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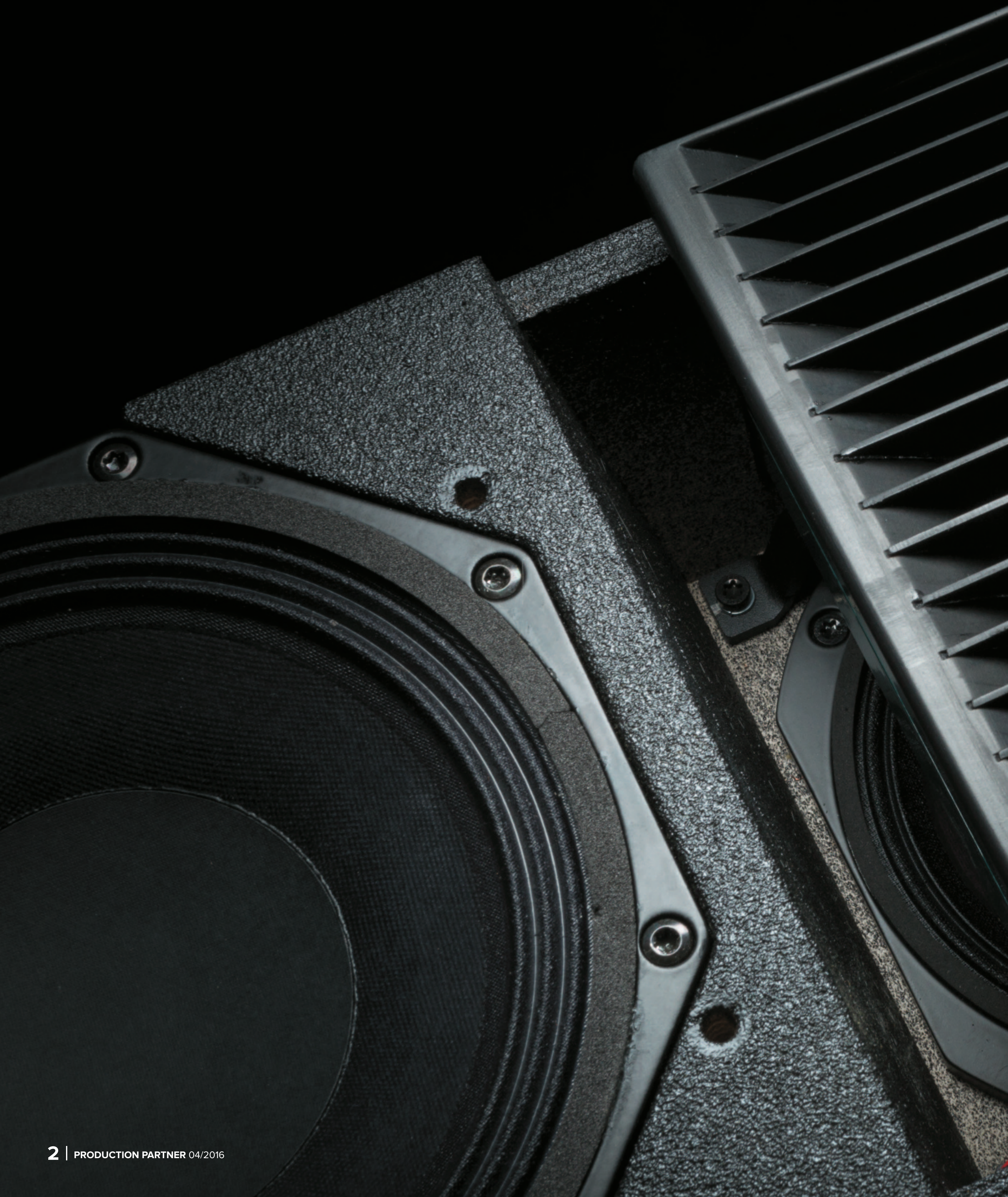
Line-array with co-axial mid-high frequency unit

Alcons Audio LR18

Between LR16 and LR28 Alcons positions its latest compact 3-way mid-size line array with ribbon tweeter. Its special feature: A fully symmetrical / coaxial design..

Text and measurements: Anselm Goertz | Photos: Dieter Stork, Detlef Hoepfner, Alcons Audio (1)

» … With the LR18 Alcons expands its line-array range with a medium sized model that is positioned between the compact models LR7, LR14, LR16 on one hand and the large touring system LR28 on the other hand. …«



Drive *The LR18 is equipped with a 7"-ribbon tweeter with 90°-waveformer for the horizontal plane, a 6.5" midrange driver and two 8" woofers: An arrangement completely symmetrical with respect to the central axis with outer-positioned woofers and a coaxial arrangement of midrange and tweeter*

The midrange *is behind the tweeter together with its waveguide - everything together works as a kind of band-pass chamber in front of the midrange, that (suitably tailored) increases the sensitivity significantly*

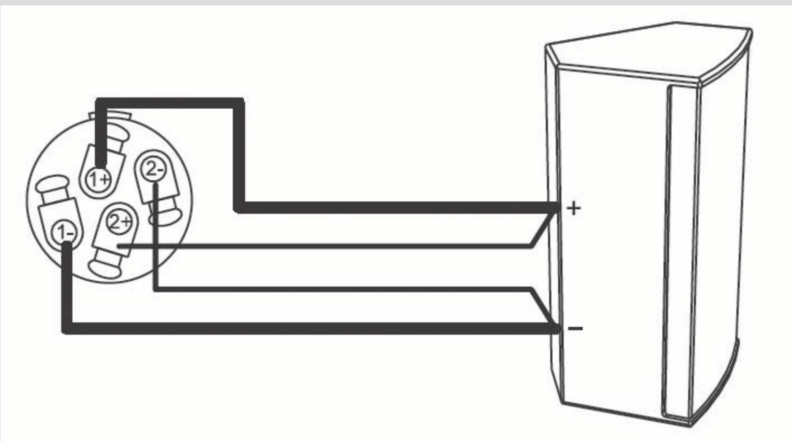
Resident in the Dutch town of Zwaag, manufacturer Alcons Audio was founded in 2002 and since then has been continuously expanding its speaker program. This includes line arrays in all sizes, classic point-source speakers and a complete line of subwoofers. The unique feature of almost all Alcons Audio speakers is the high power (pro-)ribbon tweeter, which is built at Alcons in sizes from 4" to 18". This ribbon-driver incorporates the development work and various patents of head of R & D Philip de Haan, who has been involved with this topic for over 20 years. Alcons products have obtained a solid reputation, next to the known big names in the scene, specifically there when it is about demanding sound projects of all kinds. This applies to both mobile applications as well as to fixed installations. In recent years, co-owner Tom Back and his team succeeded in establishing another presence in addition to the traditional PA products, with cinema systems in every size, in which of course also the ribbon technology is deployed. Also here it was not long before the Alcons cinema systems earned a special reputation. What is it based on? With Alcons Audio this is most certainly the technical specifications, and in particular the ribbon tweeter. With its extremely powerful drive it stands out, besides only

Alcons Audio LR18 *After removal of the front grille*

two other models, noticeably from the many conventional ribbon tweeters on the market. By its principle, this type of tweeter provides several advantages over conventional compression drivers, due to the lack of compression chambers and phase plugs, most noticeably resulting in lower distortion values. When it is about line arrays, the ribbon tweeter can bring even more advantages to the table. By design, one has already the ideal line-source to start with, where others need to try to reproduce this, or come close to, with waveformers, etc. Since the complete development and manufacturing takes place in Zwaag by Alcons, the ribbon tweeter can be designed and produced to the desired length for the specific configuration. The system featured in this test is the brand new LR18 line-array. It is equipped with a 7"-ribbon tweeter with 90°-waveformer for the horizontal plane, a 6.5" midrange driver and two 8" woofers: The configuration is completely symmetrical with respect to the central axis with outer-positioned

Loudspeaker with sense-lines

Graph caption: Sense system with return lines from loudspeaker to amplifier. With the help of the sense lines, the signal is returned from the speaker terminals to the power amplifier so that the amplifier can compensate the cable

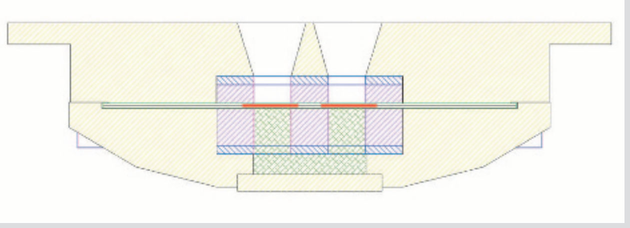


Sense system *with sense wires from loudspeaker to amplifier*

resistance. Signal losses occur of course anyway, since the current must flow through the cable to the speaker. However, the amplifier can now bring its high damping factor to the speaker terminals, by means of the sense lines. The speaker thus operates independently of the cable length to a quasi ideal source with an internal resistance, close to zero. The latter is especially important for the woofer and midrange, that enjoy an optimal electrical damping. The same is true for the passive crossover in the LR18, where with the help of the almost perfect zero ohm source at the input of the passive crossover, crosstalk between filter paths is reliably prevented. To connect the amps with the sense system, special cable types with four thick lines for the loads and four thin for the sense system can be used, as almost no current flows through the sense leads.

Ribbon tweeter: simple and effective

Graph caption: Ribbon tweeter in section with magnet assembly and membrane (red) The principle of the ribbon tweeter (planar-magnetostat, isophase tweeter or however described) is as simple as it is effective; On the extremely thin film membrane, fine conductors are applied as close to one another as possible, through which the current flows. Within a magnetic field thus the driving force arises



Ribbon tweeter *section drawing, illustrating magnet arrangement and membrane (red)*

that moves the diaphragm. As such, the drive principle corresponds to that of a conventional electrodynamic loudspeaker, in which the voice coil however is moving in the air gap, and next the force must be transmitted from the coil to the diaphragm. Since the coil engages only at the edge of the membrane with a "normal" loudspeaker, it only follows the movements within limits and forms break-up depending on the frequency. Particularly serious are these problems in HF drivers whose 3" or 4" large membranes are actually unable to cope with the frequency range beyond 10 kHz.

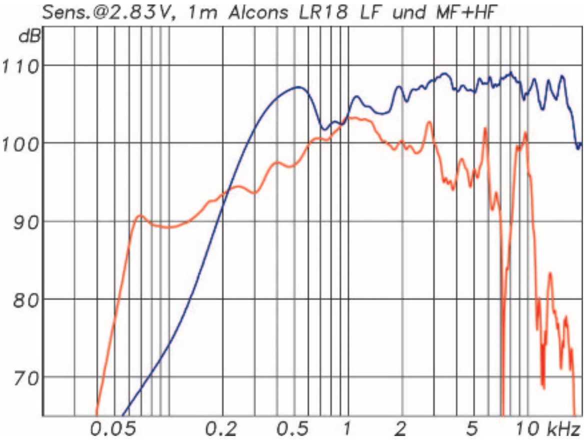
In a ribbon loudspeaker the voice coil – descriptively spoken – is situated on the membrane surface in unwound form. Accordingly, the drive forces are uniformly distributed over the entire membrane surface. So break-up arises far outside the audible frequency range only. It should not be concealed, however, that also with ribbon speakers longitudinal and transverse resonances occur on the clamped membrane. The diaphragm of a ribbon loudspeaker oscillates as a long narrow strip, and thus emits a cylindrical wave with the height corresponding to the membrane length. In the horizontal plane, the dispersion is determined by the width of the membrane so that only at higher frequencies a recognizable narrowing occurs. The magnetic field may be generated either from the front and the rear of the membrane, or exclusively from behind the diaphragm positioned magnets. The latter has the advantage that no magnets in front of the membrane disrupt the sound propagation. With only minor excursions the driving force becomes already non-linear.

The reproduction of high frequencies requires only little excursion and is also particularly vulnerable to disturbances in the sound projection, so that the one-sided magnet arrangement is strictly suitable for pure high-frequency transducers. If one doesn't want to be limited to only the highest frequencies, then a larger area and / or more excursion is required, with which one arrives automatically at the double-sided magnet assembly. This is the same with the Alcons ribbon tweeter, which, due to its long and narrow shape of the radiating surface, has a narrow magnet in front of the membrane. In total there are three rows of magnets in front of and behind the membrane.

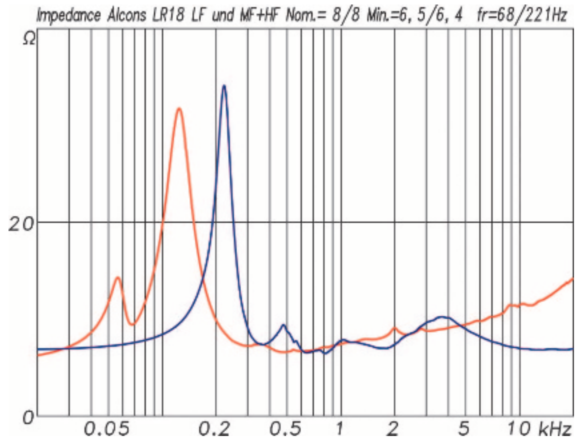
woofers and a coaxial arrangement of midrange and tweeter. The two signal paths are filtered passively. From the outside, the LR18 behaves as an active 2-way system. Connection is via NL8 Speakons with link-connections. The eight lines are used for two amplifier channels with sense lines.

Underlying: component performance

As always, the individual paths of the system were measured in the laboratory, first straight without crossover, with which the performance of a system can be judged best. The two 8" woofers play down to 60 Hz without any problem, with a tuning frequency of the bass reflex system of 68 Hz. From 150 Hz the sensitivity curve starts to increase from 90 dB to 103 dB at 1 kHz. The filtering of the mid-high section formally starts already at about 350 Hz. However, above the crossover frequency there is still a fairly wide overlapping area where the low-frequency section is still well-used. So some extra output can be obtained and the smooth roll-off of the woofer is for the horizontal directivity control very



Frequency response *with sensitivity at 2,83V/1m for the LF- (red) and MF+HF section (blue) (Fig.1)*



Impedance response *of the LF- (red) and MF+HF section (blue). Both ways are 8 ohms systems with uncritical impedance minima. The woofers are mounted in a bass reflex box with 68 Hz tuning frequency (Fig.2)*

useful. In addition to the frequency response also the impedance curves of Fig. 1 reveals something. Both ways are nominal 8-ohm systems with well-tolerated minimums of 6.5 and 6.4 ohms. On the accompanying proprietary system amplifier, up to three units can be operated in parallel, each two channels. Also from the impedance curve can be seen that the resonance frequency of the midrange is about 210 Hz. With an average of 106 dB between 300 Hz and 18 kHz, the sensitivity of the mid-high section with an internal crossover at approximately 1 kHz, is very high, so that with 1 kW amplifier power a calculated peak level of 139 dB is possible.

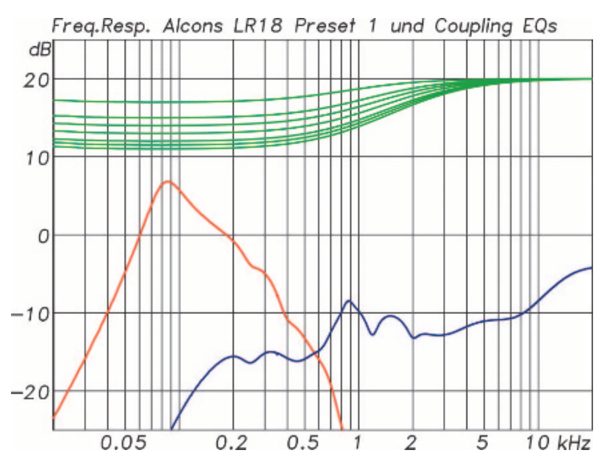
Sentinel amplified loudspeaker controllers

Within the meaning of "System Philosophy", Alcons offers the proprietary Sentinel amplified loudspeaker controller for all speakers. With the Sentinel 3 and Sentinel 10 there are

Sentinel10 controller amps *in our test set-up*

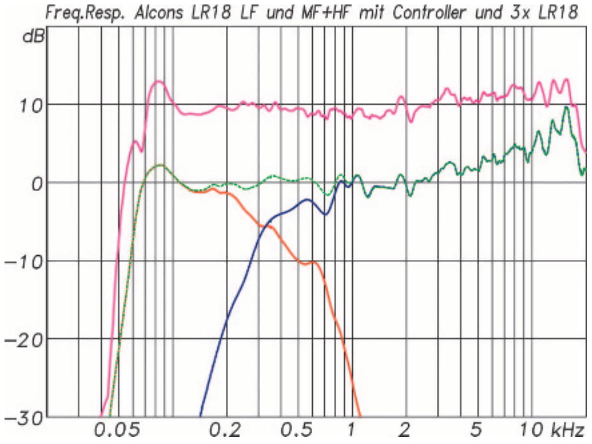
Control surface *of the ALControl software with Groups and EQ windows (Fig.3)*

Angle-setting *mechanism and rear of the LR18*

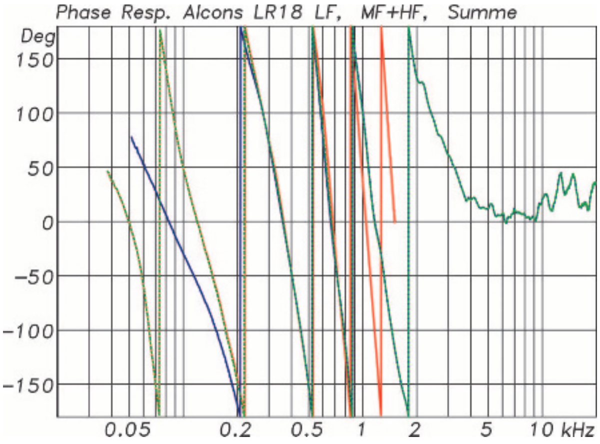


Filter curves *in the controller-amp for the LF (red) and MF+HF sections (blue). Coupling filter for larger arrays in green (Fig. 4)*

two four-channel models with 4 × 750 W and 4 × 2.5 kW output. The amplifier stages are obviously class-D type with HF switching power supplies, so that the 10 kW are efficiently-packed with 11.6 kg / 25.6 lb and 2U. The integrated four-channel DSP has four analog and four digital (2 × AES / EBU) inputs that can be assigned to an input and output matrix. The amplifier can thus take over the complete controller functions for all types of speakers. The power supplies accept all available worldwide mains voltages without manually switching by the user. A redundancy is available with two power supplies, so that in case of failure of a power supply, the output stage will continue to operate at half power. The operation of the power amplifiers and the integrated controller can be done either through the user interface on the device with a large TFT color touch screen or through control software. In the amplifier itself, a Linux-based micro-computer operates to manage and control all functions. Individual Sentinels can therefore be accessed with a simple VNC app from any preferred device. For more complex systems, networking of the amplifier is recommended with ALControl software for Windows or OS X, with which even group formations and detailed monitoring is possible.



Frequency response *of one single LR18 with controller. In red the low- and in blue the mid-high section. Summed response in green. With three systems (rose), Preset1 gives a linear response (Fig. 5)*

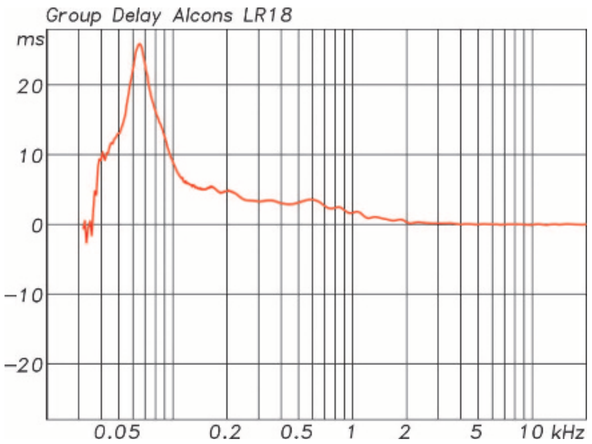


Phase response *of the LR18 with controller. In red the low frequency and in blue the mid-high frequency section. Summed response in green. Only through the use of all-pass filters it is possible to obtain an overlapping phase response for the extended transition area between woofer and mid-range (Fig. 6)*

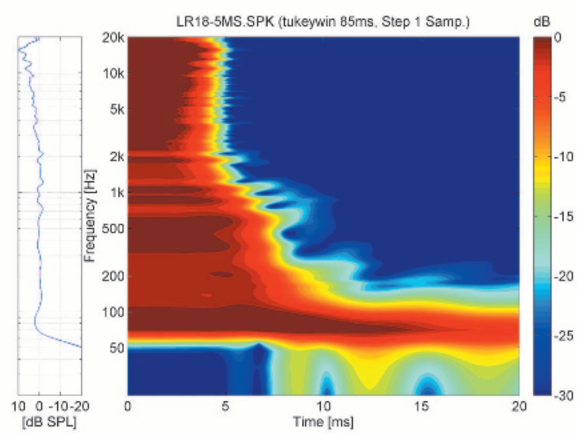
For the operation of the LR18, the Sentinel 10 is recommended, which can supply and fully utilize a maximum of six LR18. The available presets are designed for three or more LR18 in an array. Fig. 4 shows respective filter curves for the woofer and the mid-high section. In green the additional coupling filters for larger arrays with more than three units.

LR 18 with controller

The cooperation between LR18 with the Sentinel 10 is shown in Fig. 5: With only one box measured, the summed frequency response shows a rising towards the high frequencies, that compensates exactly with three units. In the



Group delay *derived from the phase response in Fig. 6 (Fig. 7)*

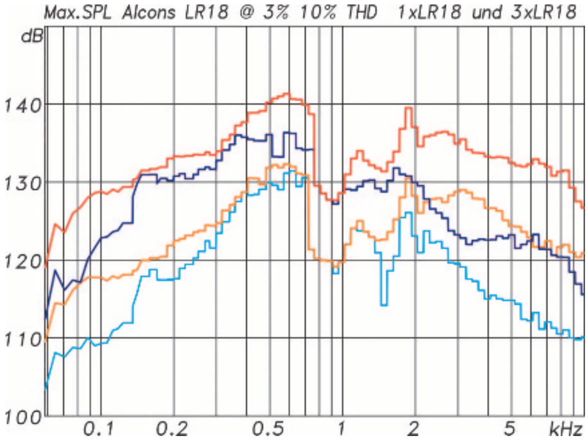


Spectrograph *of the LR18 with an immaculate response. The increase of the group delay below 1 kHz is easy to detect (Fig. 8)*

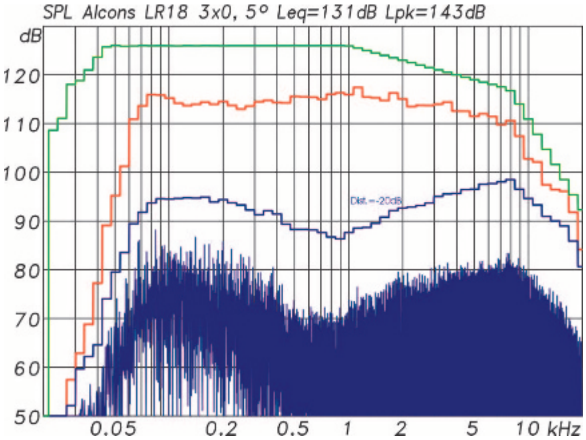
Symmetrical design *of the LR18*

response of the red and blue curves of each of the individual paths the overlapping transition area is recognizable that extends up to approximately 800 Hz. Interestingly is the phase response of the LR18 from Fig. 6. Note the strong phase shifts in the mid frequencies, which are also reflected in the group delay curve of Fig. 7. From about 1 kHz down the group delay increases. The reasons can be found in two all-pass 4th order filters, needed to match the phase response of the woofer and the midrange over an unusually wide frequency range. That is necessary because of the overlapping opera-

Laboratory *preparation of our measurements on an LR18 with laser pointer, the measurement microphone lies on the floor on the right in the back.*



Maximum output *for one and for three units LR18 at maximal 3 % (light and dark blue) and at maximal 10 % (orange and red) distortion with 185 ms sine burst measurements (Fig. 9)*

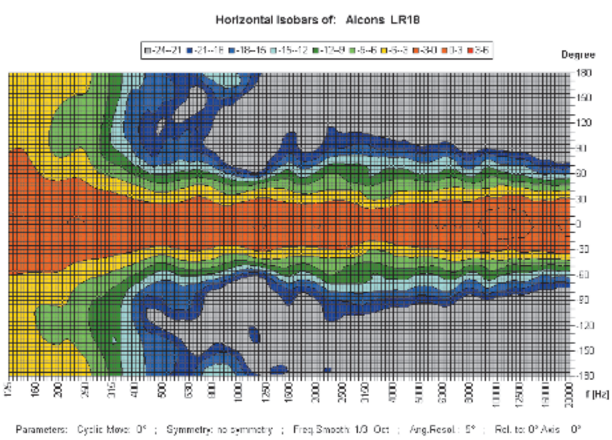


Multitone measurement *with three units LR18 at 131 dB average level and 143 dB peak level with respect to 1 m free field distance. Distortion ratio of total harmonic and intermodulation distortion is -20 dB corresponding to 10 % (Fig. 10)*

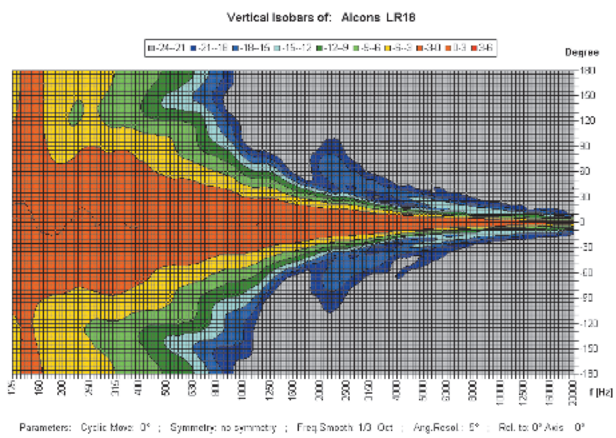
tion that works only when the phase characteristics of the two paths involved are identical. Otherwise there would be unwanted interference phenomena.

Maximum possible SPL

For the distortion measurements, the two usual methods of measurement with sine bursts and a multi-sine-wave signal have been applied. First we consider two series of measurements from Figure 9 in which the distortion limits of 3 % and 10 % are specified and then was determined, what maximum sound pressure level the speaker thereby achieves at 1 m / 3 ft. distance under free-field conditions. The measurements were made with 185 ms sine-wave burst signals. The otherwise usual additional power limitation did not exist here, because it must be assumed that in an active system with



Horizontal isobarics *of the LR18 with near perfect response already from 300 Hz upwards (Fig. 11)*



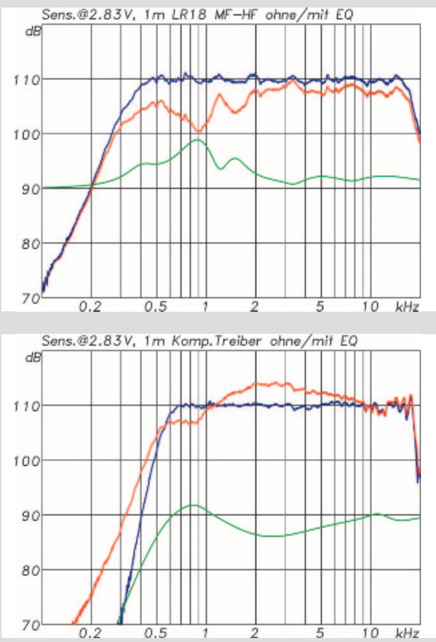
Vertical isobarics *of a single LR18 with the "perfect needle" (Fig. 12)*

Ribbon coax compared to conventional compression drivers

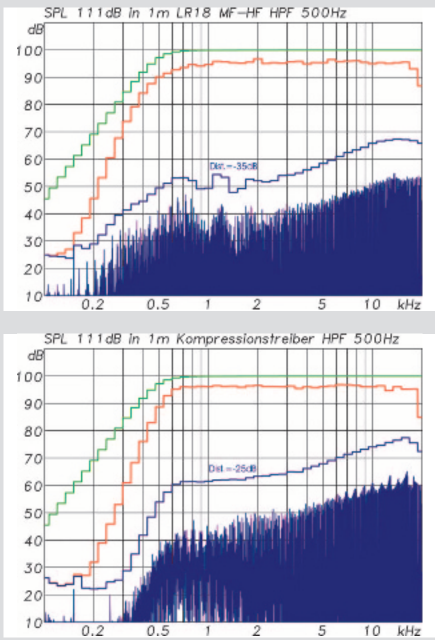
Separately from the test of the LR18, we already carried out a series of measurements at various compression drivers at the end of 2015. For comparison of fundamentally different concepts, the mid-high section of the LR18 was included in the test series.

For all drivers, we first determined the frequency response and then derived therefrom each individual EQ-settings, that generated a flat frequency response for all drivers. The red curves in the diagrams show the frequency response of the bare driver with the sensitivity of 2.83 V / 1 m. Both the compression driver as well as the LR18-mid-high section are 8-ohm systems, so that the 1 W / 1 m value is equivalent. The green curves show the selected filters and the blue curves the driver with filter. The compression driver received in addition to the EQs a 4th-order high pass filter in the signal path at 500 Hz. With the LR18 MF + HF combination this was waived, since the measurement signal was already band-limited to 500 Hz downward. With this setting, the target was to achieve a sound pressure of 111 dB average and 123 dB peak, based on 1 m distance. As a test signal a multi-sinus with random phase, a linear frequency response and a 4th order high-pass filtering at 500 Hz were used. The signal has a crest factor of 12 dB, which is already very close to a real music signal.

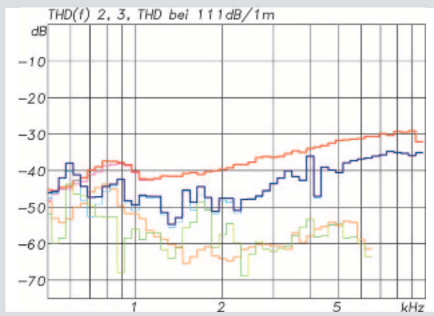
The respective green curves in the following figures show the spectral curve of the test signal. With this signal, both candidates delivered a 111 dB sound pressure at an identical flat frequency response. For the compression driver, an average power of 0.77 W was required and for the LR18 combination 2.5 W to drive it, as here, the sensitivity dropped slightly against the compression driver. Important here is the aspect, to compare at the same volume level and the same frequency response (and not at the same terminal voltage), because the sound pressure is the final key comparison value. The blue spectral lines or their 1/6-octave-summed curves represent the distortion components in the signal. If



Frequency *response and sensitivity of the LR18 mid-high section (upper) and of the compression driver (lower) in red and with filtering (green) for a flat frequency response (blue)*



Multitone measurement *of the LR18 mid-high section (upper) and of the compression driver (lower) respectively at 111 dB average level (red) and 123 dB peak level, related to 1 m / 3 ft. distance. In green the filtered measurement signal with a 500 Hz high-pass. THD and IMD distortion components in blue*



THD, k_2 and k_3, *LR18-combination and compression driver compared*
Compression driver:
THD (red), k_2 (magenta), k_3 (orange)
LR18 mid-high section:
THD (blue), k_2 (light blue), k_3 (light green)

one sums all distortion components and puts these in relation to the overall signal, then the result with this measurement for the compression driver is -25 dB (= 5,6 %) and for the LR18 mid-high section -35 dB (= 1,8 %) Included in this type of measurement were both the harmonic distortion components as well as the intermodulation products.

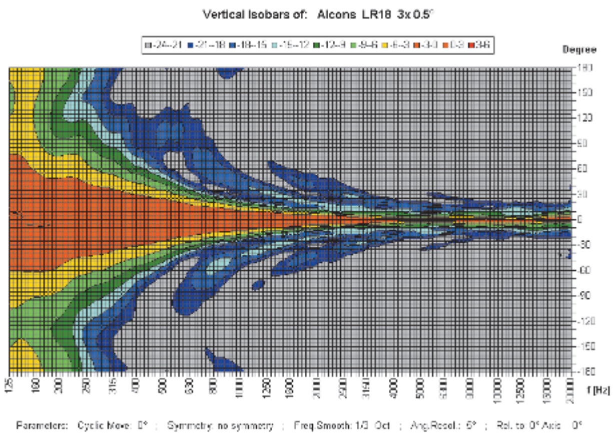
With 10 dB lower distortion, the combination of ribbon tweeter and midrange cone driver wins, with the same sound pressure level and frequency response. The compression driver shown here is a 1.5" driver with 4" voice coil, neodymium magnet structure and beryllium membrane, which for years is the best what driver manufacturers have to offer. For the test, all compression drivers have been loaded with a spherical wave horn with 500 Hz lower cut-off frequency.

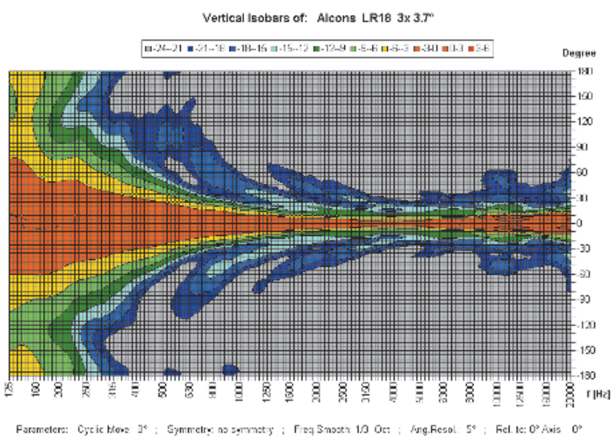
The result of these measurements is two: The approach of Alcons offers advantages in terms of distortion, even if this involves slightly more amplifier power is required. The compression driver distorted more than expected, so other aspects need to be explained. Measurements were taken not only from the drivers shown here, but also various other types, up to the historical 2440 2" JBL drivers. Of each driver two copies were measured to exclude possible aberrations or defects.

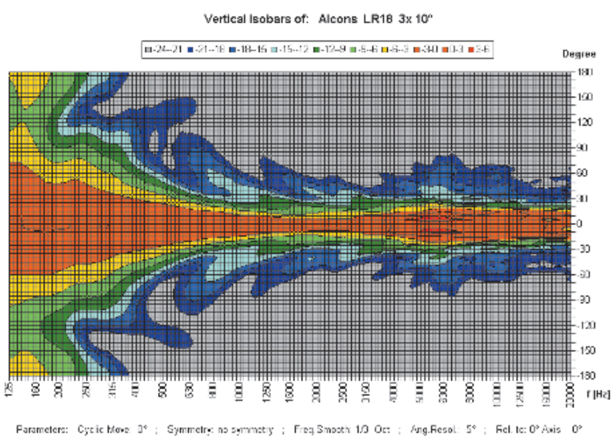
The recognizable behavior of the compression driver shown here, also showed in all other compression drivers without exception. A pure THD measurement versus frequency, also at 111 dB SPL, brings further insights. The THD curve of the compression driver is highly k_2-dominated, the k_3 curve is 20 dB or more below and the k_2 curve steadily rises towards high frequencies. Both indicated nonlinearities of the air as a cause, as there are extreme sound pressure levels inside the compression driver due to the high compression and the phase plug. With increasing frequency, the problem gets worse. The cause is therefore in the working principle and cannot be solved through better membrane materials or motors. A lower compression ratio would be a possibility, but then again, at a loss of sound pressure. Basically, however, it can be seen that the high-frequency reproduction with individual conventional drivers reaches its limits here. If you want to achieve higher sound pressure levels, then multiple drivers need to be combined, such as in line arrays. On the other side one should also not overlook the fact that 111 dB with a sine-wave signal or 123 dB peak level with a multisinus already are very high sound pressure levels.

The combination with the ribbon tweeter from the LR18 has at this point a great advantage, as there is no compression chamber and it also doesn't need any phase plugs. The THD curves are correspondingly more favorable. In the response, the curves with this combination are less smooth, which is an indication that not a single cause is dominant here, but several aspects are of influence.

controller, the system is fully protected by limiters. Where both curves come together the measurement was limited by the limiter and not by the distortion. Measurements were performed on a single LR18 and an array of three units with 0.5 ° angles between the cabinets. The curves show a nice consistent response up to 800 Hz and then again above about 1.8 kHz at a high level, that for three boxes from 500 Hz achieves a remarkable 140 dB. Between 800 Hz and 1.8 kHz there is a small weakness of a scarce 10 dB. The cause lies in the intervention of the limiter, which can be seen from the fact that the 3 %- and 10 %- curves coincide. The limiter is activated for the protection of the tweeter with the long signals used. For short signal peaks, the problem does not occur, as the subsequent measurement shows. This previously discussed type of maximum level measurement with sine bursts shows primarily, in which frequency ranges the speaker has weaknesses when it comes to maximum outputs, and where the reasons for the limits of the achieved level might be. For the practical result which level a speaker can provide with "normal" broadband signals, however, the multitone measurement is better suited. A total of 60 sine-wave signals with 1/6 octave distance were combined with a random phase and spectrally weighted as desired. That could be a spectrum of an average music signal according to EIA-426, a speech spectrum or an equal weighting (and thus a pink signal). The crest factor of such a synthesized signal is approximately 12 dB and is therefore also very close to reality. If you send such a signal through the speakers, then the







Vertical isobars *of three LR18 with angles of 0.5 °, 3.7 ° and 10 ° between the units. The perfect behavior of a single LR18 is, as expected, continued (Fig. 13)*

distortion components in the frequency range can easily be evaluated by simply subtracting all spectral lines of the excitation signal and the rest is brought in relation to the total signal. Since these are now no longer single-frequency signals, all intermodulation distortions (IMD) can be evaluated in addition to the harmonic distortion components (THD). Such a measurement provides three important values: The total distortion (THD + IMD), the achieved average sound level Leq and the peak level Lpk. Fig. 10 shows this type of measurement for an array of three LR18. The level was also so increased until a distortion proportion of -20 dB (= 10 %) was achieved.

The thus measured and to 1 m free-field related level values are 131 dB as L_{eq} and 143 dB as a peak value. The red curve shows the overall sound level in 1/6 octave frequency bands, the dark blue curve only the distortion components, that are additionally also registered as spectral lines (the sum of all spectral lines in a frequency band gives the value of the associated dark blue curve, that is then correspondingly higher than the individual spectral lines). The green curve represents the spectrum of the excitation signal according to EIA-426B. The detected weakness in the measurements with sine-wavel bursts between 800 Hz and 1.8 kHz is no longer recognizable. On the contrary even, the distortion values here are amazingly low.

Directivity

For the directivity measurements first a single LR18 was placed on the turntable. In this measurement, the horizontal dispersion and the projection behavior of the tweeter in the vertical plane are to be determined. How multiple systems behave together, cannot yet be derived from this. The figures 11 and 12 show the associated isobarics for the horizontal and vertical plane. For the horizontal plane, the 90 ° angle is achieved from 300 Hz. Further towards the higher frequencies the response is almost perfectly even. This is achieved firstly by the centrally symmetrical arrangement in which the individual paths expand in width, starting with HF to MF to LF. In addition, a clever overlap is made by the cross-over filters, so that the effective radiating surface is continuously widening towards the lower frequencies.

In the vertical plane, the LR18 is the almost ideal line source thanks to the ribbon tweeter. Also these produce inevitable secondary maxima, which correspond to those of a spatial rectangular window and thus be of the order of -13 dB from the main maximum. Exactly this can also be seen in the vertical isobars of a single LR18 in Figure 12, where at 2 kHz and rudimentary even at 4 kHz inconspicuous lateral lobes can be seen. Isobars in this form of an almost perfect needle show the feasibility for line arrays. In the next step, three LR18 were measured together. The adjustment of the angle between the two units takes place on the rear arranged mechanics, that allows a total of ten logarithmically stepped settings from 0.5 ° to 10 °.

The angles are preset without load. Once the array is pulled up, the individual systems lock into the desired angles. On the front the speakers are connected with each other by a largely inconspicuous standard mechanism with quick release pin. For simple handling of the 28 kg / 61.7 lb. light-weight box there are side handles and two additional recessed grips on the back.

The set of three was measured with 0.5 °, 3.7 ° and 10 ° angles between the individual cabinets. As expected, this also presented nearly perfect curves. The raised (blue) side lobes remain similarly weak here and move in frequency by a factor of three down with further lobes in multiples thereof. The measurements with 10 ° angles show a complete and homogeneous dispersion of exactly ± 15 °.

Accessories

Besides the LR18 discussed here, there is also an LB18 as sole bass extension to the LR18. The LB18 has exactly the same form factor and is also from the outside indistinguishable, at least at first glance from the LR18. However, the mid-high is completely absent and the woofers are tuned a little deeper. The LB18 can be used whenever more output at lower frequencies or improved vertical directivity are required.

Array *of six LR18*

Conclusion

With the LR18, Alcons expands its range of line arrays with a compact medium-sized model, positioned between the compact models LR7, LR14, LR16 on one hand and the large touring system LR28 on the other hand. Exactly in this size class, the market is likely to have the greatest demand, so that the LR18 can be guaranteed a market-strategically good starting position. Another new feature is the coaxial arrangement of the ribbon tweeter with a 6.5" cone-driver in a bandpass chamber, whereby a completely symmetrical three-way arrangement was made possible. Thanks to smart filtering between the three ways, an almost perfect dispersion is achieved in the horizontal plane, just as you would already know from the LR28. The advantages of the ribbon-concept for line array and the distortion values are already widely recognized. The LR18 and its components are thus another highlight from the development of Tom Back and Philip de Haan, for which the success in the market can be predicted. Despite the three ways, the LR18 economically only requires two amplifier channels, with a passive cross-over between MF and HF. The associated Sentinel system amplifiers can thus be optimally utilized. Considering the total price of a complete system, these aspects then relativize the, at first glance, fairly high price of the individual components.