VARIABLE BEAM-STEERING

KS Audio CPD18

Active 3.5-way System with Variable Beam-Steering; VALTEC™

Text and measurements: Anselm Goertz | Photos: Dieter Stork, Anselm Goertz | Translation: Frank Schulenberg

A pair of CPD18s in our anechoic chamber; thanks to the slim design, the CPD18 can be placed inconspicuously at the edge of the stage

The complete product "loudspeaker" at KS always includes the associated electronics with filters, limiters and, depending on the model, beam-steering technology, which are precisely tuned to the system. Owner and founder Dieter Klein still manages the KS Audio company from Hettenleidelheim in the Palatinate region of Germany. KS has been an established name in professional sound reinforcement technology for more than 40 years and, together with its employees, it has been responsible for innovative new developments in the industry on a regular basis over the past decades. From the very beginning, KS has relied on a high level of manufacturing and it's own breadth and depth of R&D. "Compromises in development" or even an "impossible" do not occur in the dictionary of Dieter Klein. It is precisely these qualifications that also predestine KS products for many special tasks and special structures. Among the best-known are probably the two half-traffic lights in the plenary hall of the Reichstag building, which KS developed for Siemens 28 years ago - and which are still in service there today.

KS's own electronics as an external controlled amplifier or as an integrated unit have been standard for a long time, which means that the customer or user is always offered a complete system that is tuned in itself and no longer requires any further "development" by the customer. Today, almost all renowned manufacturers rely on offering only complete systems consisting of loudspeakers and the associated electronics. Thirty years ago, however, this was still real pioneering work for a company like KS, which was rather small compared to the big names on the scene at the time. A milestone in KS history was the introduction of the FIRTEC™ controllers in 1995, which enable an overall phase linear loudspeaker system with the help of digital FIR filters. FIRTEC™ is just one of the typical examples where KS was at the forefront and played a leading role in the development long before a certain technology became mainstream.

The fact that KS's innovative strength has by no means diminished even after 40 years is demonstrated by the current product portfolio. The CPD 18 presented here is certainlyamong them. At first glance, the CPD18 is a PA speaker in the form of a slim column, as they are currently en vogue with many manufacturers. The CPD 18 consists a tweeter unit, eight 5" mid-woofers and four 10" woofers. The latter are located on the side, which makes the design of the slim column possible. In order to enable placement close to the wall at the edge of the stage, the CPD18 is available in two versions with a mirror-symmetrical arrangement of the woofers. The configuration of the CPD18 already indicates that this is not just a "typical column speaker" for voice reproduction, but a fully-equiped PA box. Areas of application include concert and theater stages as well as use as a monitor in large demo rooms, control rooms or for mastering. The CPD18's little sister, the CPD14, with half the configuration and without variable beam steering, has been used for several years in the famous Semper Opera House. as a four-level sound reinforcement system for the stalls and the three circles. By the way, the CPD18 would also make a good impression as a large hi-fi speaker and would provide a solution for many acoustically problematic living room. The dimensions of the CPD18 are 1380 " 208 " 465 mm, the weight is 51 kg.

CAD rendering of the CPD18 Around the centrally-mounted tweeter unit there are eight 5" midrange drivers and four side-mounted 10" woofers.

Acoustics: variable dispersion

The aim of a loudspeaker with this shape of construction is to radiate the sound as direct as possible to the listeners and at the same time avoid reflections and delays caused by the room. What is vital for a good sound for many instruments - the surrounding space that amplifies the sound - usually has a counterproductive effect on loudspeaker reproduction. Precise reproduction with a good speech transmission (STI) and clarity of music requires precise directivity of the speakers used. In general, you cannot speak of right or wrong when it comes to dispersion behaviour, but rather of suitable or unsuitable for the respective application. The dispersion pattern of a loudspeaker must be adapted to the respective requirements. The desired dispersion angle is determined by the speaker's placement ➔

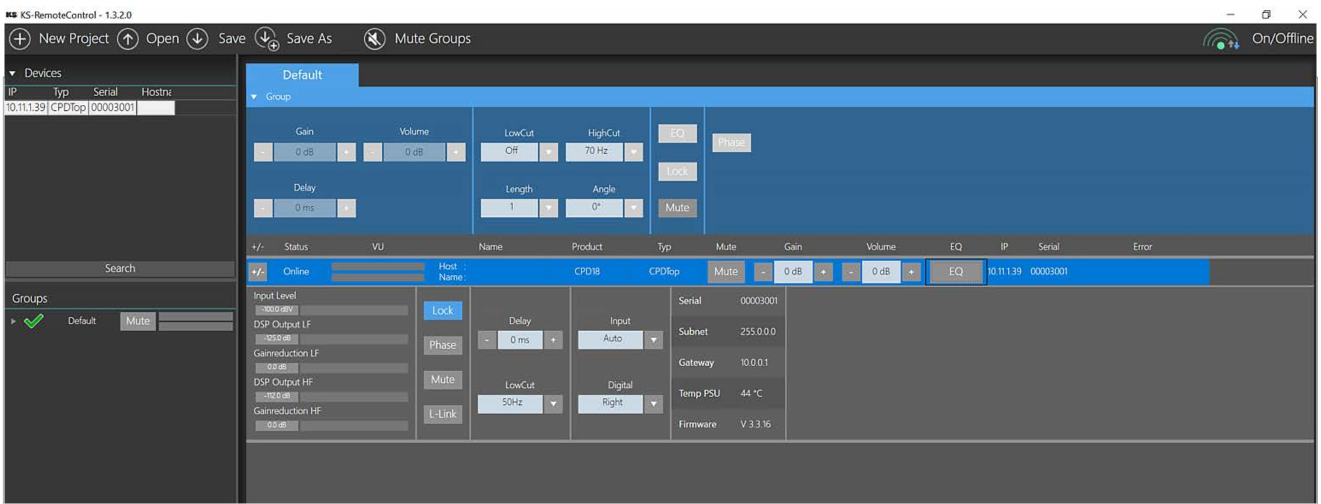
(which is often not optimal due to external circumstances) and the position of the listeners. In the horizontal plane, a relatively wide dispersion is usually required; with opening angles of 60° to 120°, depending on the width and depth of the room. However, it becomes more difficult on the vertical plane, where a rather narrow radiation pattern and often a slight tilt (downangle or upangle) of the direction are desirable. To adapt to this, one can fall back on modular line arrays with corresponding curving or on systems with electrical beam steering. However, both require compromises. Classic line arrays are designed for variable box-to-box angles (splay), whereby overlaps or gaps can never be completely avoided. Electronic beam steering requires a source distance smaller than half a wavelength for directional dispersion without sidelobs. For high frequencies, this can only be realised with great effort or not at all. In the CPD18, electronic beam steering is therefore only used for the midrange drivers up to 1.8 kHz. In addition, variable beam steering is implemented with the help of VALTEC™. It stands for "Variable Acoustic Lens Technology" and enables to adjust the vertical dispersion angle and tilt angle of a line source via two "acoustic lenses" in the path of the sound.

- More information and details on VALTEC™ can be found in the topic box on page 59 -

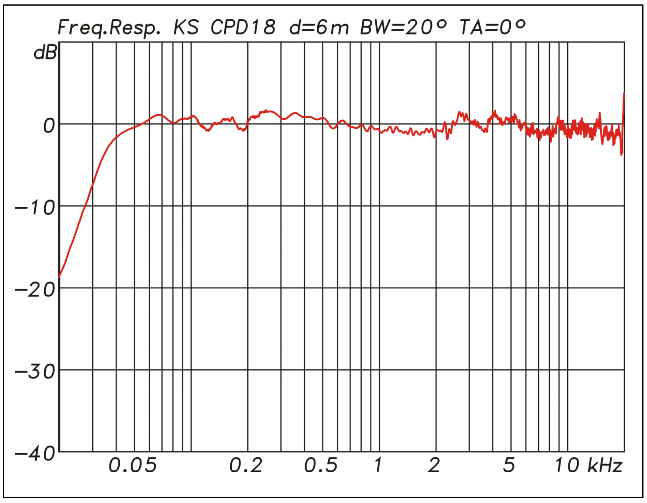
At the centre of the CPD 18 is the VALTEC™ high frequency unit using a BMS driver with a 1.75" Mylar diaphragm. Via two rotatable acoustic lenses, the soundwaves are then guided into the waveguide where the cylindrical wavefront is created. Attached to the waveguide is a horn which then emits the soundwaves with a 120° horizontal dispersion angle.By using two rotating acoustic lenses and their variable position, both the opening angle and the tilting angle can be determined, respectively in 0° to 30° opening and -15° to +15° tilting. The lenses are adjusted by small motors from model making that can turn the lenses via toothed belts. Fortunately, an expensive replacement of the toothed belt every few years is not necessary. In the CPD18, thanks to VALTEC™, it is possible to adjust the dispersion behaviour without compromise over the entire frequency range up to 20 kHz.

DSP System and Electronics

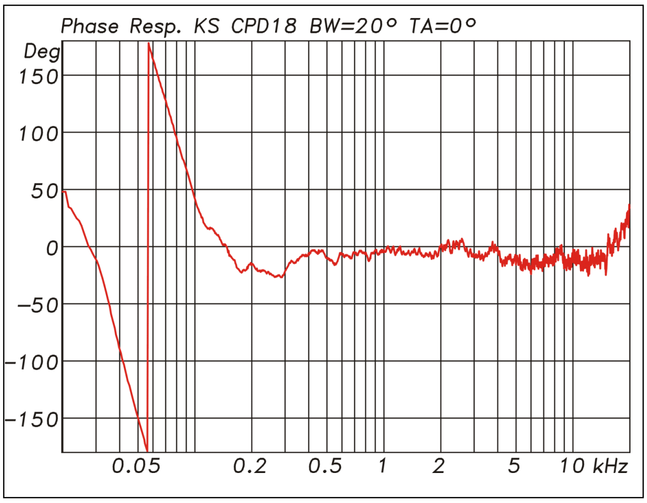
The integrated electronics have seven power amplifiers with a total power of 1,000 W for the woofers, 500 W for the midrange drivers and 100 W for the tweeter. According to the data sheet, the total peak power is 3 kW. Class D power amplifiers are used for the woofers and midrange drivers, and a well-established KS MOSFET power amplifier developed in-house is used for the tweeter. The system is controlled via seven DSP channels, two of which are used for the woofers, four for the midrange drivers and one for the tweeter. The midrange drivers are driven in pairs, whereby the one on the outside still has an inductor in the signal path that acts as a passive low-pass filter.



KS Remote software for controlling and monitoring the active KS loudspeaker models and power amplifiers.



Frequency response of the CPD18 measured on axis at a distance of 6 m for a beam setting with 20° dispersion angle and 0° tilt angle (Fig. 1)



Phase response of the CPD18 with a linear phase from 120 Hz upwards. The overall latency of the CPD18 is 9 ms. (Fig. 2)

The entire electronics of the CPD18 are recessed mounted on the rear side. The mains connection is by means of a PowerCon connection with PowerCon a loop-through output. The signal feed can be analogue or digital via AES/EBU or Dante. Despite the high amplifier power, the electronics of the CPD18 do not require a fan. The low power loss thanks to the Class-D power amplifiers can be completely dissipated via the flat cooling body on the electronics module, so that no fan is required. This aspect is especially important when used in theatres close to the audience. The power supply unit in the electronic module is a wide-range switching power supply unit for voltages from 110 V to 240 V without manual switching.

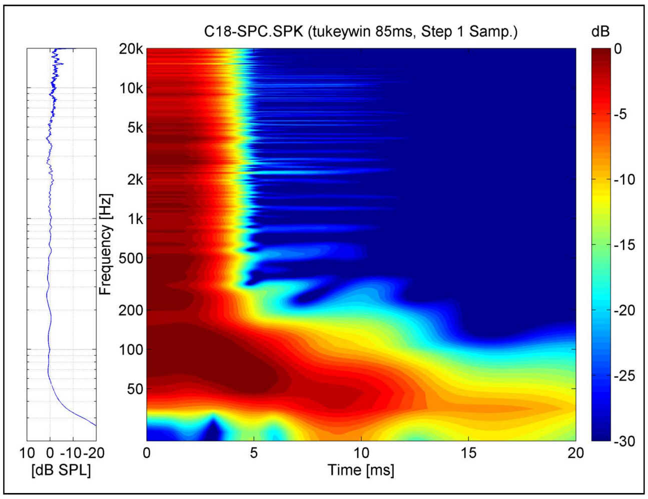
The basic settings such as gain, delay, dispersion angle and tilt angle can be made directly on the loudspeaker with the help of a few buttons and the corresponding display. A more comprehensive configuration and monitoring can be done via the KS Remote software.

Measurement results

A state-of-the-art loudspeaker like the CPD18 with FIRTEC™ and VALTEC™ technology inevitably arouses great interest in its measured values. Characteristics such as a linear phase response or variable beam steering can only be comprehensively tested and evaluated by measurement in a neutral environment (anechoic room).

Let's start with the frequency response on Axis in a setting with an 20° vertical dispersion angle and 0° tilt angle. Fig. 1 shows the response measured at a distance of 6 m without any further smoothing. The 38 Hz to 20 kHz ±3 dB specified in the data sheet are more than fully met. The response is almost perfect. The result of the measurement Fig. 2 shows how this looks in terms of measurement. From approx. 120Hz upwards, the phase response is largely constant around the 0 line. Neither the X-over functions nor the filtering for beam steering can be seen in the phase response. Thanks to the FIR filters, it is possible to perform all functions in linear phase and also to equalise the phase response of the speakers. Merely at the lower end of the frequency scale does the phase rotate 360° + 180° due to the bass reflex cabinet and an electronic high-pass filter. A linear phase-response would also have been possible here, but only with a relatively high latency due to the FIR filters in the order of 30 ms or more, instead of the 9 ms now measured.

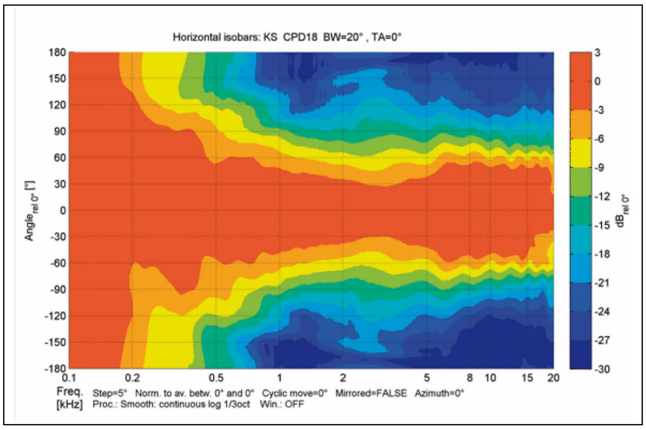
The spectrogram in Fig. 3 shows that the CPD18 is unproblematic. As usual with FIR filtering with equalisation of the individual paths, the transient-response is very smooth and free of resonances. The longer resonance at low frequencies is caused by the phase rotation of the high-pass function, which is also accompanied by an increase in the group delay time to 25 ms.



Spectrogram of the CPD18 with a consistent and smooth transient-response free of resonances. … (Fig. 3)

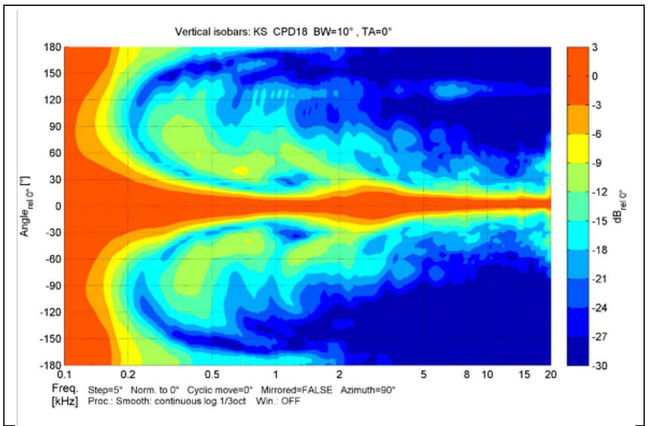
Beamforming

In terms of dispersion behaviour, there is the horizontal plane with a fixed beam angle and the vertical plane with variable beam shaping. The isobar graphs measured for this are shown in Figs. 4 -7. The measurement in the horizontal plane shows an overall even course of the isobar lines with an average beam angle (-6 dB) of 120°, which is also specified in the data sheet.

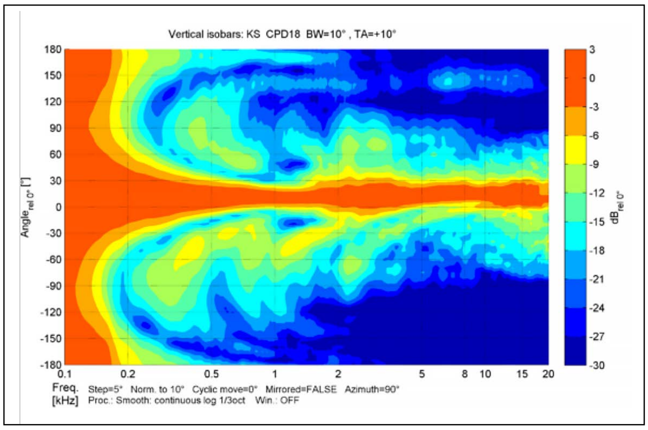


Horizontal isobars of the CPD18 with an opening angle of 120°. The isobar -6 dB is the transition from orange to yellow (Fig. 4)

It gets more interesting in the vertical plane, where three configurations were measured. Firstly, with a 10° opening angle at 0° and at +10° (upwards) tilt angle as well as at 20° opening angle with 0° tilt. Figs. 5 and 6 clearly show the 10° opening angle, which once has its centre of gravity on the centre axis at 0° and once at the set angle of +10°.

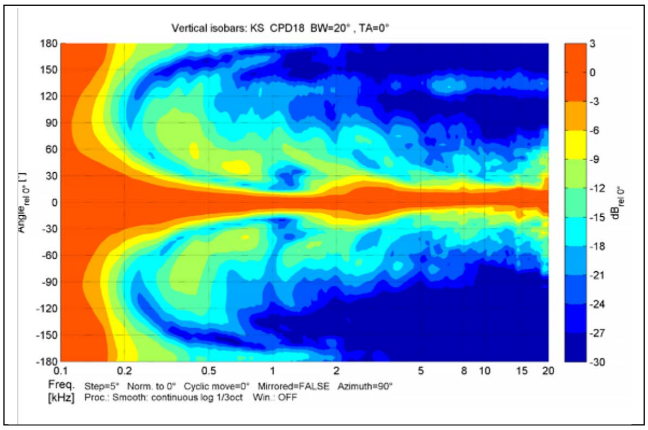


Vertical isobars of the CPD18 for a setting with 10° opening angle and 0° tilt angle (Fig. 5)



Vertical isobars of the CPD18 for a setting with 10° opening angle and +10° tilt angle (Fig. 6)

For the measurement in Fig. 7, the opening angle was extended to 20°, where the widening can be seen in comparison to the 10° settings.

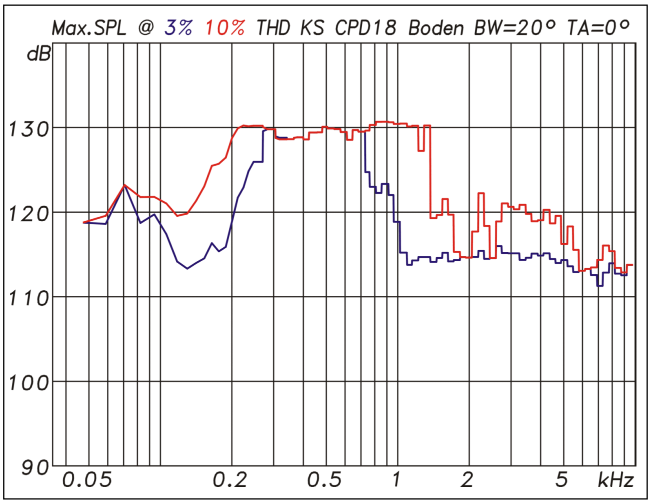


Vertikale Isobaren der CPD18 für eine Einstellung mit 20° Öffnungswinkel und 0° Neigungswinkel (Abb. 7)

In all three vertical isobars it is also noticeable that there are no lateral side maxima in the working range of the tweeter. This would not have been possible with an array of many small individual sources. Below 2 kHz, where the eight midrange drivers take over the sound reproduction as a line of individual sources, slight sidelobes can be detected, which, however, remain 9 dB or more below the value on the centre axis and are thus largely negligible.

Maximum SPL

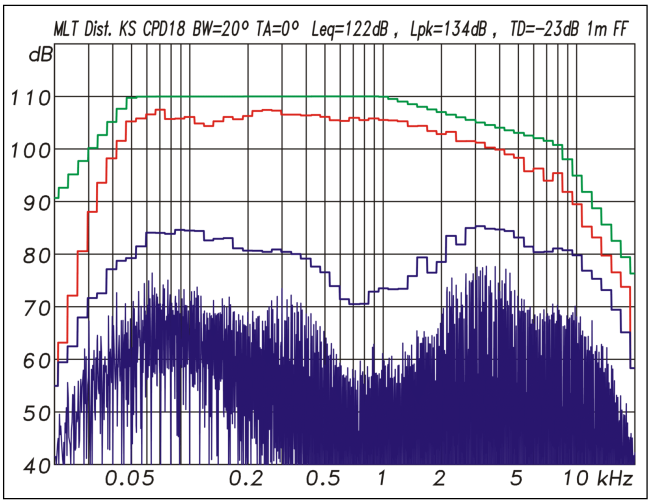
For the measurements to determine the maximum SPL, the two usual methods were used; sine-burst and the multitone signal variant. The measurement of the sine-burst determines the level possible at a defined maximum distortion value in relation to a certain frequency. Measurements are taken at a frequency at which the level for the 185 ms long burst is always increased until a predefined distortion limit is reached. The level is increased in 1 dB steps. The frequency steps are 1/12 octave. Fig. 8 shows the result for the CPD18. The red line indicates a distortion value of 10% measured between 50Hz and 10kHz, the blue line indicates a distortion value of 3%. Based on this measurement, possible weaknesses in certain frequency ranges would be easy to identify. Individual dips in the curve are not visible here. However, it is notable, that there is a +10 dB jump from 200 Hz to 1.5 kHz, and thus exactly in the frequency range of the midrange drivers. For the woofers, as well as for the tweeter, it can be assumed that a limiter already intervenes for the 185 ms burst, which prevents clipping of the power amplifiers and/or overloading of the tweeter driver.



Maximum level of the CPD18 referred to 1 m distance in free field with maximum 3% (blue) and maximum 10% (red) distortion. Beam setting: 20° vertical dispersion angle, 0° tilt angle (Fig. 8)

In practice, therefore, the multi-tone measurement is much more meaningful, using a test signal whose spectrum corresponds to that of an average music signal. At 12 dB, the crest factor (ratio of peak value to effective value) of the test signal is quite close to a music signal that is not too heavily compressed, so that the distortion-free reproduction of signal peaks is primarily evaluated here. The multitone signal consists of 60 sine signals with random phase and frequency spacing of 1/6 octave. The evaluation is simple with an FFT measuring system with synchronous measurement, in which all components not belonging to the excitation signal and thus the distortions are set in relation to the total signal. Both harmonic distortion (THD) and intermodulation distortion (IMD) are captured. Both together are also called Total Distortion (TD). The distortion limit for this type of measurement was also defined at 10%.

Fig. 9 shows in 1/6 octave bands, the signal spectrum (green), the reproduced total signal (red) and its distortion components (blue). With 7% total distortion, the CPD18 achieves an average level Leq of 122 dB and a peak level Lpk of 134 dB with this measuring method, both related to a distance of 1 m in the free field under full-room conditions. A measurement for 10% distortion was no longer meaningful, as the limiters already kicked in noticeably here. The peak value of 134 dB measured in this way largely corresponds to the value of 133 dB from the data sheet.



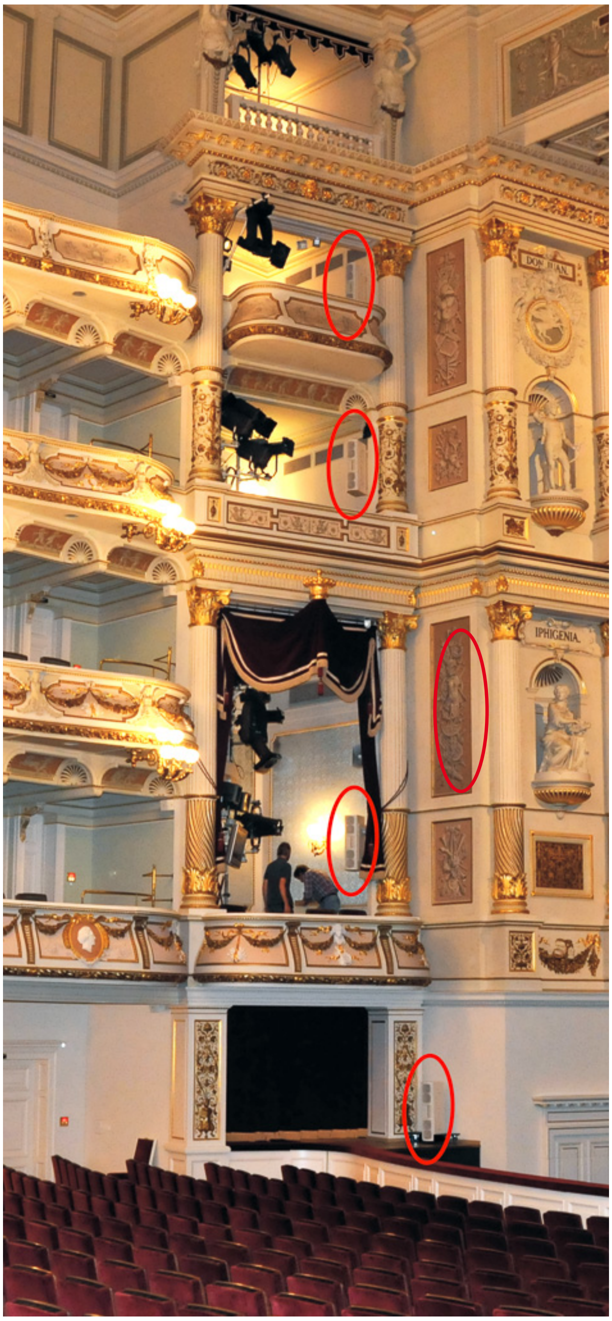
Multitone measurement with an EIA-426B spectrum (green curve). In relation to 1 m free field, 122 dB average level (Leq) and 134 dB peak level (Lpk) are achieved with -23 dB total distortion (TD) (Fig. 9).

Listening test and conclusion

The CPD18 has already demonstrated its capabilities in the test lab. A linear frequency response from 38 Hz to 20 kHz in amplitude and phase, an even and easily adjustable dispersion behaviour without artefacts as well as a high maximum level of 134 dB peak speak for themselves as key data. Dieter Klein, who had personally come to the test appointment with the

CPD18s, then, of course, did not miss the opportunity to do a little listening session with us after the measuring procedure. The result clearly reflected the measurements. Everything was just right, down to the smallest detail. Neutrality, imaging, precision and everything else was exactly on point, as one would expect from a very good studio monitor. The difference, however, is that the CPD18 can do it all at PA volume. For small concert stages and theatres, the CPD18's capabilities combined with its slim, unobtrusive appearance make it an ideal choice. If you want to have even more reserves, you can add a subwoofer, which can then also provide the required foundation in the low bass for EDM and special effects.

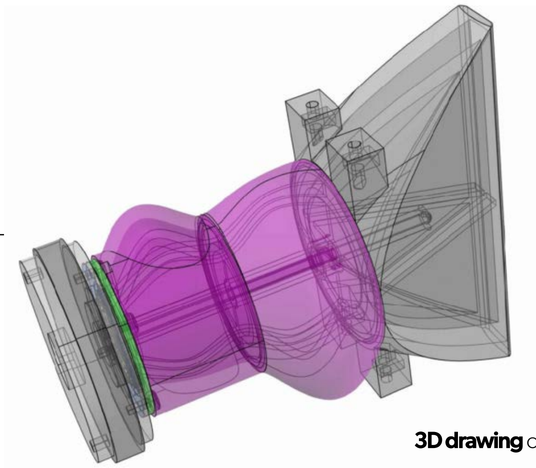
The CPD18 features a lot of modern loudspeaker technology, equipped with 13 high-quality drivers from well-known manufacturers and an amplifier power of 3 kW, which is optimally distributed over seven active channels by a DSP system. The system features, as well as the manufacturing quality and the external appearance round off the very good overall impression. The final plus point is the price of 7,800 net, which is rather surprising - in view of what is being offered, a five-digit sum would not have been out of place.



In the Semper Opera, Here, five CPD14s per side provide sound for the stalls and the rings; the box for the second ring is not visible and is built into the wall behind the picture; the CPD14 is a small version of the CPD18 without variable beam steering

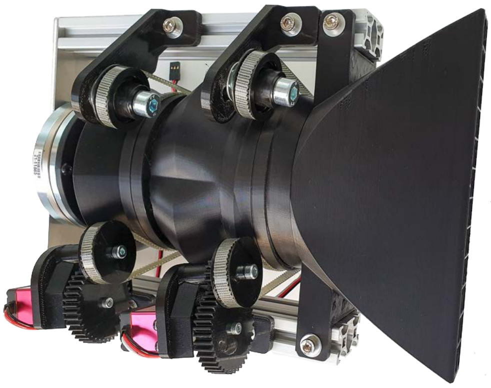
VALTEC™

The designation VALTEC™ stands for "Variable Acoustic Lens Technology" and makes it possible to adjust the opening and inclination (tilt) angle of the sound dispersion from a line source in the path of the sound via two "acoustic lenses". In detail, the acoustic lenses are circular shaped waveguides whose diameter increases towards the centre. Now, however, the individual centre points of the rings are not arranged on a straight line, but on a specific point of each outer radius. The driver radiates into the first acoustic lens, whose output is directly connected to the second lens, which then acts on the waveguide, which finally performs the transformation to the line source. The diversions of the soundwaves through the bellows of the lenses creates the shape of the wavefront of the line source. Depending on the angle of rotation of the acoustic lenses to each other and to the front waveguide, the curvature and angle of the wavefront emerging from the waveguide can be adjusted. The 3D drawing of the VALTEC™ waveformer shows, viewed from left to right, first the driver, then the first acoustic lens, followed by the second acoustic lens and the final waveguide for creating the line source.
The drawing clearly shows that the bellies are only on one side of the lenses. If one now change the setting, respectively rotate the lenses with respect to each other and with respect to the waveguide, so it becomes possible to create a line source where the shape of the wavefront can be changed.



3D drawing of the variable VALTEC™ waveformers

The 3D-printed acoustic lenses are rotatably mounted between the driver and the waveformers and can be rotated into the desired position by two small motors from model making via toothed belts.



VALTEC™ waveformer with two servomotors

VALTEC™ is used in the CPD18 to variably adjust the vertical dispersion angle and tilt angle of the built-in tweeter. In KSs VC LINE Array, the curvature of the wavefront can be optimally adjusted from 0° to 15° for each individual element in the array, depending on the angle to the next speaker. Gaps in the line source at large box-to-box angles or overlaps at small angles can thus be avoided.