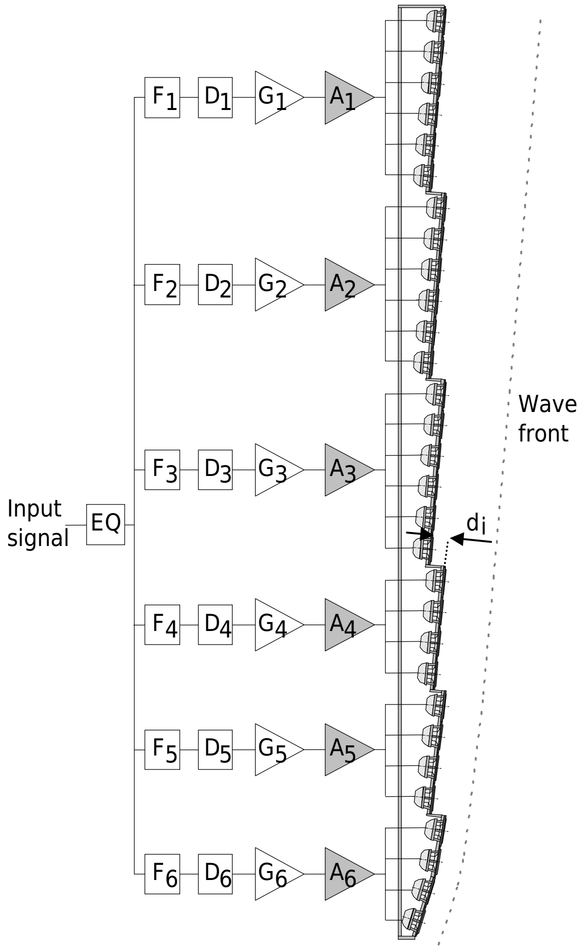


Figure 4: The DGRC principle used by StepArray columns. The wave front is controlled both by the positioning and orientation of the loudspeakers, and by filters F_i, delays D_i, and gain G_i of each channel.

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 **UT26** digital signal processor (DSP) and powered by the **MPA6150** 6-channel amplifier. Having external electronics has the following advantages:

- Possibility to use a **single UT26 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 UT26 processors are tuned with the **SAdrive** software through RS232 serial communication. UT26 processors feature filtering functions such as the control of directivity, equalization, delay, and high level functions.

In addition, the StepArray system features a set of **options** such as subwoofer output (SUB), active gain control (AGC), and security system supervision (SSS).

2.1 StepArray system example

Figure 5 is an example of a complete StepArray installation.

The audio signal is fed into the UT26 processors which then supply DGRC compatible signals to the MPA6150 amplifiers. A UT26 can also provide sub-bass output when equipped with the SUB option. The settings are made with the SAdrive software through an RS232 serial bus.

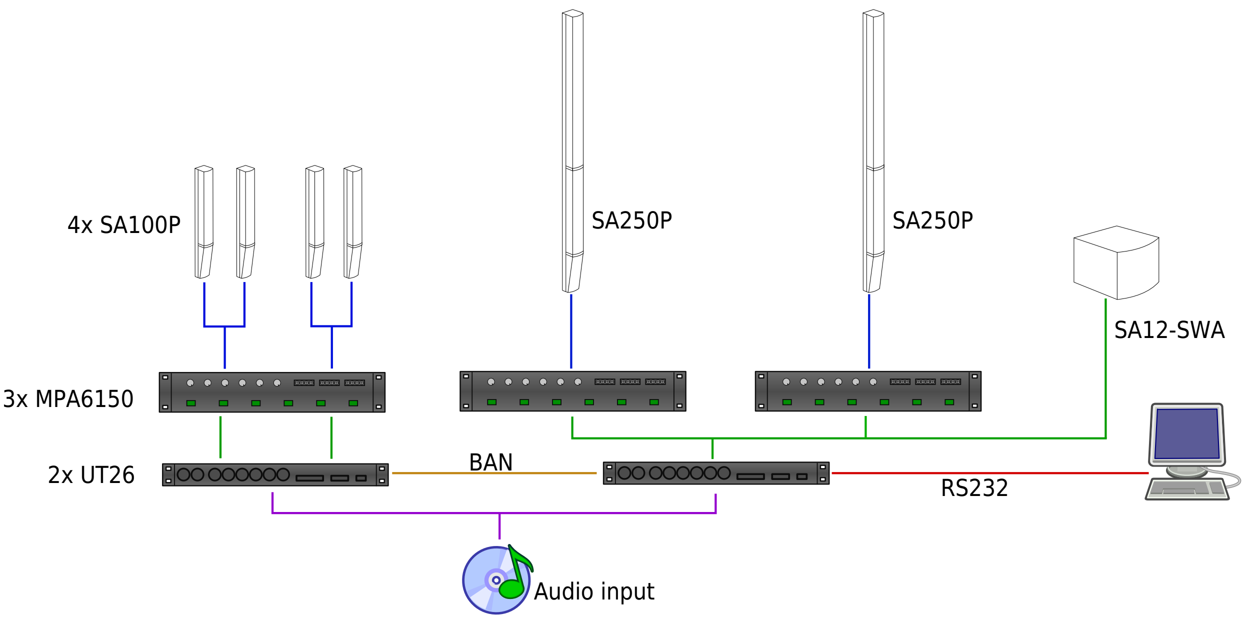


Figure 5: Example of StepArray system

2.2 StepArray column models

Table 1 on the next page 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 14 and 15.

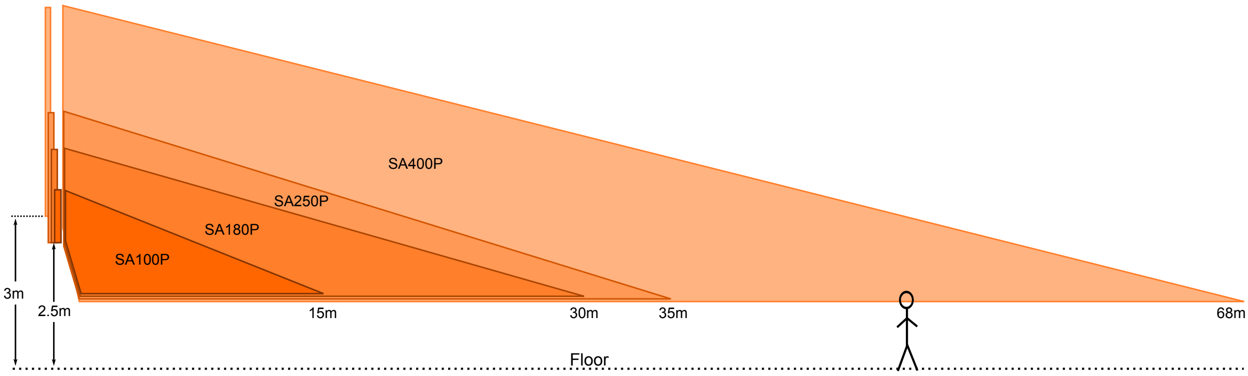


Figure 6: Listening zones (P-models)

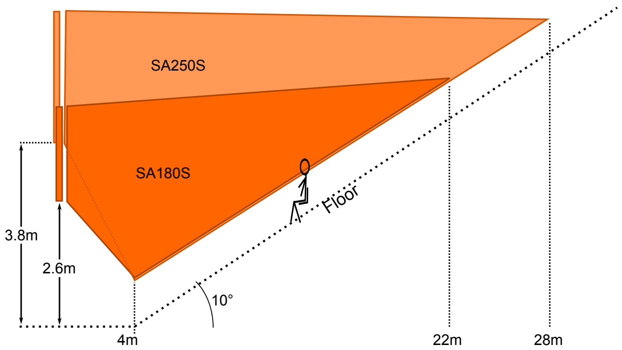


Figure 7: Listening zones (S-models)

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 UT26 processor.

A UT26 processor features 6 analog symmetrical outputs. Therefore a single UT26 processor can be used to deliver signals for:

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

Moreover, a UT26 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 9.1 on page 22).

In the example installation figure 8, 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!

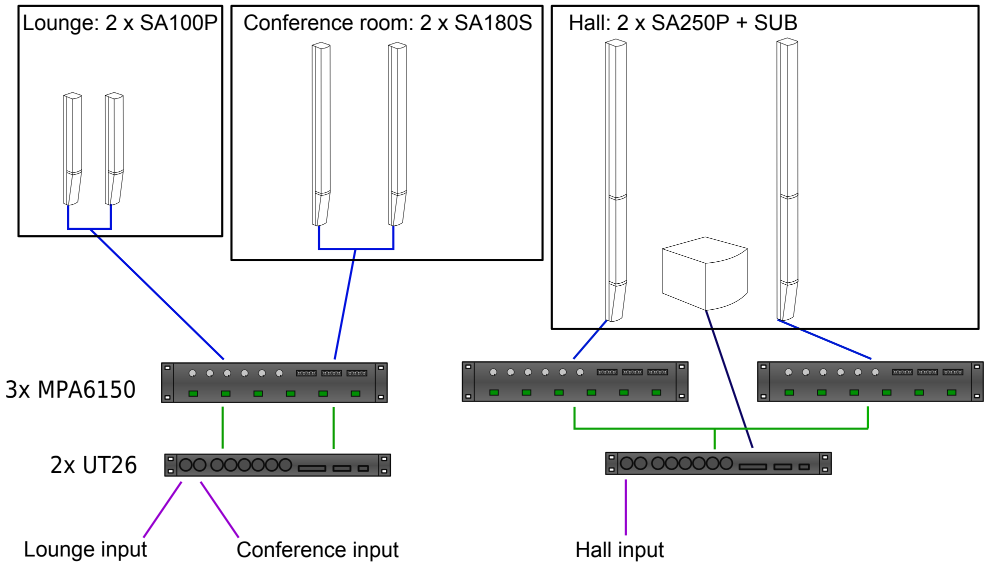


Figure 8: Shared electronics example

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.

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

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, are listed on table 2. The nominal situation corresponds to the conditions for which the column has been designed. By specifying the effective positioning of the column and the shape of the listening area in the *Directivity* bloc of SAdrive, the DSP filtering parameters are automatically adjusted to the situation.

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

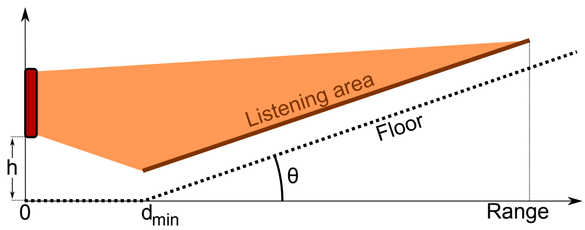


Figure 9: Listening area definition

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 Processors

The UT26 processor has 6 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 9.1.

3.3 Amplifiers

The MPA6150 amplifier is capable of delivering 6×150 watts under 4Ω load, or 6×100 watts under 8Ω loads.

More details on wiring can be found in section 9.1.

[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 $\pm 5dB$.

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 very long 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 an UT26 processor fitted with the SUB option (see section 5.2).

Active Audio proposes subwoofers (SA12-SW and SA12-SWA) suitable for StepArray installations (see section 14.3).

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 7.

[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 page 13). When placing columns at non nominal altitude, use SAdrive 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.

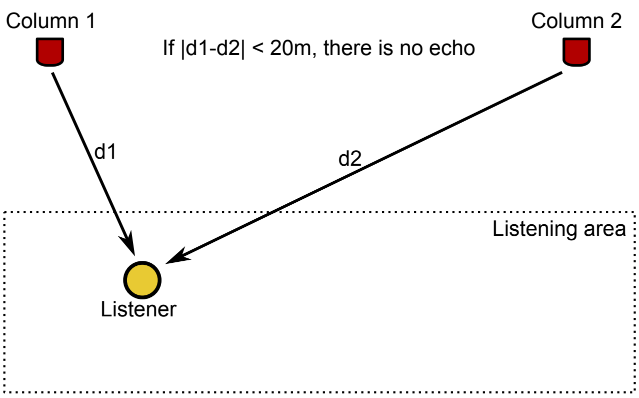


Figure 10: Interferences between columns

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 Options

Several options are available for the StepArray system. These options bring additional electronic cards within the UT26 processor and the columns. A marqued plaque on the back of the processor indicates the options as shown in figure 11.

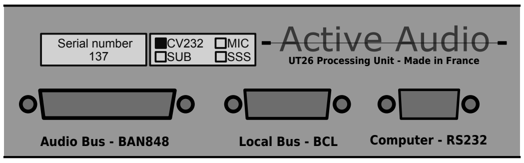


Figure 11: Indication of options on the rear panel of the UT26 processor (CV232 only in this example).

5.1 Microphone (MIC)

This option brings an electret microphone in the connection box at the back of the column, and its phantom power supply delivered through input 2 by the UT26 processor.

This option is needed to enable the AGC (automatic gain control) function (section 12.1).

5.2 Sub-bass Output (SUB)

When playing music, it is generally necessary to complement the columns with a sub-bass loudspeaker. The SUB option gives a sub-bass output on the BCL port of the UT26 processors (wiring is described in section 9.6).

When using the SUB option, the subwoofer signal is low-pass filtered by the UT26 processor with a 4th order Linkwitz-Riley type at 180 Hz, and the column's signal is filtered with the complementary high-pass filter.

Note that for speech diffusion, there is no point extending the bass response.

5.3 Sound Security System (SSS)

The SSS option (Sound Security System) brings EN-60849 conformance to a StepArray system. It is suitable for installations diffusing security messages. It consists of monitoring of proper functioning of the system as per the requirements of the norm, using two daughter boards inside the UT26 processor and a sensor for electric current measurement. Processor, amplifier, and speaker faults are detected.

> *Beyond the norm:*
> The SSS option is a great way to ease maintenance of an installation by keeping you informed of proper fonctionning.

6 SAdrive software

The SAdrive software is primarily used to tune the operating parameters of StepArray columns, but it is also a great simulation tool. The software can be downloaded for free on Active Audio's website:

http://www.activeaudio.fr/en/gamme-steparray/sadrive

SAdrive provides access to a full range of operations including, for each column:

- input selection with adujstable noise gate,
- equalization: 6 fully parametric biquadratic filtering elements,
- sub-bass output management,
- delay,
- directivity control,
- automatic gain control management,

These operations are directly accessible through the SAdrive *Synoptic* frame as shown on figure 12.

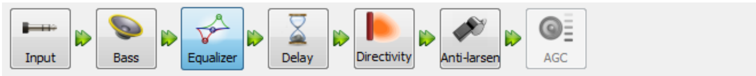


Figure 12: Synoptic frame

Additionally, it is possible to save and recall operating parameters in presets.

The main feature of SAdrive is the directivity control block, which allows the user to change the radiation pattern of StepArray columns in real-time. This block is presented in figure 13.

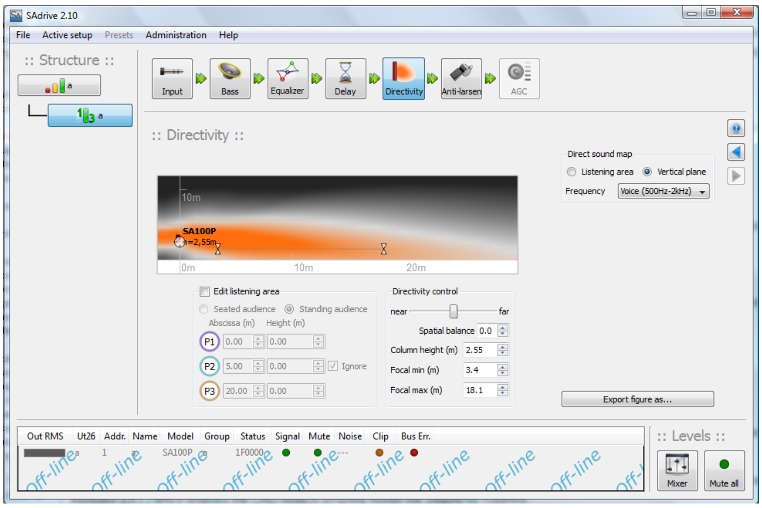


Figure 13: SAdrive directivity block

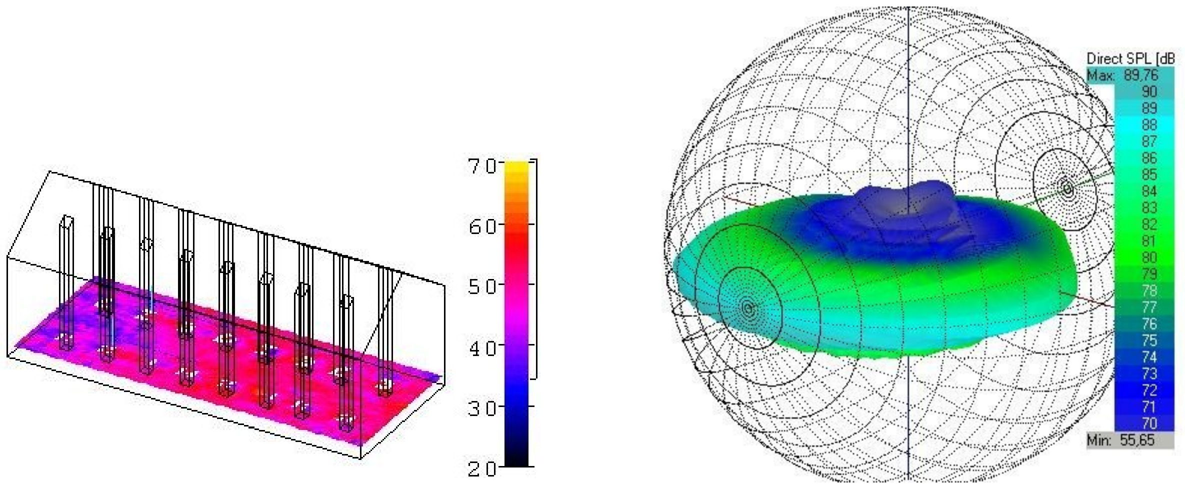
7 CAD modeling

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 (DLL) which enables the CAD tools to properly model the StepArray columns are included inCATT-Acoustic and EASE.

Figure 14 shows examples of a modeling results for CATT-Acoustic and EASE.

With the StepArray DLLs, the directivity parameters can be adjusted as can be done in real situation with the **SAdrive** software.



(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 14: 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.

StepArray

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Part II

StepArray technical reference

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8 Installation of the columns

StepArray columns are mounted verticaly, usually on a wall, using the supplied brackets. Figure 15 illustrates the steps to follow for column mounting. See also figure 25 on page 36 for technical drawings of the brackets.

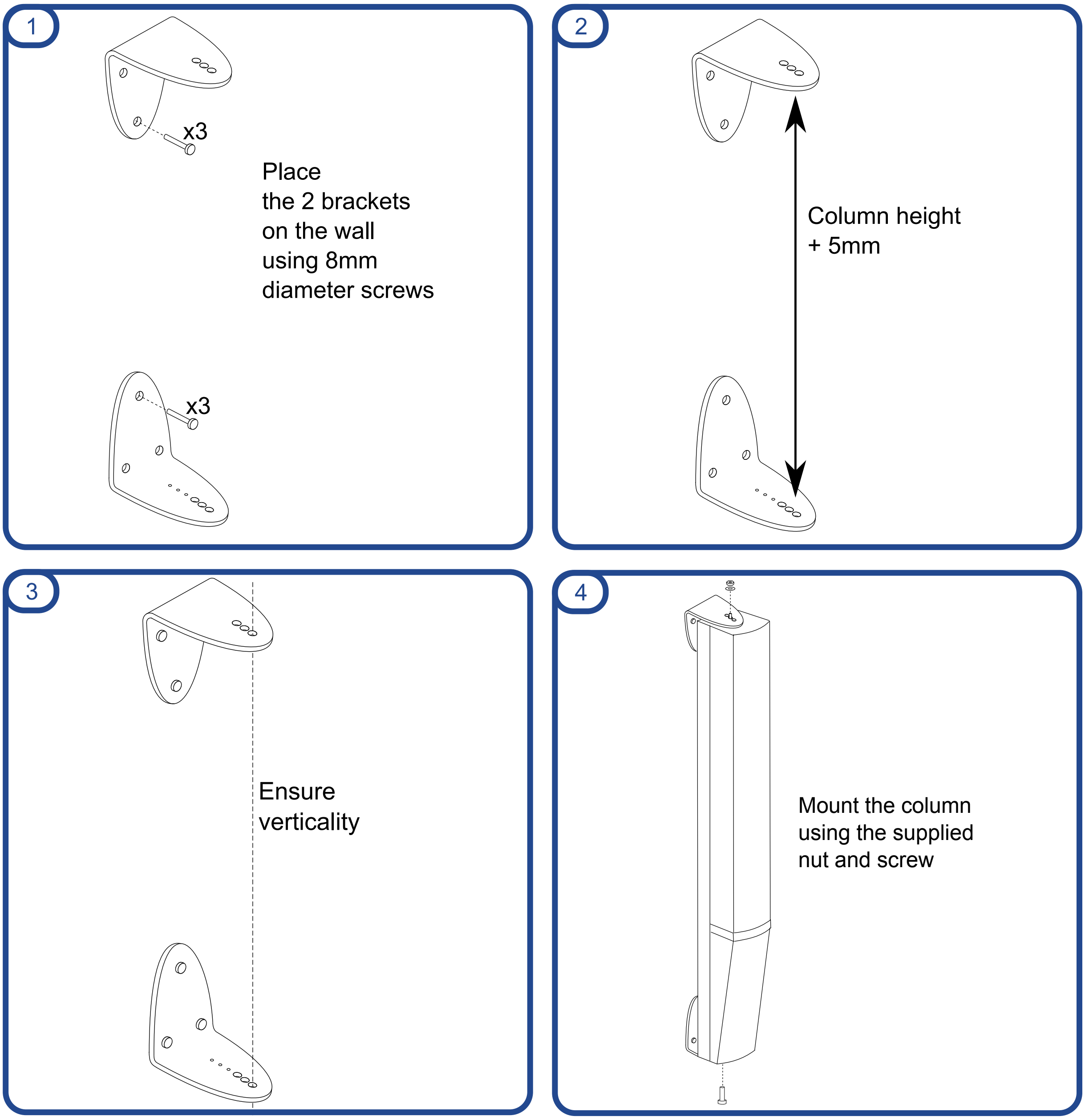


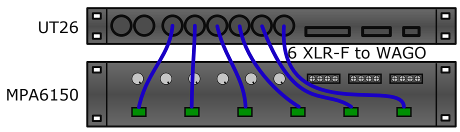
Figure 15: Column mounting on a wall

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

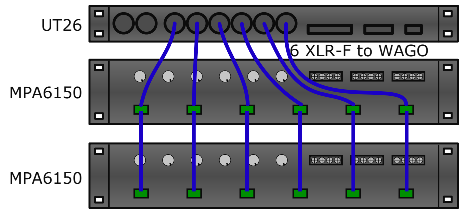
9 Wiring

9.1 UT26 processor to amplifier

A UT26 processor can be connected to one or several StepArray columns via amplifiers (see figure 16). When a UT26 is used with several amplifiers (to feed several columns with the same signal), the inputs are simply daisy chained (see figure 16b).



(a) Direct wiring



(b) Daisy chain wiring

Figure 16: UT26 to MPA6150 wiring

XLR-F to Wago cables use standard XLR wiring convention as shown in table 4.

XLR	Wago
pin 1	Ground
pin 2	pin +
pin 3	pin -

Table 4: XLR to Wago wiring.

9.2 Amplifier setup

MPA6150 amplifiers should be tuned with **all gains to max**, and microswitches set for **independent channels**, as described in figure 17.

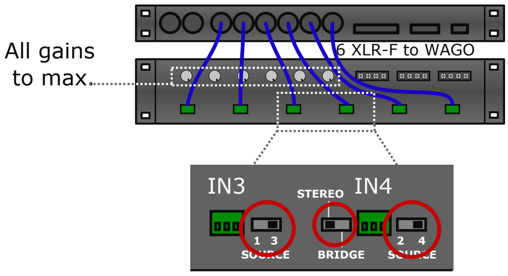


Figure 17: MPA6150 amplifier set-up

9.3 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 18.

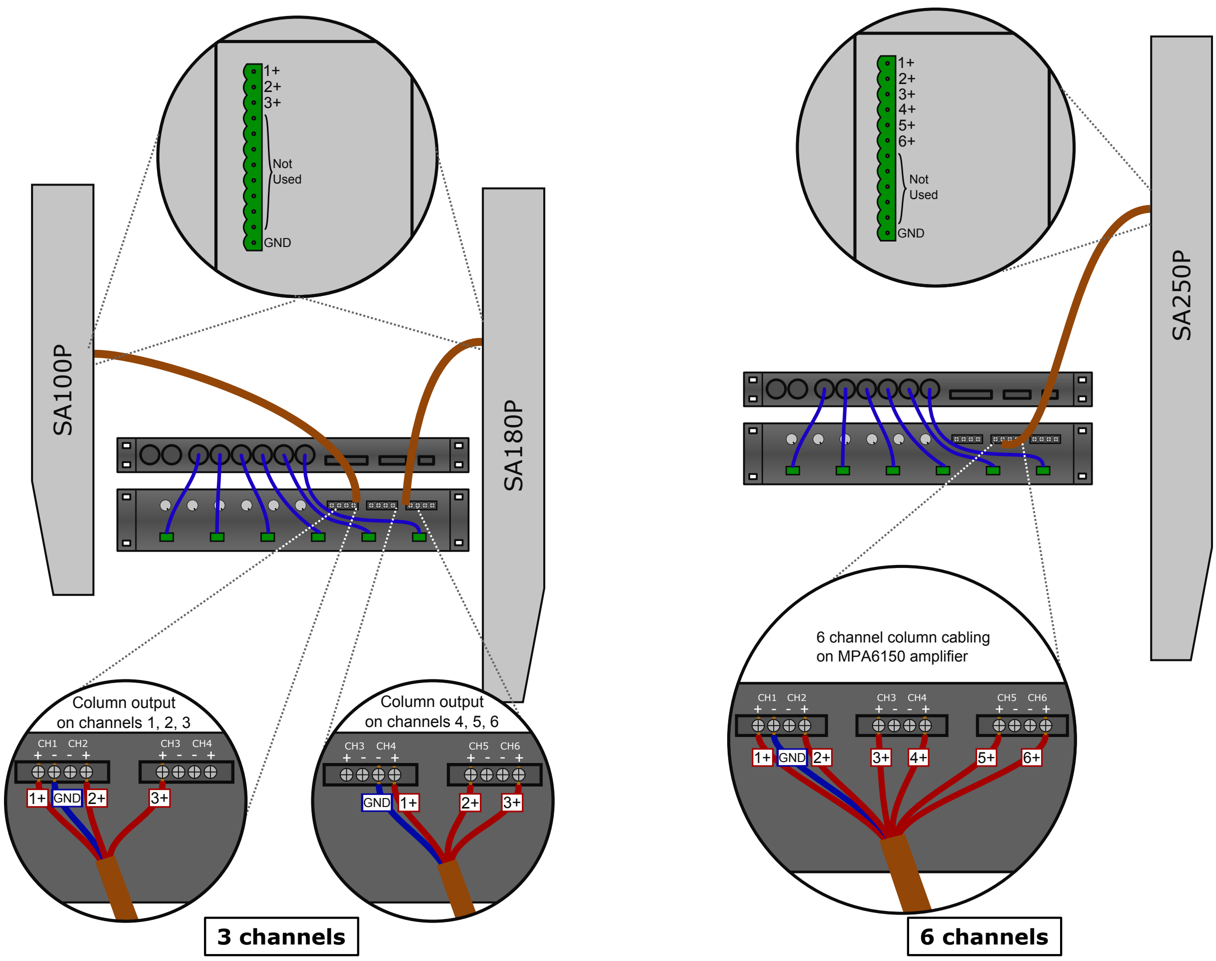


Figure 18: MPA6150 to column wiring

9.4 Wiring the microphone (MIC option)

The MIC option consists of a microphone integrated inside the column and a daughter board placed inside the UT26 processor, which supplies phantom power on input 2 of the processor.

The microphone output of the column should be linked to input 2 of the UT26 processor using a shielded conductor pair. Wiring is described in table 5.

GND	+	-
Pin 1	Pin 2	Pin 3

Table 5: Wiring of the microphone: standard XLR.

9.5 RS232 wiring

Only one processor should be connected with RS232 to the computer. If there are several UT26 processors, then communication with all processors is possible when the BAN connectors are connected in daisy chain. This is illustrated in figure 19.

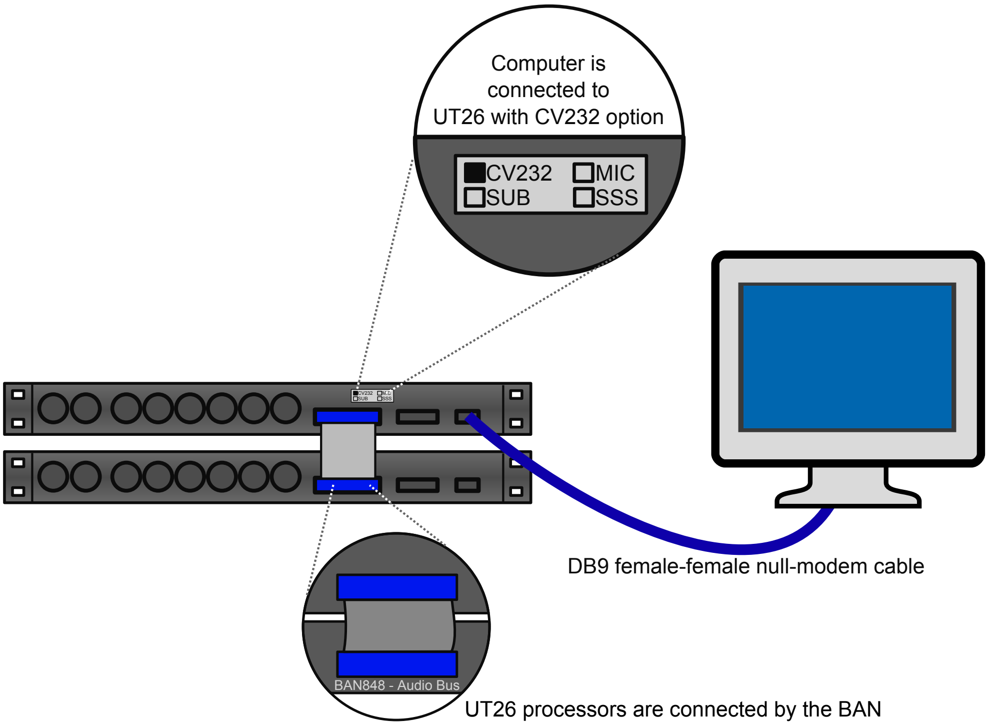


Figure 19: RS232 wiring diagram

RS232 wiring uses standard DB9 null-modem wiring as shown in figure 20.

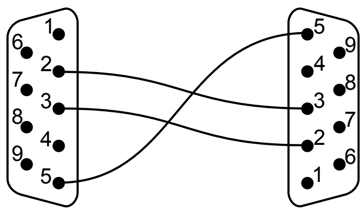


Figure 20: RS232 wiring: standard DB9 null-modem.

When several UT26 processors are used, they can be inter-connected by the BAN connector. In this case **only one of the UT26 connected to the BAN must be fitted with the CV232 option**.
The CV232 option is disabled by putting the JP1 jumper of the CV232 board to «PC» position.

When the distance between the computer and the processor is over 30 meters, it is possible to use an RS485 port connected to the command channel (GND on pin 1, **-** on pin 2, **+** on pin 15) of the BAN connector. In this case, the CV232 option is not needed.

9.6 SUB wiring

When the UT26 processor is equipped with the SUB option (section 5.2), a sub-bass output is delivered on the BCL port of the UT26 processor. Table 6 describes the wiring used.

Pin	Sig
pin 5	+
pin 6	-
pin 14	Ground

Table 6: SUB wiring on BCL port.

10 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 18 on page 23.

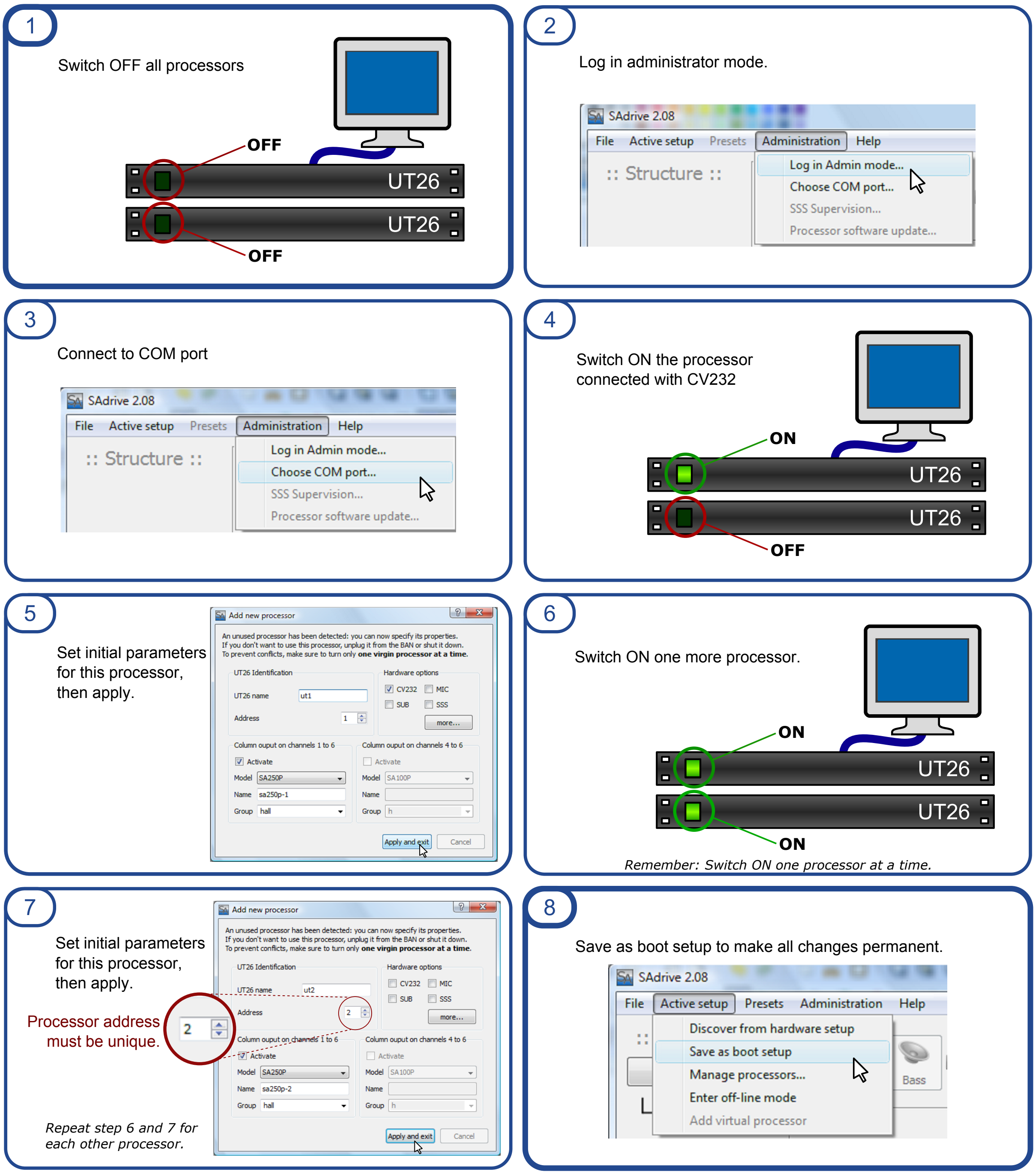
When measuring the electrical resistance, the cable resistance must be taken into account (about 1.3Ω for 100 meters of $1.5mm^2$; 0.7Ω for 100 meters of $2.5mm^2$).

11 SAdrive software

The SAdrive software is used to tune all the filtering parameters of StepArray columns, it is available as free download here:
http://www.activeaudio.fr/en/gamme-steparray/sadrive

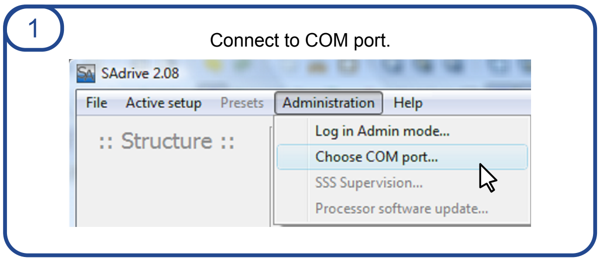
11.1 Init new processors

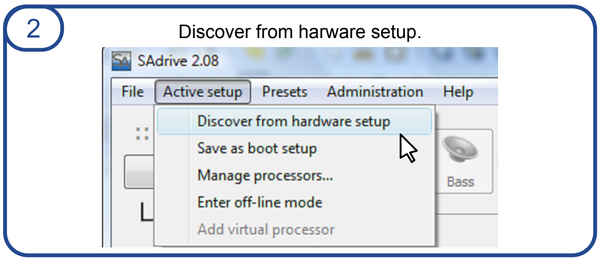
When a new processor (factory settings) is first connected to SAdrive, it needs to be initiated. The initalization steps are described below.



11.2 Check connected processors

Already inited processors don't show up automatically in SAdrive. To discover those processors, follow the steps below:





12 Advanced functions

12.1 Automatic gain control: AGC

Automatic Gain Control is available if the UT26 processor is equipped with the MIC option (section 5.1).

AGC allows automatic adjustment of the diffusion level according to the sound level captured by the microphone when no message is played. Using this function, the sound level perceived by listeners is adjusted for optimal comfort: moderate level when the ambiant noise is low, higher level when the ambiant noise is high in order to provide good intelligibility.

The amplitude of the ambiant noise captured by the microphone is smoothed with a *time constant* adjustable by the user. This resulting smoothed value is used as a basis for gain calculation: below a *threshold* adjustable by the user, the AGC gain is set to $0dB$; above this *threshold*, the AGC gain increases proportionally to the ambiant noise up to $+12dB$.

For example:

- If the ambiant noise is $75dB_{SPL}$ and the AGC enters in action (*Threshold*) at $65dB_{SPL}$, then the AGC gain will be $10dB$ (i.e. $75dB - 65dB$).
- If the ambiant noise is $80dB_{SPL}$, and the AGC enters in action (Threshold) at $65dB_{SPL}$, then the AGC gain will be $12dB$ (i.e. $80dB - 65dB = 15dB$ but AGC gain is $12dB$ max) .

The AGC algorithm is summarized on figure 21.

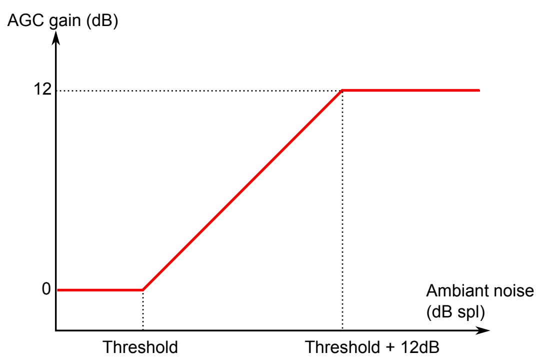


Figure 21: Automatic gain control functional graph

- When the AGC function is used, the Input selection of the Input block is forced to Input 1 type analog.
- The ambiant noise value is displayed (by steps of $2dB$) in the Status frame of SAdrive.

12.2 Security Sound System: SSS

Security Sound System conformance is available when the UT26 processor is equipped with the SSS option. This option includes:

- daughter boards in the UT26 processor,
- a push button with 2 LEDS on the front panel of the UT26 processor,
- an SSS sensor box

The SSS principle of operation is to use a probe signal along with a current sensor to monitor effective current consumption of each channel of the system.

A UT26 processor equipped with the SSS option adds a high-frequency sine component to the audio signal output, and synchronously detects this high-frequency signal on its analog input 2 (where the SSS box is connected). This loopback allows precise monitoring of the current consummed by the columns.

The cabling diagram for an SSS installation is shown in figure 22.

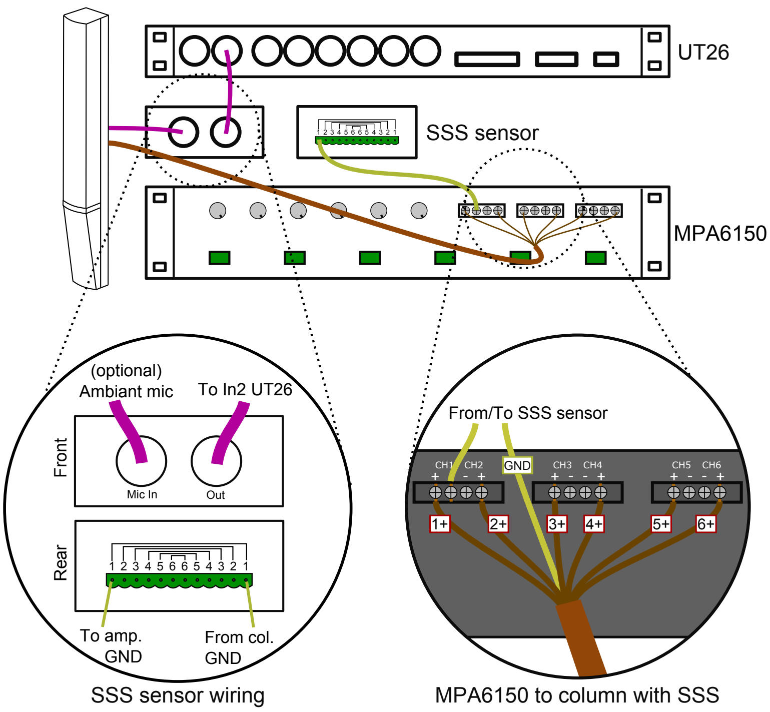


Figure 22: SSS cabling diagram

Any malfunction detected by the processor will have the following effects:

- red LED is turned ON on UT26 front panel,
- processor beeps
- SSS contact between pins 1 and 9 is open on the BCL port of the UT26 processor is open.

If the UT26 processor fails, the beep and LED signals won't work, but the SSS contact will still be opened, so that the failure is reported to the central monitoring system of the installation.

> The SSS contact[a] is the primary indication for failure: it will be opened even if the processor fails (on missing power supply for example), so that failure is always reported.
>
> [a] SSS contact is between pins 1 and 9 on the BCL port of UT26 processor

Examples of malfunctions:

- a column channel is disconnected from the amplifier,
- amplifier is off,
- a gain on the amplifier was changed by mistake,
- a loudspeaker burned,
- the column cable is cut,
- etc.

12.3 Feedback killer

The feedback killer used in the UT26 processors is a modulated delay.

The delay is modulated sinusoidally with a constant depth of $2.6ms$, while the modulation frequency is adjustable for more or less agressive feedback elimination. The variation frequency is as follows:

- *Off*: no modulation.
- *Low*: $0.6Hz$ modulation frequency.
- *Mid*: $1.3Hz$ modulation frequency.
- *High*: $4.0Hz$ modulation frequency.

On-site measurements indicate that the gain margin can usually be increased by 4dB.

> • The feedback killer maybe used for speech diffusion, but should be switched off for music diffusion.
> • The time variant nature of the algorithm used is not compatible with standard anti-larsen products.

12.4 Remote control

It is possible to control UT26 processors using a remote controller. The only requirement is being able to send hexadecimal code on RS232 connection. For example, remote controller model Extron MLC-104 can be configured to control UT26 processors.

Table 7 present the list of accessible operations with their corresponding hexadecimal code

Operation	Hexadecimal code
Mute	$81
Un-Mute	$82
Increase gain (+2dB)	$83
Decrease gain (-2dB)	$84
Load preset 1	$85
Load preset 2	$86
Load preset 3	$87
Load preset 4	$88

Table 7: Remote control character codes

13 Troubleshooting

Symptom	Possible cause	Solution
The green switch of the UT26 processor is not ON	A fuse is burned	Replace fuses in power supply connector at the back of UT26 processor (160mA delayed fuses)
No sound comes out of the column.	No input signal detected	Check that the *Sig* LED is ON in SAdrive's Status frame. If the LED is OFF, check that the *Input threshold* is not too high.
	The UT26 processor is not inited.	Follow the steps presented in section 11.1 on page 26 to init processors with SAdrive.
SAdrive does find the UT26 processor	The computer to UT26 cable is defective.	Check that RS232 cable is wired as described in section 9.5 on page 24.
	The UT26 processor is not equipped with the CV232 option.	Connect the UT26 processor through the BAN to a UT26 processor equiped with the CV232 option as explained in section 9.5 on page 24.
	The COM port selected in SAdrive is wrong	Select the correct COM port in SAdrive (*Administration→Choose COM port)*
	The processor is already inited	Use menu *Active Setup→Discover from Hardware* to discover inited processors (see also section 11.2 on page 27).
The sound is not homogeneous or distorted	Amplifier to column connection is incorrect	Make sure columns are properly connected, as described in section 10 on page 25.

Symptom	Possible cause	Solution
	Input signal level is too high	Reduce input signal level (Max signal input is $\pm 3.25V$ as described in 14.1 on the next page).
	Filtering parameters are wrong	Reduce the gain (Mixer Block). Correct the equalization.
	The column is a pre-2010 column	Check the tick-box using the menu: *Active Setup→Manage processors.* In the *Options* frame, use *more...* then specifiy if the column is a pre-2010 one.
	There is a wiring problem.	Make sure the wiring is correct (see 10 on page 25).
	The parameters of the *Directivity* block are wrong	Check that listening area defined in the *Directivity* block of SAdrive matches real situation (see figure 9 on page 13).
	The column model in SAdrive doesn't match the real column model.	Correct the column model using the menu *Active Setup→Manage processors.*
No bass signal on SUB output	The SUB option has not been selected in SAdrive	Check the SUB option using menu *Active Setup→Manage processors.*
The AGC function is not accessible and the *Noise* field in the status frame shows «–»	The MIC option has not been selected in SAdrive	Check the MIC option using menu *Active Setup→Manage processors.*
The AGC function doesn't work and the Noise field in the frame Status shows «40dB»	The microphone is not properly connected to input 2 of the UT26 processor.	Make sure the microphone is properly connected on input 2 of an UT26 equipped with the MIC option (see section 9.4 on page 23 for wiring).

14 Hardware specifications

14.1 UT26 processor characteristics

Audio data	
Analog inputs	2 symmetrical inputs, connectors XLR-F Max input voltage: $\pm 3.25V$ (+9.5dBU) 1st order high pass cutoff at 6Hz. Crosstalk : < -90dB. Input impedance : 15 $k\Omega$ with option MIC, input 2 delivers a 14V phantom power supply.
Digital input	AES/EBU, 48kHz
Analog outputs	6 symmetrical outputs, connectors XLR-M Max output voltage : $\pm 1.6V$ $(+3.3dBU$, i.e. max input of MPA6150 amplifier). Output impedance : 46 Ω Dynamic range : 95 dB
Sub-bass output (option)	Symmetrical output on DB25 female BCL port 4th order Likwitz-Riley lowpass filter at 180Hz Max output voltage : $\pm 1.6V$ $(+3.3dBU)$

General data	
Communication	RS232 port at 38400 bauds
Mains	230V / 50Hz, 15W max
Power consumption	45W
Dimensions	$430 \times 44 \times 285mm$ (Rack 19" - 1U)
Color	Black
Weight	4kg

14.2 MPA6150 amplifier characteristics

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.

14.3 Subwoofers characteristics

Acoustical data	
Frequency bandwidth	40-500Hz
Type	Bass-Reflex
Max SPL at 1m	130dB (Peak)
Sensitivity	97dB / 1W / 1m
Directivity	Omnidirectionnal
Loudspeaker	12", neodymium
Electrical data	
Power handling	450W AES
Inputs	SA12 SW: Dual Speakon SA12 SWA: 2x XLR sym. 0dBV
Impedance	8Ω
Amplification	SA12 SW: Compatible with MPA 6150 amplifier SA12 SWA: Digital amplifier Class D
Electrical connection[7]	Neutrik Powercon, 195V - 250V AC 50-60Hz
Mechanical data	
Materials	Plywood
Dimensions	$435 \times 400 \times 440mm$
Weight	SA12-SW : 18.5kg SA12-SWA : 19.8kg
Color	Black
Tuning and exploitation	
Software	Supplied SAdrive software: Filtering processor: UT26 with SUB option

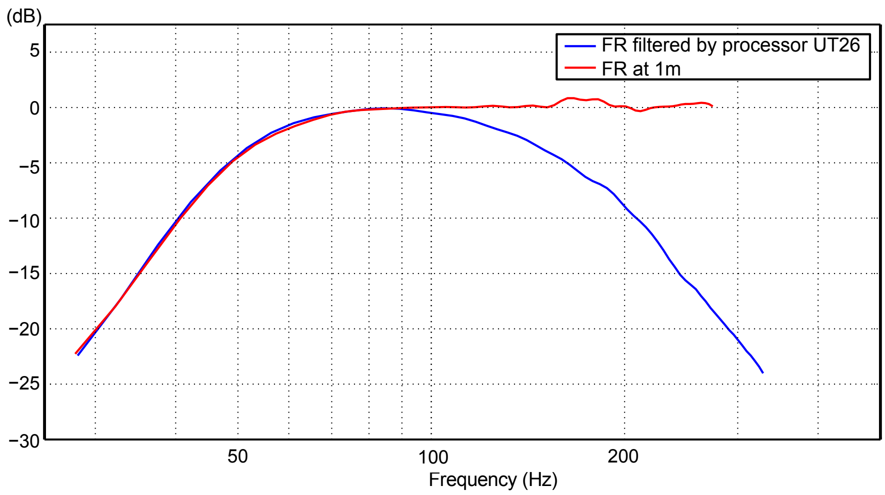


Figure 23: SA12-SW frequency response.

[7] **Only for SA12-SWA**

14.4 Columns characteristics

14.4.1 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 9: DC resistance of StepArray columns.

For details on connector pin assignement, see figure 18 on page 23 in section 9.3.

14.4.2 Mechanical characteristics of StepArray columns

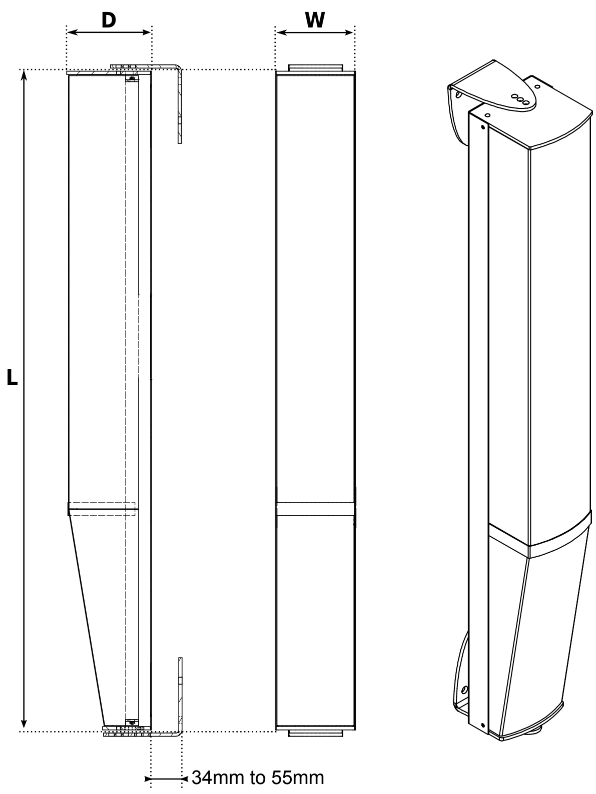


Figure 24: StepArray column dimensions

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

Table 10: 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

14.4.3 Fixing brackets

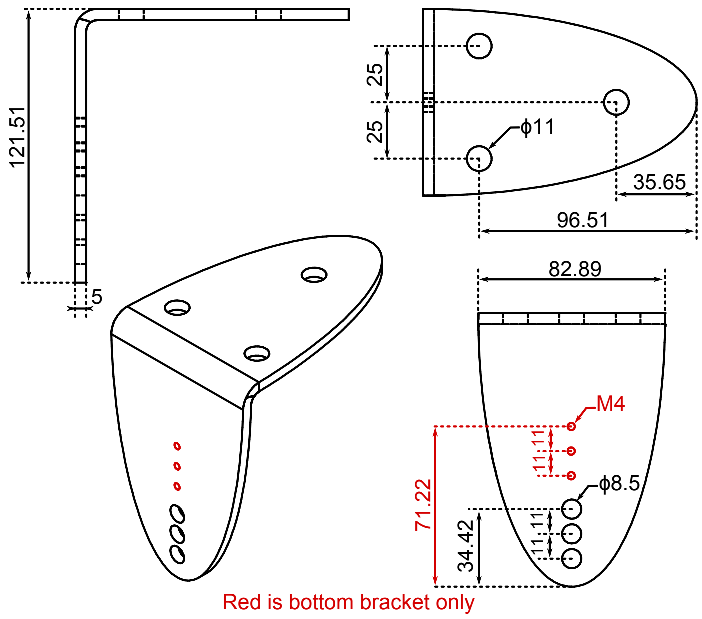


Figure 25: Fixing brackets for wall mounting of StepArray columns.

15 Acoustical data

15 Acoustical data

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

15.1 Common data

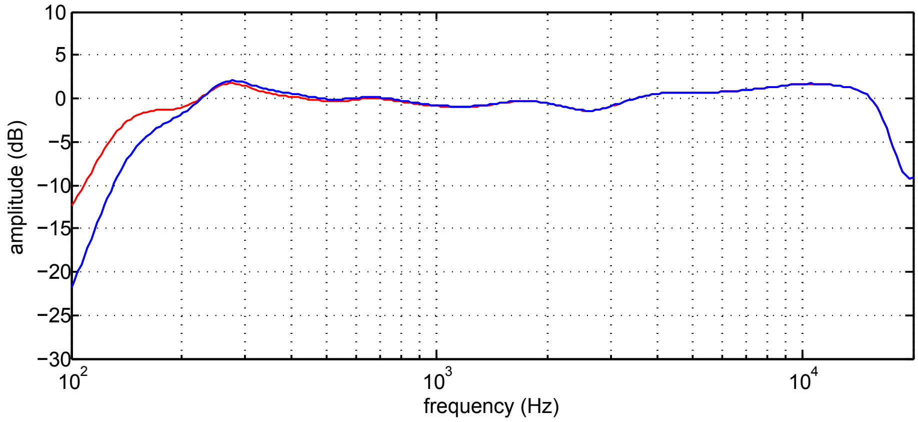


Figure 26: Frequency response (column SA250P). Average of the mesurements at 7, 10, 15, 20, 25, and 30m. In red: with bass high-pass on position «100Hz», in blue: with bass high-pass on position «200Hz».

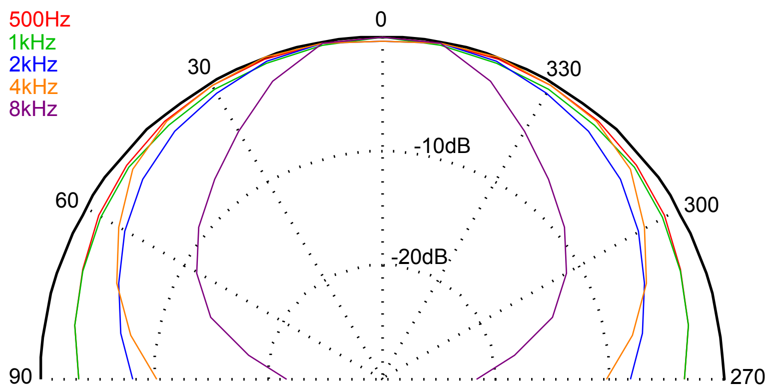
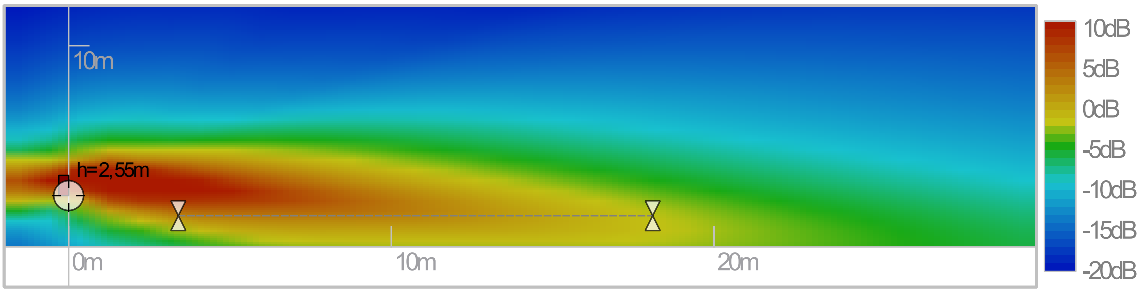
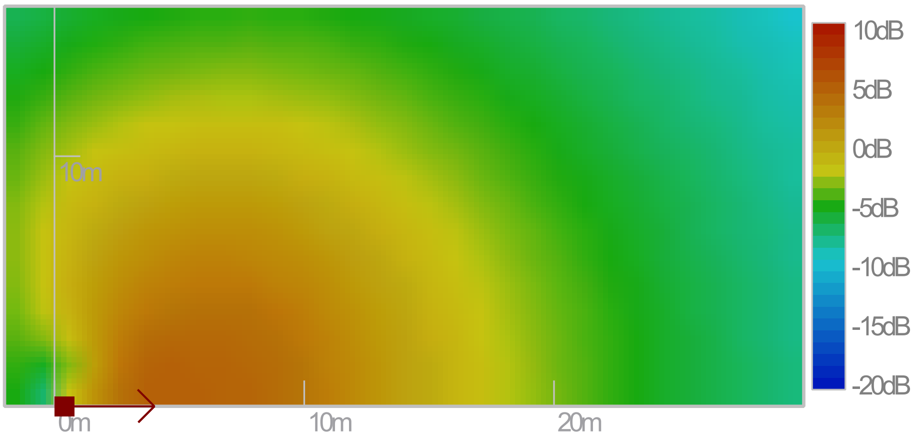


Figure 27: Horizontal directivity (column SA250P)

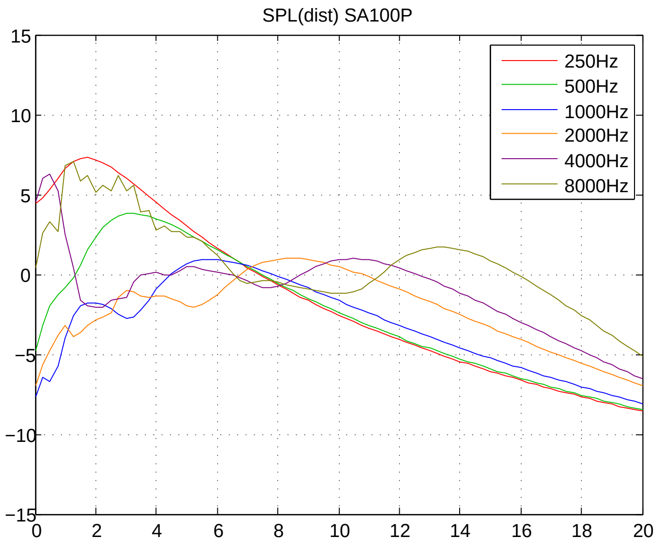
15.2 SA100P acoustical data[8]



(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.

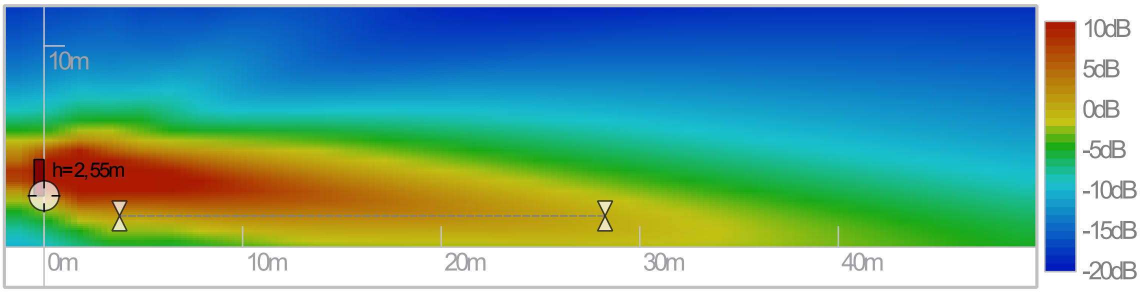


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

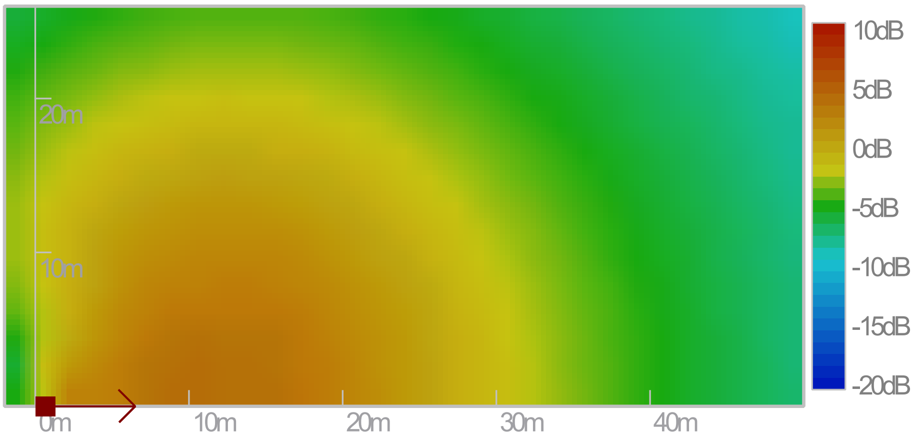
Figure 28: SA100P acoustical data.

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

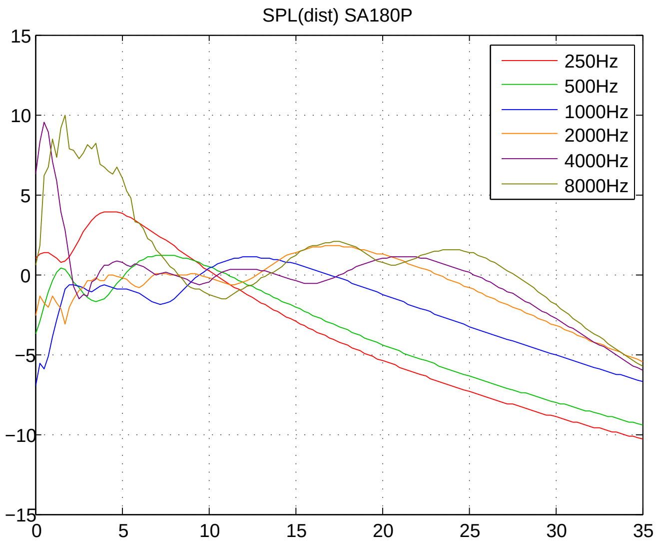
15.3 SA180P acoustical data[9]



(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.

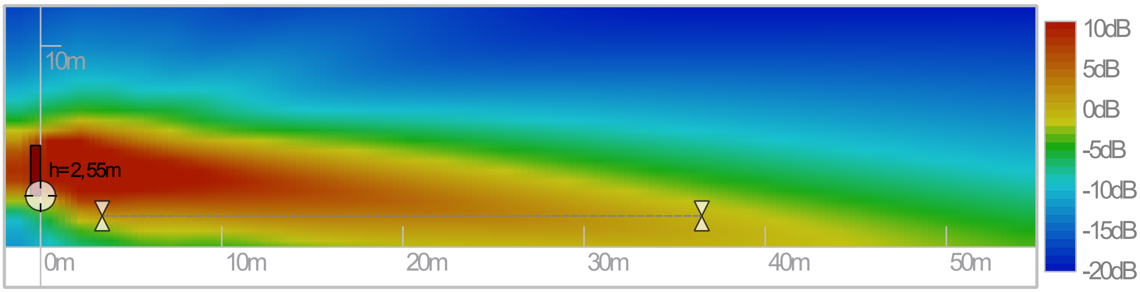


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

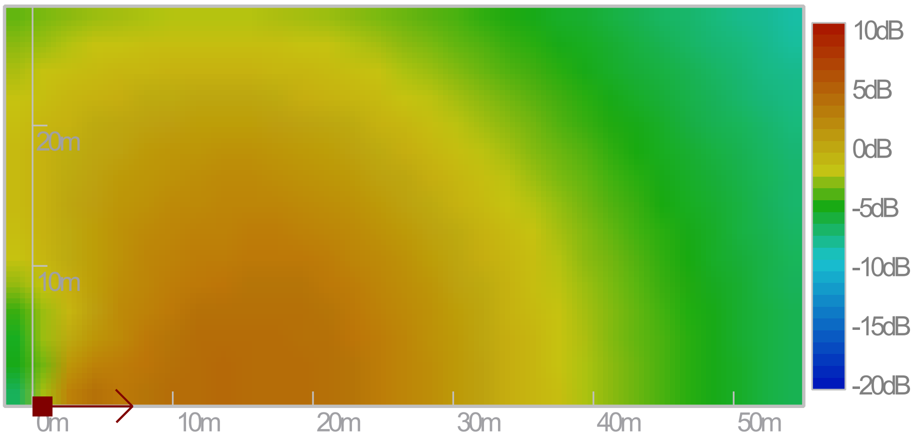
Figure 29: SA180P acoustical data.

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

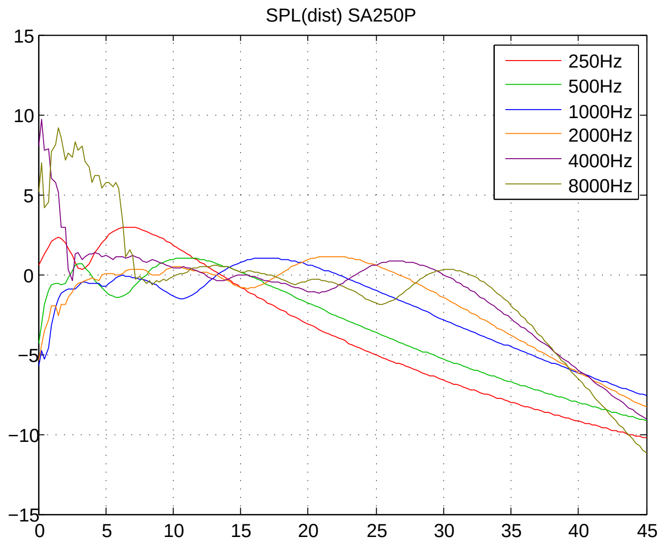
15.4 SA250P acoustical data[10]



(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.

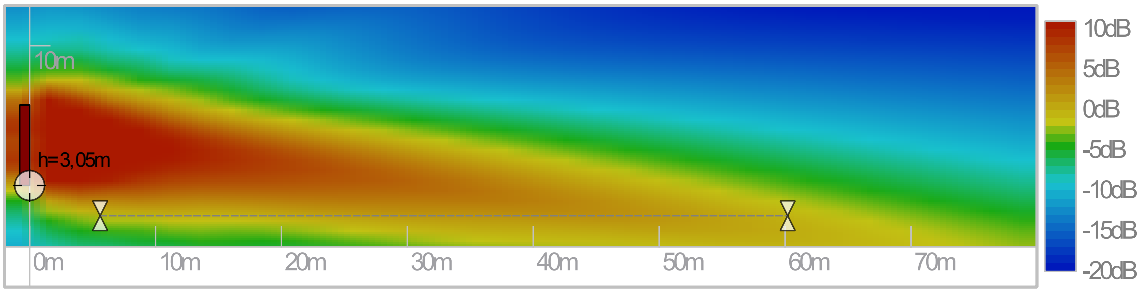


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

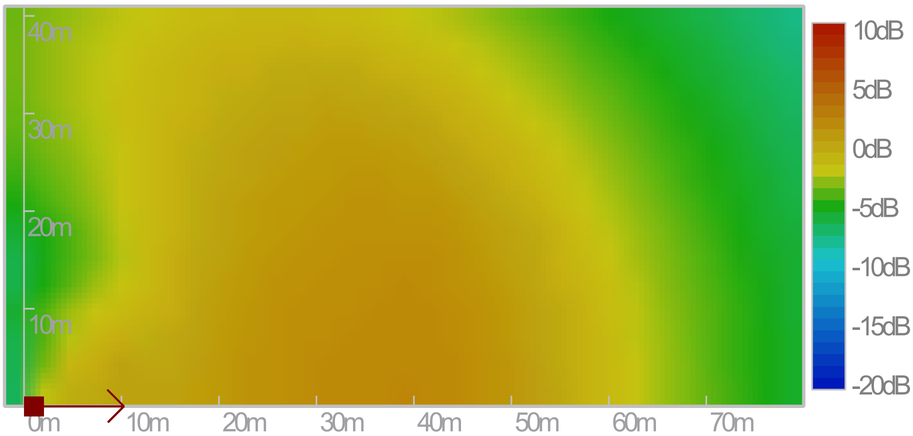
Figure 30: SA250P acoustical data.

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

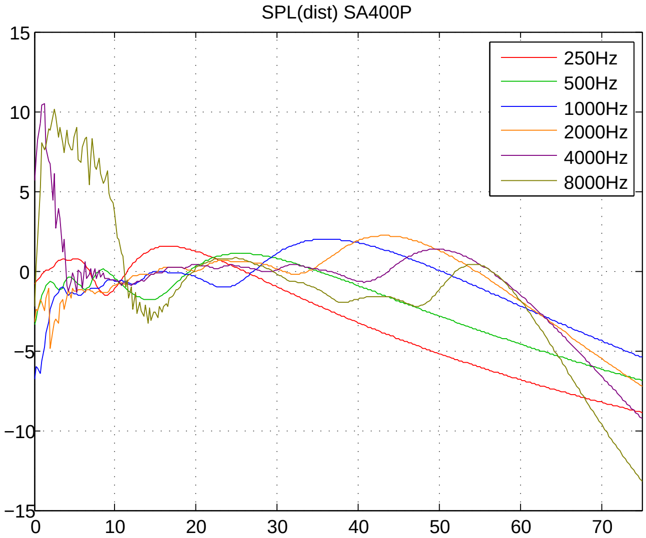
15.5 SA400P acoustical data[11]



(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.

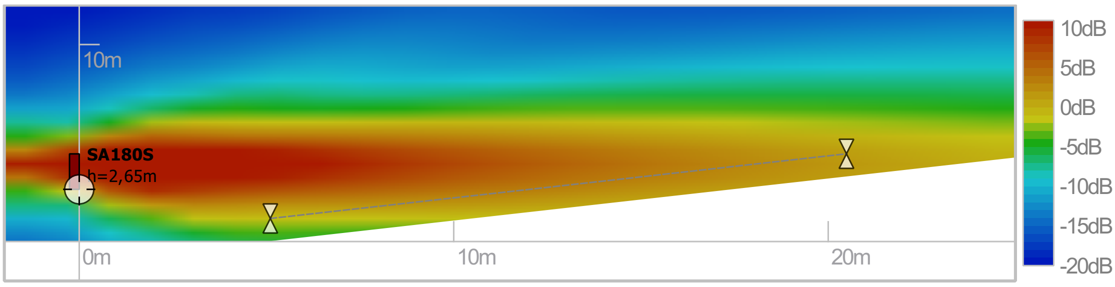


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

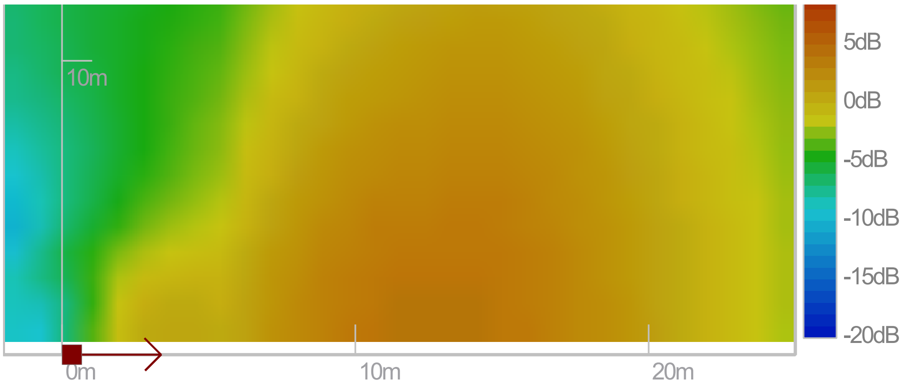
Figure 31: SA400P acoustical data.

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

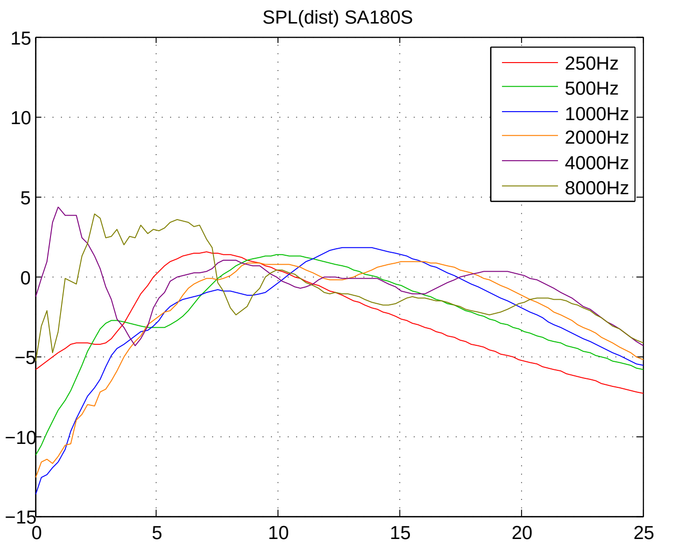
15.6 SA180S acoustical data[12]



(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.

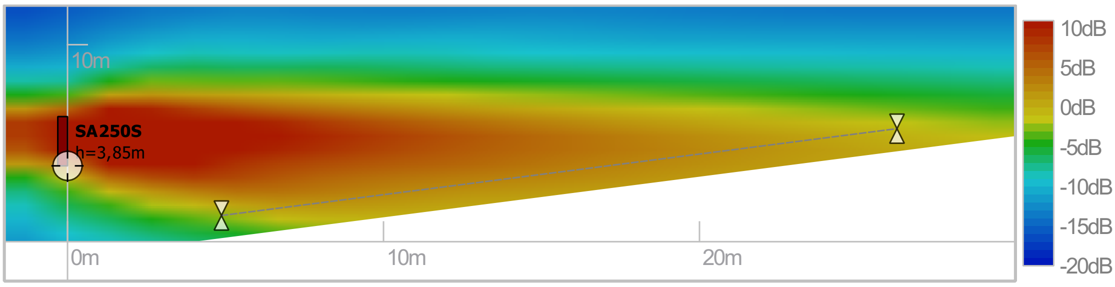


(c) Sound level by octave in the axis of the listening plane in front of the column with respect to the distance from the column.

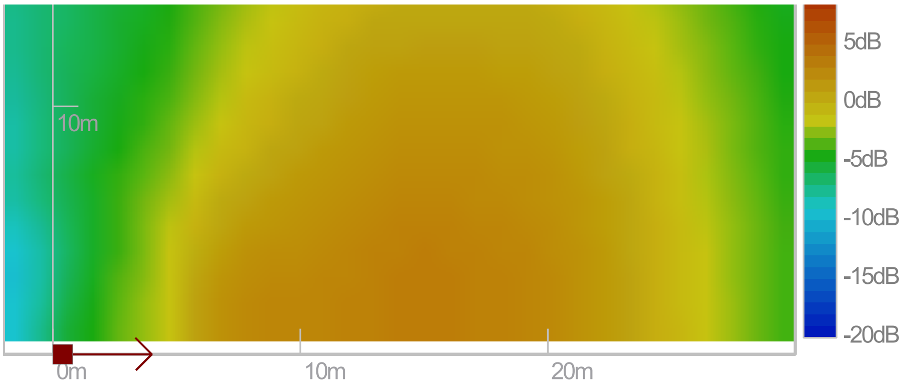
Figure 32: SA180S acoustical data.

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

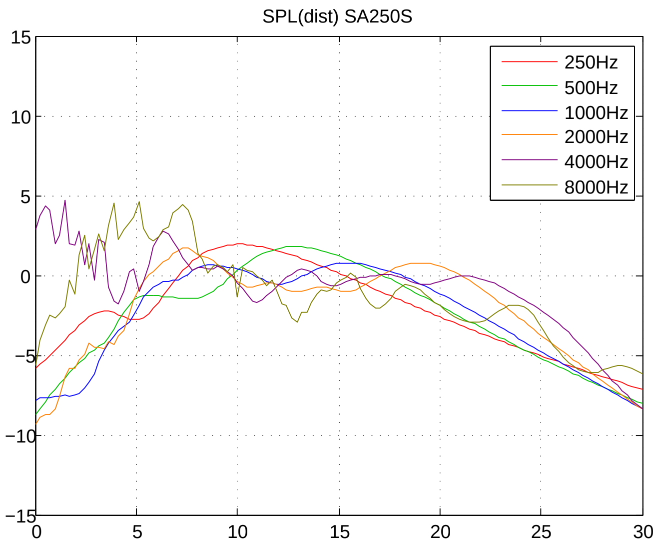
15.7 SA250S acoustical data[13]



(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 33: SA250S acoustical data.

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

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