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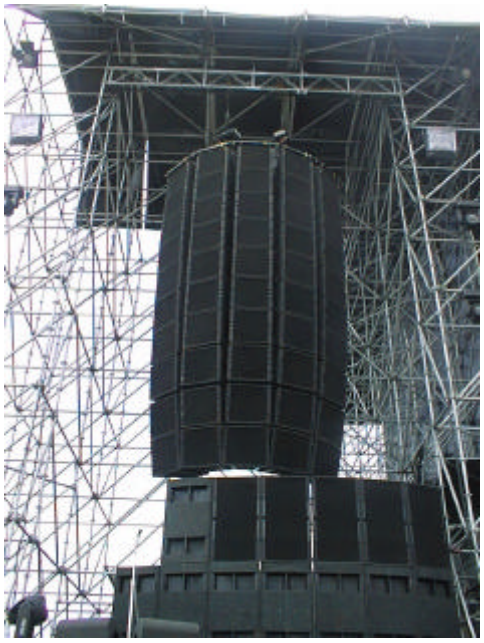
PA Test

Large-scale sound reinforcement systems



Nexo Alpha System

Nexo's Alpha System was next on the agenda of our test series of narrow-dispersion sound reinforcement systems. We tested the French high-tech company's top product both during a live gig and using our well-known series of detailed measurements.

In spring 1996, the first Alpha prototypes were on display at the Siel exhibition in Paris, and the same year Nexo could record a first spectacular success: their large-scale P.A. system was chosen for installation in the Stade de France in Paris, and the renowned English hire company SSE Hire of Birmingham opted for the Alpha. So far, Nexo have won 40 major European hire companies as Alpha customers and can today boast a long list of reference installations in concert halls and sports stadia throughout the world.

The original concept of the Alpha system, as it was exhibited at trade fair stands in 1996, only comprised the mid-range/HF cabinets and a 2x18" woofer cabinet. The crucial crossover point from an 18" band-pass system to a horn-loaded HF cabinet with a 10" driver complement was quite a headache for developers at Nexo. As it was known from other systems, the crossover zone is almost always the weak point in any such combination, in terms of sound and maximum SPL. So, the Nexo people decided to close this gap with the B1 cabinet, a combined 15"-horn/bass reflex system that produces enough power and punch and is still usable in the low-frequency range down to nearly 40 Hz.

And the B1 features a variety of additional advantages, in that it has the compact dimensions of a mid-range/HF cabinet—which makes it perfectly suited for flying applications—while it eliminates the power rating problems usually encountered in such speakers. Additionally, there is no need to compromise the adjustment of the band-pass resonators in the 2x18" woofer cabinet. To counter the higher costs that result from the use of a fourway system, Nexo can offer improved flexibility and cost reductions when no sub-woofers are required at all, or need not be flown.

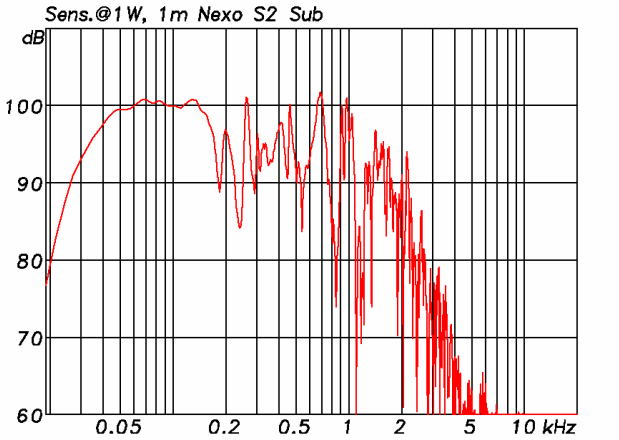


Figure 1: Frequency response for the S2 Sub Bass

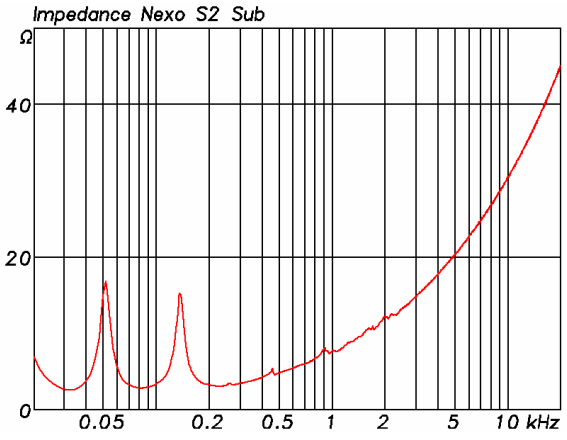


Figure 2: Impedance curve for the S2 Sub Bass

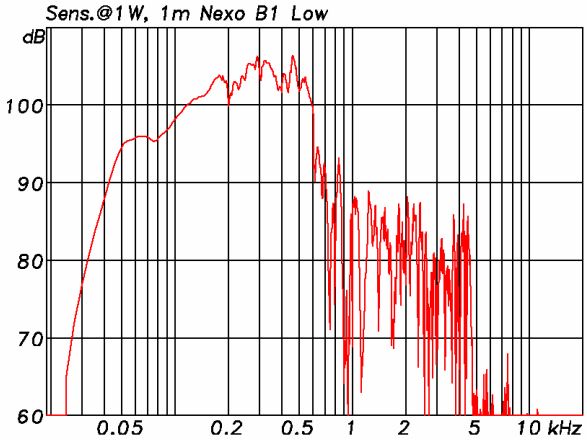


Figure 3: Frequency response for the B1 Bass

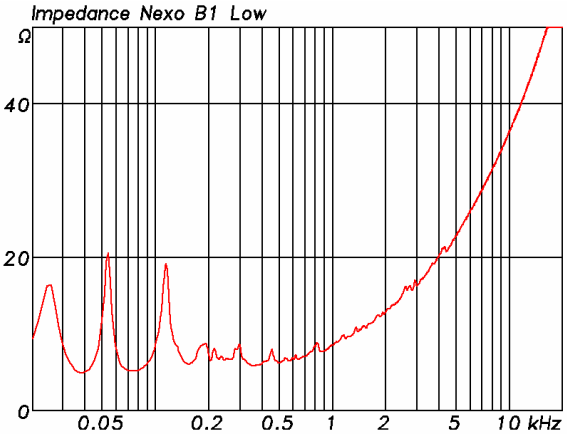


Figure 4: Impedance curve for the B1 Bass

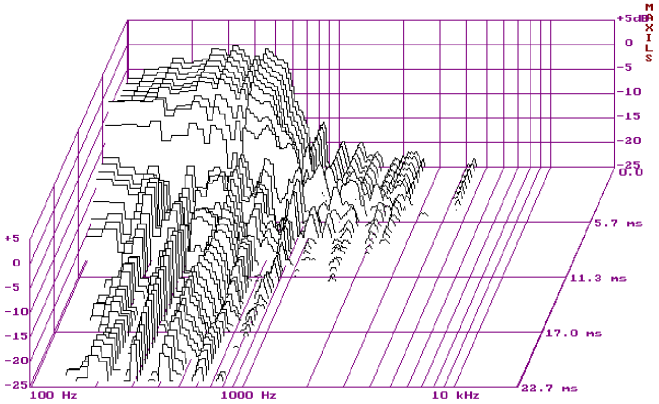


Figure 5: Waterfall Spectrum for the B1 Bass

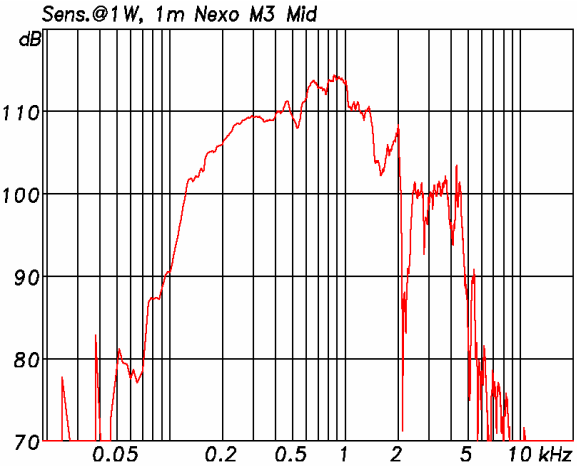


Figure 6: Frequency response for M3 Mid/Hi

System components

The Alpha system comprises a total of four speaker components and two controllers. The heart of the system are the two mid-range/HF cabinets M3 and M8 which are designed as coaxial horn speakers with a specified dispersion angle of 35° x 35° and 75° x 45° respectively. The low-frequency range is reproduced by the bass cabinet B1 which is equipped with a 15" short-horn driver. All systems (M3, M8 and B1) have identical cabinets and are very compact in size. Featuring the same cross-section but twice the height, the sub-bass extension cabinet S2 reaches down to the bottom end of the audio spectrum. However, the S2 sub-woofers are not absolutely necessary to operate the Alpha, as the B1, too, reaches down to as low as 40 Hz. All speaker ranges are designed for active operation under the control of Nexo's mono 3-way system controller which assists the two mid-range/HF cabinets M3 and M8 as well as the woofer cabinet in doing their jobs. An additional controller providing the corresponding filtering and protection circuitry is needed for the S2 sub-woofers. Rather than relying on third-party suppliers for the flying hardware, the Nexo people designed their own "Crossbow" system which is perfectly adapted to the Alpha cabinets.

Applications

The Alpha can be used in almost all fields of high-quality sound reinforcement applications. As the individual components are very compact in size, the Alpha can also be used on small stages in clubs or as side and front-fill systems.

As a matter of fact, the users of smaller set-ups also want the clear directivity of large-scale systems, a plan that is often frustrated because of the sheer size of such huge speakers. When you tour small clubs there's no way of handling Community's AirForce or JBL's HLA. The compact dimensions of the Alpha components, however, allow for smaller set-ups with two woofers and one HF cabinet per stack, and the user can even choose a broader dispersion angle (using the M8) or an extremely narrow directivity (M3), when room acoustics are difficult. Weighing only 50-60 kg, these cabinets give you no problems when you have no motorized lifters. According to Nexo's specifications, you can also go for the other extreme, i.e. stack up to 16 cabinets to form huge clusters. For example, some impressive clusters with 70 systems per side could be seen during Metallica's tour of 1996. The SSE crew's set-up time was a record-breaking two hours.

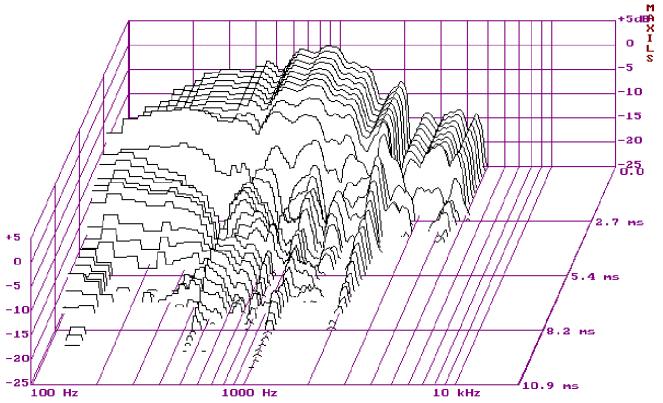


Figure 7: Waterfall Spectrum for the M3 Mid range

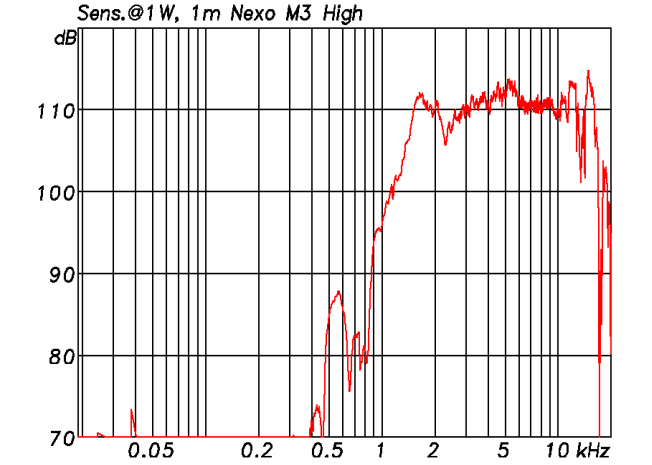


Figure 8: Frequency response for the M3 HF Horn

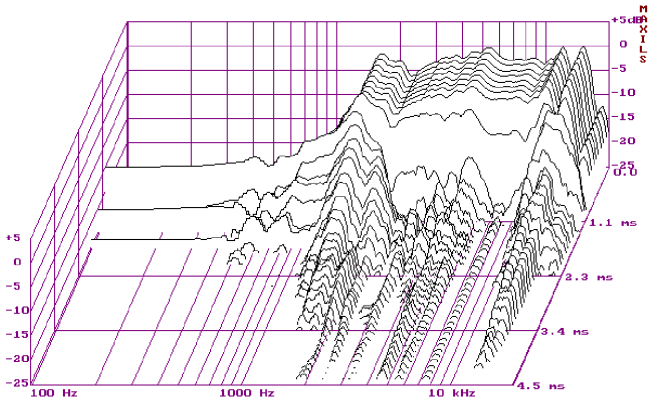


Figure 9: Waterfall Spectrum for the M3 HF Horn

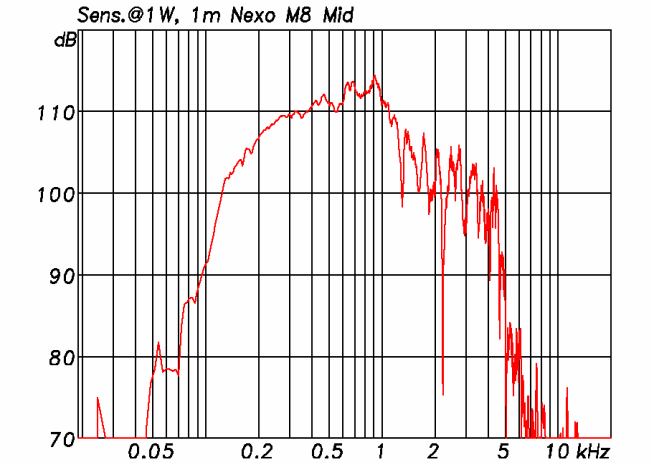


Figure 10: Frequency response for the M8 Mid range

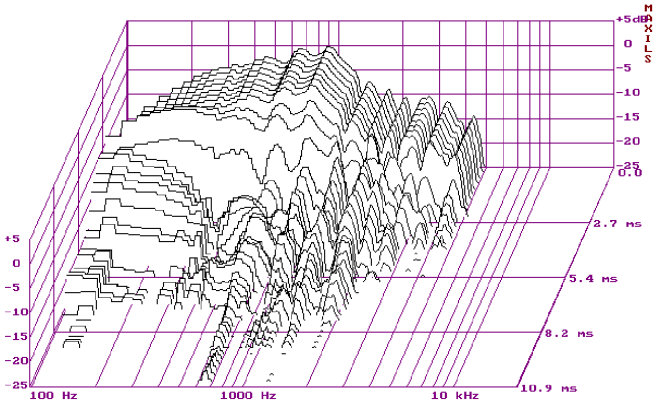


Figure 11: Waterfall Spectrum for the M8 Mid range

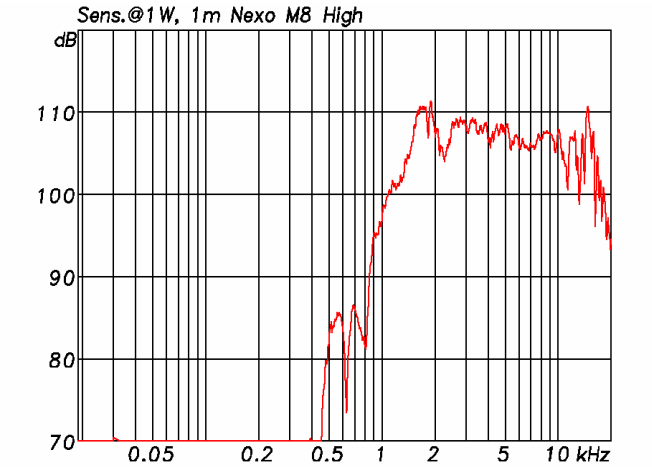


Figure 12: Frequency response for the M8 HF Horn

Flying hardware

Already at an early stage of development, there was a productive cooperation with the English hire company SSE, with regard to the flying hardware and the exterior design of the cabinets. The experience of a renowned hire company and the commitment of SSE proprietors John Penn and Chris Beale made it possible to agree on Alpha-specific developments, rather than relying on existing accessory components. Another interesting aspect was SSE's rather unusual request for a carpet finish, as such a finish had usually been rejected by hire companies before: because rough handling finishes get shabby quickly and cannot be brightened up with a bit of paint. However, the finish used for the Alpha seems to be almost indestructible, which has been proven in daily use at hire companies. A cabinet version without flying hardware and painted surfaces is available for fixed installations.

The "Crossbow" rigging system already mentioned above is based on a double T flying bar fixed to the cabinets at three points. The cabinets are fastened on the rear using a solid hinge, and are chained on the front with two steel cables. Steel rails across the cabinet front or on the inside rear wall allow for linking as many as 16 units (one S2 cabinet = two units each 60 cm high). Owing to the rear-wall hinges and the seven-increment front fixtures even curved arrays can be realized easily. With the 2°-increments vertically inclined positions between 0°and 24° are possible. As the motor-pick point on the flying bar allows for positioning the speakers through the force of gravity, rear-wall tension belts are not required. So, you can achieve a 45° curve with only six Alphas fixed on top of each other.

The horizontal angle can be set as desired thanks to the connectable flying bars. All in all, the flying hardware seems a pretty elegant solution, requires only few accessories and fixtures, and also its own weight is very low. However, there's quite a price to be paid for it: contact local dealers for current prices

Mid-range/HF cabinets M3/M8

The two mid-range/HF cabinets are coaxial horn systems with identical driver complements. The tweeter horn is a brand-new B&C driver from the 900 Series, featuring a neodymium magnet and a 3" voice coil. Owing to its small size this speaker is excellently suited for coaxial speaker arrangements. The incentive to develop this driver as well as the basic calculations for the magnet came from Nexo's development department some time ago. The larger midrange horn is driven by two RCF 10" cone speakers which Nexo modifies by applying an extra silicone layer to the diaphragm. A dual-concentric phase plug is used to link driver and horn. The M3 cabinet is specified with a nominal dispersion angle of 35° x 35° degrees, and the M8 has a 75° x 45° dispersion angle at 500 Hz and higher.

If necessary, the horn of the M8 can be rotated for improved dispersion on the vertical axis. The outside dimensions of the two trapezoidal cabinets are identical: 60 x 69 x 76 cm (HxWxD), their weight is 57 kg. The standard models have a carpet finish that seems to be very durable. Their front is protected by a foam-padded metal grille. Optionally available wheelboards can be easily quick-fastened to the front side. Owing to their low weight the cabinets can be tilted forward by a single person, once the wheelboard has been fixed. The Alpha HF cabinets are wired with 8-pin Speakon connectors which can be looped through from one cabinet to the next. The 8-conductor cable also carries the signals for the B1 and S2 woofers which are linked to the HF cabinets with 4-pin Speakon cables. Faulty connections are thus avoided, and the entire stack can be connected to the amp racks by means of one single cable.

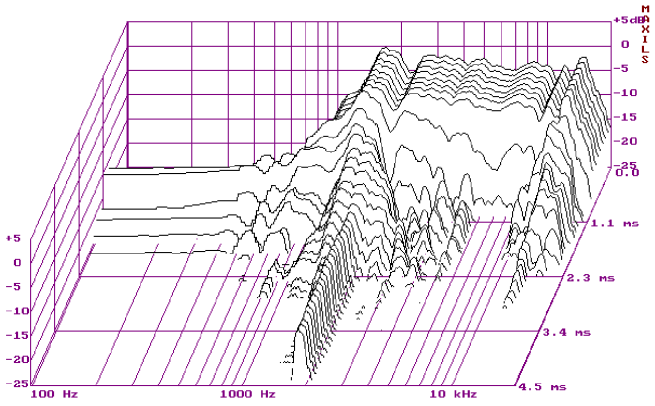


Figure 13: Waterfall Spectrum for the M8 HF Horn

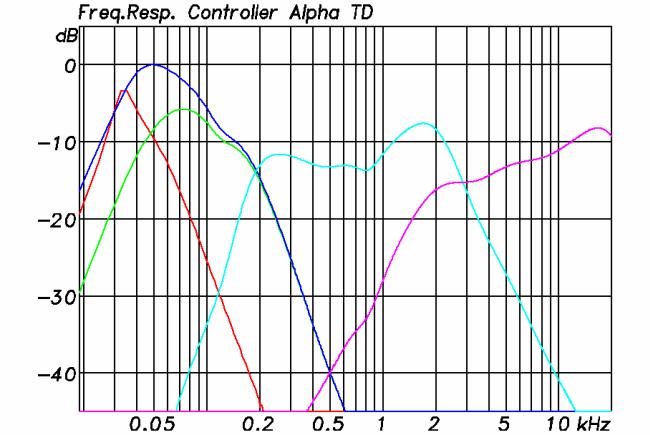


Figure 14: Frequency response with Alpha TDA + SUB.TD

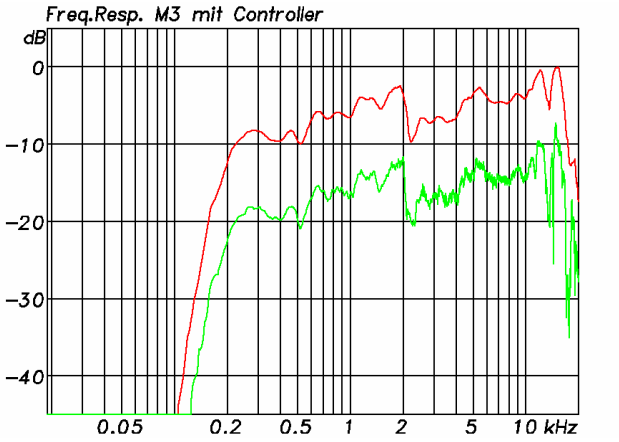


Figure 15: Frequency Response M3 Mid/Hi with Controller

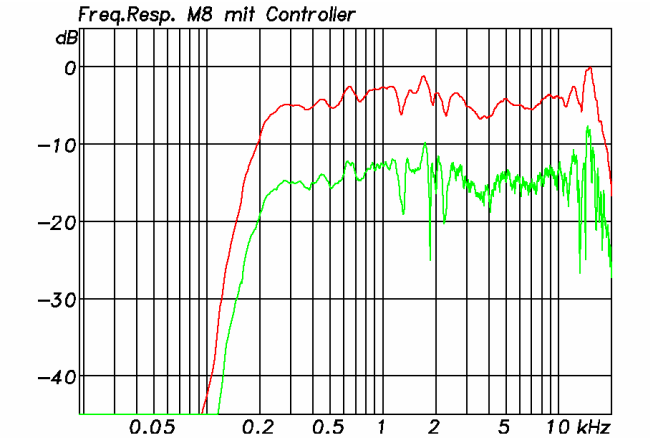


Figure 16: Frequency response M8 Mid/Hi with Controller

Test results M3/M8

First, we measured on both mid-range/HF cabinets the individual speaker ranges without controller to obtain some indication as to their frequency response and efficiency. To avoid drowning in a flood of measurement diagrams, we present no phase and impedance curves here. According to Nexo, the mid and tweeter ranges have a nominal impedance of 12 ohms. Our measurements yielded a minimum impedance of 11.0 ohms (mid-range) and 7.5 ohms (HF).

In both cabinets, the coaxial horns harmonize well with each other. The larger mid-range horn showed first interference drops slightly above 2 kHz. The tweeter horn's behavior was completely stable and unaffected by the larger horn, except for a small drop at 2.2 kHz. The two mid-range speakers of the M3 and M8 have a similar frequency response and sensitivity, on a very high level of 110 dB @ 1 W/1 m, which is no surprise as both horns are similarly shaped, the only difference being the slightly modified shape of the tweeter horn between them. However, in terms of on-axis efficiency the two horns varied by as much as 2 dB, which is of course due to differences in directivity. Here, too, an average value of 110 dB is achieved at 1.8 kHz and higher. Quite a surprise was the linear curve up to highest frequencies of 18 kHz, which was achieved despite the CD behavior in terms of directivity. Here, the sophisticated simulations of horn behavior which Nexo's development department realized with tons of computers seem to have been fruitful. Similar results could be reported in the test of Kling&Freitag's Access, where a tricky horn design allows for CD-like response with the usual level loss in the treble range.

The spectral plots of the four horns showed harmless vibrations (2 x 10" mid-range horn) and somewhat annoying "noises" in the case of the tweeters, which are particularly large on the M8 at 2 kHz.

The next series of measurements examined the frequency response and directivity of the M3 and M8 if connected to a controller. By accepting a few minor compromises, Nexo succeeded in finding controller settings that match both HF cabinets, so there was no need for any controller switch-over. Figures 15 and 16 show the frequency response for both variants, without a woofer cabinet connected. The M3 tends to produce a (wanted) increase in the treble range, taking account of the air cushioning effect that increases at greater distances. While the M8 shows a quite ideal overall response, the M3 suffers from a few ripples in the crossover zone, which would certainly be avoidable if specific filter settings had been used for each system.

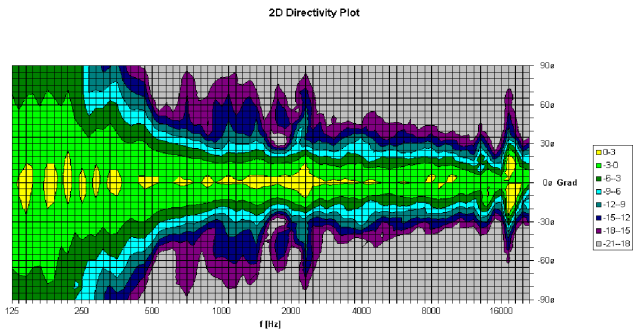


Figure 17: Horizontal directivity: 1 x M3 Mid/Hi

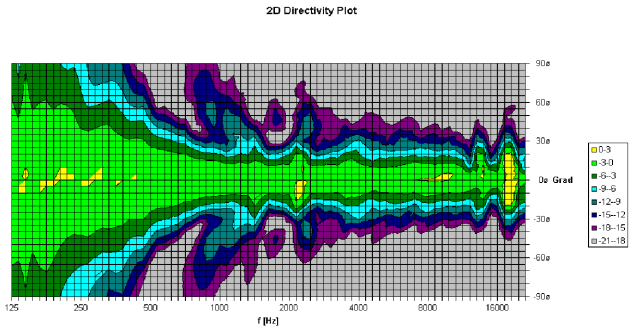


Figure 18: Vertical directivity: 1 x M3 Mid/Hi

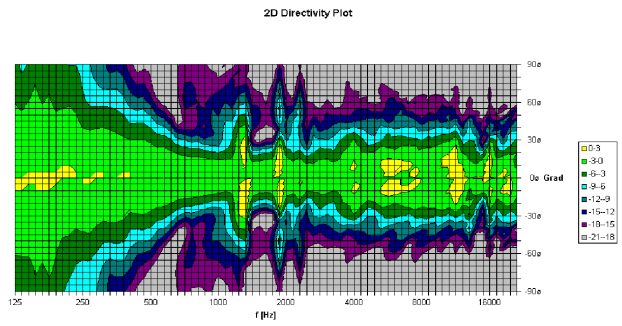


Figure 19: Horizontal directivity: 1 x M8 Mid/Hi

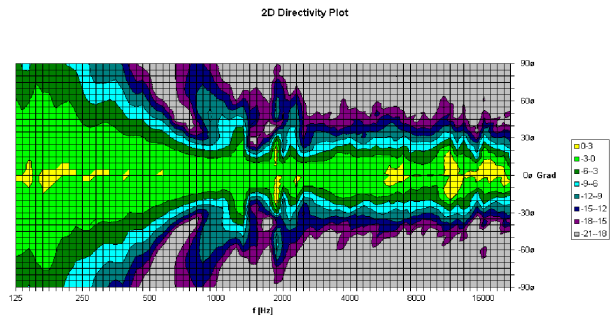


Figure 20: Vertical directivity: 1 x M8 Mid/Hi

Directivity

The directivity of both mid-range/HF cabinets is displayed in the form of 2D plots in figures 17-20. Here, the M3 benefits from the compromises made in the filter design, as its directivity curve is absolutely flawless. The coaxial design in combination with a bit of nicely chosen overlapping in the crossover zone between the mid and tweeter ranges yields such accurate results that have been hardly found before. With a bit of delay correction you can compensate coaxial systems so that there are virtually no interference effects between the two ranges. In this case, the mid-range and tweeter horns are also a perfect match in terms of dispersion characteristics in the crossover zone, which would inevitably lead to annoying cancellations with conventional speaker arrangements.

The measurements of the controller-backed frequency response (fig. 14) shows that with a nominal crossover frequency of 3 kHz both ranges overlap by about half an octave. Still, it is hardly possible to determine the M3's crossover frequency from the two 2D plots. The 35° x 35° dispersion angle is accurately maintained at approx. 500 Hz and higher, even though the M8—which has a broader dispersion pattern—showed a few minor inaccuracies between 1 and 2 kHz. Here, it hits the eye that both cabinets use the same mid-range horn, and hence the M8's dispersion angle is somewhat narrower than specified between 500 Hz and 3 kHz. The lateral peaks which are produced only by the M8's mid-range horn (despite the fact that both cabinets use identical models) are due to the somewhat broader shape of the coaxially arranged tweeter horn.

All in all, we can only say the best about the M3's directivity behavior, and also the M8 showed very good results compared to other systems. If you take a look at the results yielded by the systems Kling&Freitag Access, d&b 402 or GAE Director, the system-specific superiority of the coaxial arrangement becomes instantly clear. With skillfully adjusted crossover filters this design produces an almost perfect directivity response.

Bass cabinet B1

The B1 was designed as a genuine woofer cabinet right from the start, requiring no sub-extension cabinets, which is astounding considering its compact dimensions. On the outside the B1's cabinet is identical to the mid-range/HF cabinets, inside there is a 15" PHL driver with a short horn. This driver, too, was modified specifically to suit Nexo's requirements, i.e. higher pulse power rating and mechanical safety. The 15" speaker is mounted in a small bass reflex enclosure, its diaphragm points towards the horn. Owing to an additional bass reflex resonator, the B1 reaches down to just below 50 Hz and does not suffer from the typical drop between 80 and 100 Hz, which can be perceived when a driver loads a small closed enclosure from its rear side.

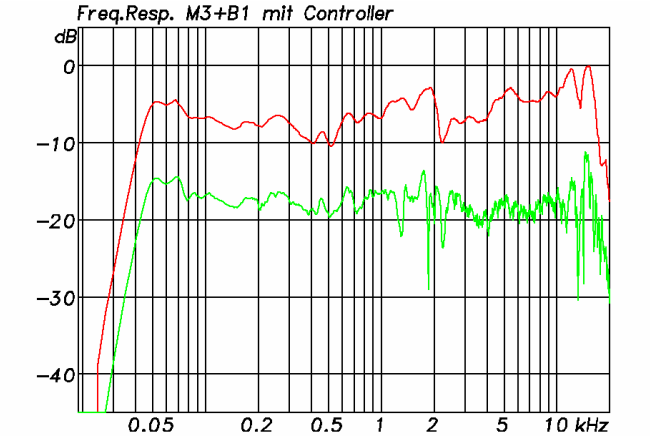


Figure 21: Frequency response for M3 with B1

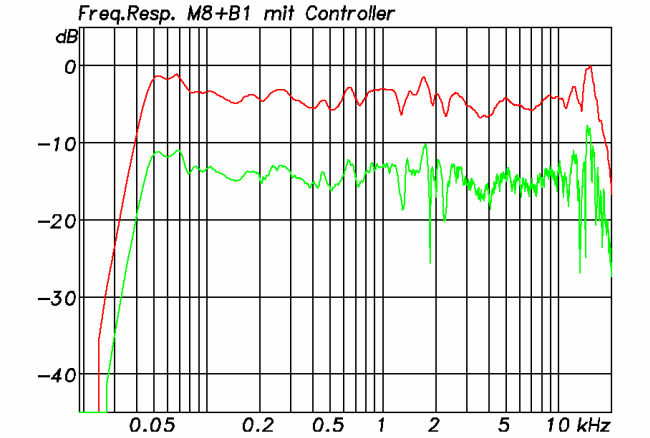


Figure 22: Frequency response for M8 with B1

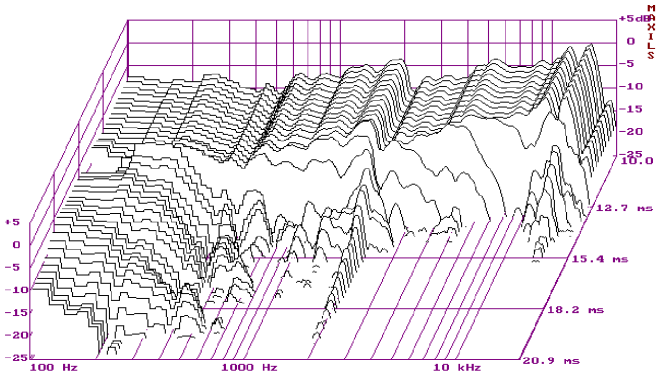


Figure 23: Waterfall Spectrum for M3 with B1

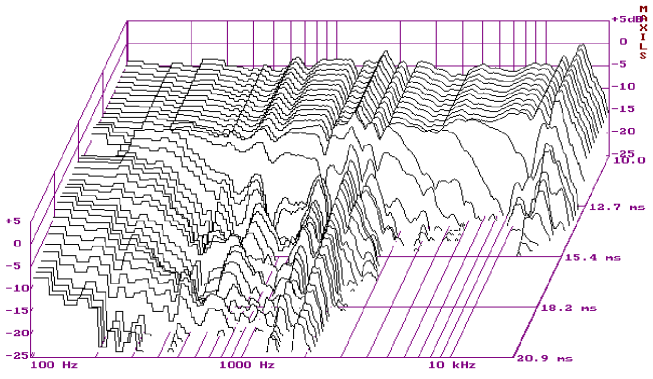


Figure 24: Waterfall Spectrum for M8 with B1

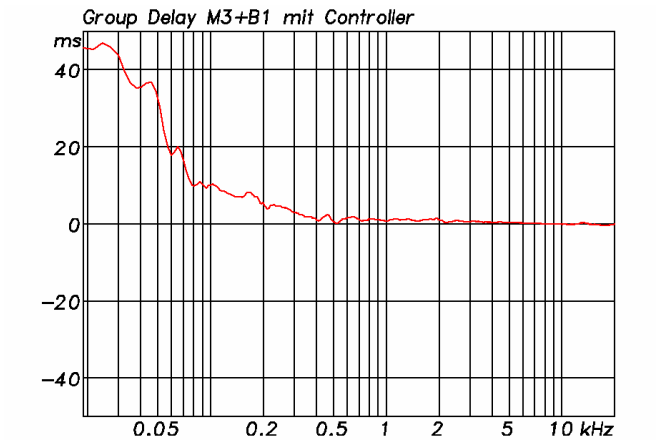


Figure 25: Propagation time response for M3 with B1

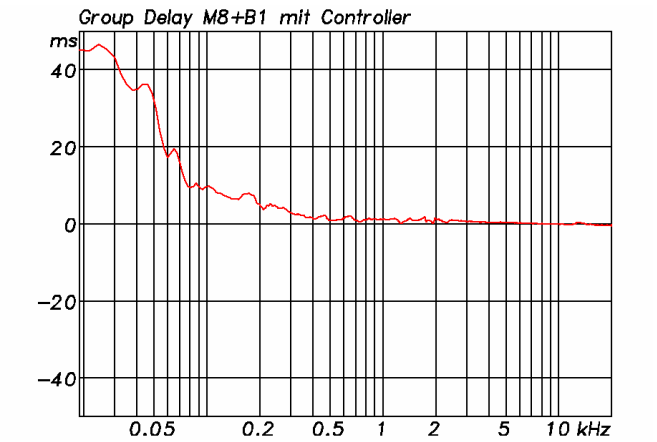


Figure 26: Propagation time response for M8 with B1

Sub S2

The woofer cabinet S2 is a sub-extension system that rounds out the Alpha program towards the bottom end. With two B&C 18" long-throw drivers in a band-pass cabinet, this system has been optimized for the frequency range from 30 through 100 Hz. On the outside, the cabinet with its three large resonator ports corresponds exactly to two B1 cabinets and thus integrates seamlessly into the Alpha system. Transport and flying hardware are also the same. It is astounding to see that the two resonators have been tuned so successfully that despite the large ports and the relatively small cabinet volume the S2 reaches down to 30 Hz. The overall surface of the three resonator ports even surpasses the effective diaphragm surface of the two 18" speakers, which should make flow noise and port compression a thing of the past.

Test results B1/S2

Figures 1 through 4 show the frequency and impedance response of the S2 and B1 woofers. The impedance curve of the S2 gives a clue as to the tuning frequencies of the Helmholtz resonators at about 32 Hz and 80 Hz. Both resonators cooperate almost perfectly and provide for a completely flat response between 40 and 150 Hz, with a sensitivity of 99 dB @ 1 W/1 m (40 - 100 Hz). Even at 30 Hz the system still has an efficiency of 93 dB. The sensitivity of 105 dB given in Nexo's data sheet, which seems contradictory at first sight, refers to half-room conditions which yield a value that is 6 dB higher.

The B1's impedance curve, too, shows that this speaker is a band-pass system, though this may seem surprising at first sight. After all, the 15" driver loads a conventional bass reflex resonator from its rear side, while its diaphragm front is linked to a horn. However, the effect produced by a horn that is so small in relation to the wavelengths it radiates cannot be perceived in the low-frequency range. Rather, the horn does not function as a waveguide but as a concentrated "spring-mass system", i.e. as a resonator. Our measurements indicated a resonance frequency of approx. 78 Hz. From 150 Hz upward the response curve showed a hefty increase in efficiency. Therefore, the B1 works like a conventional bass reflex box in the sub-woofer range, which is underlined by an efficiency of 96 dB. Above 120 Hz it is 100 dB or even 105 dB, not least owing to the horn. In combination with the controller's EQ settings, the B1 can thus also be used for the woofer range, with the exception that it lacks in this range the typical high efficiency of a horn. The spectral plot of the B1 (see fig. 5) shows a few vibrations at 200 Hz and higher which are caused by chamber resonance's.

This is the highest crossover point for the B1. The TD controller has the crossover frequency set to 175 Hz, which is bordering on the limits of what is acceptable, however, a compromise had to be made in this range in terms of maximum level, because the 2x10" mid-range horn produces its full efficiency only at 200 Hz and higher.

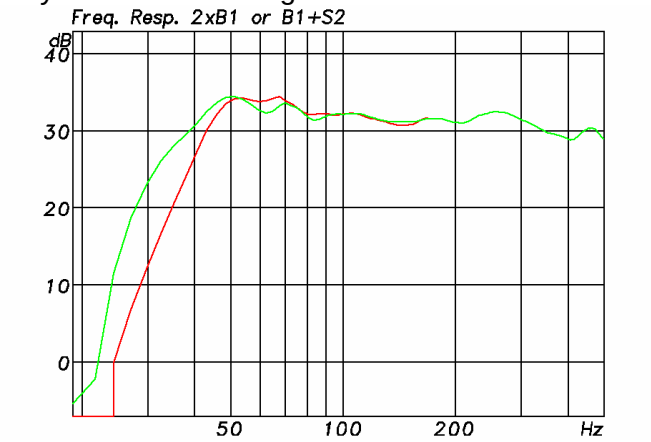


Figure 27: Frequency response for 2xB1 (Red) **or** 1xB1 + 1xS2 (Green) with TD Controller

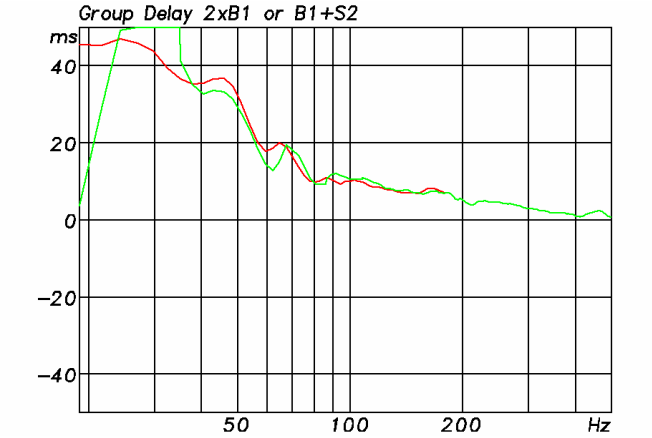


Figure 28: Propagation time response for 2xB1 (Red) **or** 1xB1 + 1xS2 (Green) with TD Controller

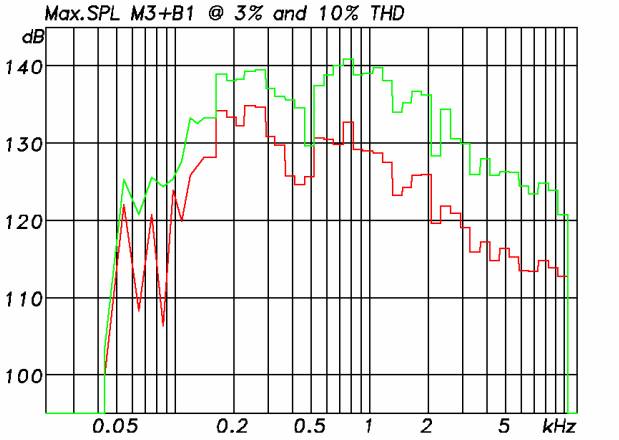


Figure 29: Maximum SPL for combined M3 + B1

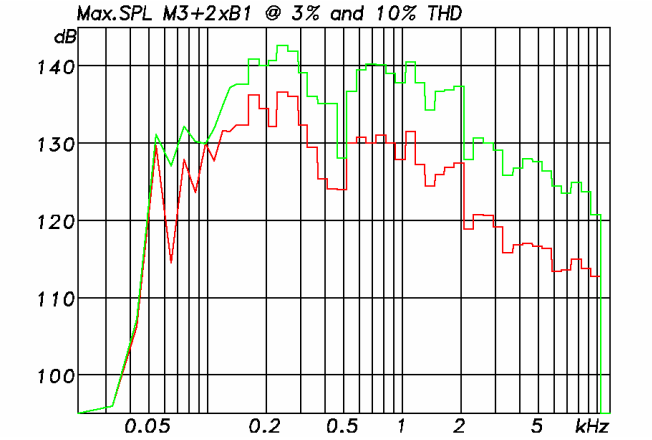


Figure 30: Maximum SPL for combined M3 + 2xB1

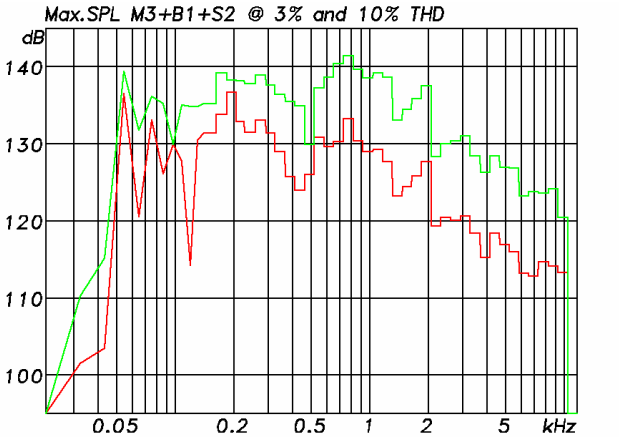


Figure 31: Maximum SPL for combined M3+B1+S2

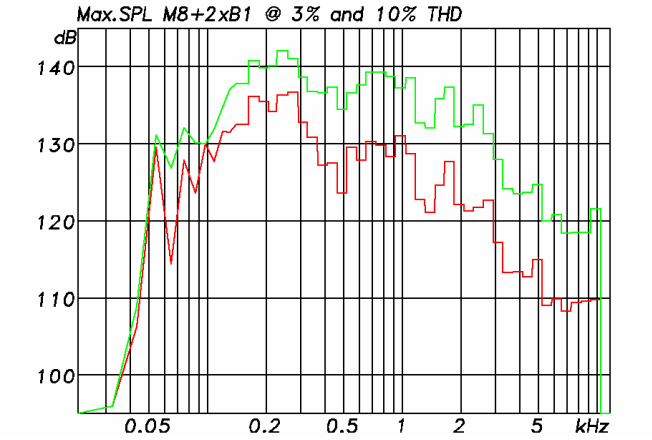


Figure 32: Maximum SPL for combined M8 + 2xB1

Controller

The Alpha's standard controller is configured for 3-way operation. If a fourth speaker range is required for the sub-woofers, an additional sub-TD controller comes in at 65 Hz providing the necessary filtering and protection circuitry. The sub-woofers are handled as a fully independent fourth way driven with a mono mix signal from the two inputs. Also, the controllers use separate amps wired independently of the remaining system. A freely adjustable delay of up to 18 ms can be used in the sub-channel to perfectly adapt the sub-woofers to the B1 cabinets. In particular, when the sub-woofers are used as mono blocks installed underneath or floor-mounted on both sides of the stage, it is necessary to adapt them to the flown woofer cabinets, in order to avoid large drops in the woofer range. Of course the level of the sub-woofers can be raised or lowered by +/-9 dB respectively. The TD controller features a level control for the three higher ranges and also an array alignment function using a shelving-type filter (+/-6 dB) below 500 Hz. When several systems are used as a combination, the acoustic coupling effect in the low-frequency range becomes more noticeable. The required compensation for this effect depends on the shape and size of the arrays. Both TD controllers have Sense inputs for the power amp signals, and can thus provide specific protection against overloading, irrespective of the actual power delivered. Additionally, the two controllers are equipped with analog computers capable of simulating the diaphragm displacement and voice coil temperature of the speakers. The computers reduce the power delivered by the amps if necessary. With these sophisticated analog controllers it is possible to set up the Alpha perfectly and use it to full capacity. However, you won't get that for free: one sub-TD and two Alpha TD controllers together cost more than you would expect to pay for a stereo 4-way digital controller. Without any doubt, however, Nexo's solution gives you more features (e.g. Sense inputs, simulation of displacement and temperature) than any digital controller can offer today.

Additional test results

The next step was to measure the M3 and M8 cabinets in combination with the B1 bass cabinets. Figures 21 through 26 show the frequency response, spectral plot and delay curves. In addition to the already known response of the two mid-range/HF cabinets, you can see a slight bass increase of about 2 dB and a lower cutoff frequency at approx. 45 Hz. The seamless transition between the ranges at 175 Hz shows no drops nor peaks. Except for the already mentioned peaks in the HF cabinets at 2 kHz, the spectral plots give no indication of any other inaccuracies. With regard to the delay curve, the combination of an acoustic 4^{th} order high-pass filter in the bass reflex box and the controller's electrical high-Q 2^{nd} order high-pass results in a 6^{th} order high-pass filter providing a steep delay rise up to the cutoff frequency. As much as 35 ms of delay at 50 Hz might lead to a less direct sound in the absolute low-end woofer range.

Combinations with B1 and S2

Finally, we added the S2 sub-woofer to measure the complete Alpha system. To allow for a clearer presentation of the results, the frequency response and delay curves of the B1 and of the combinations including the B1 and S2 (fig. 27 and 28) show the woofer range only (enlarged).

The sub-woofer does not change the basic characteristics of the system, it simply expands the frequency response by a few Hz.

In terms of sound this means that both variants (with and without sub-woofer) give you the same sound, and the decision whether or not to use the sub-woofer depends on the bass power you need. The low crossover frequency of 65 Hz allows you to mount the sub-woofer anywhere you want.

Maximum level

As with any large-scale P.A. system the achievable maximum sound pressure level is a point of special focus. In the end, it is this aspect that determines whether or not a system can compete with other products in terms of efficiency—as long as all other requirements are fulfilled. We tested four different Alpha variants: with M3 and M8, and in combination with two B1 woofers. To allow for a comparison of bass performance, we used one B1, two B1's and a combination of B1 and S2.

All measurements showed that the Alpha is a system that is logical in itself and does not suffer from any weak points. As could be expected, both mid-range/HF cabinets delivered 140 dB between 150 Hz and 2 kHz, to drop gradually to 120 dB as frequency goes up. The critical 3% curve, too, is very regular. There are no drops in level, and a solid offset to the 10% curve. Using different combinations you can adapt the achievable level in the bass range to suit your needs. The smallest set consisting of one top and two B1 woofer cabinets delivers as much as 130 dB down to 50 Hz, which is enough power for many small clubs with audiences of 300-500 people. By adding the S2 the bottom-end level can be raised close to the 140 dB margin, so that combinations of two to three mid-range/HF cabinets per side and two to three B1 woofers work happily with one sub-woofer each.

Live tests

For our live test we used a combination consisting of two B1 woofers and one M8 per side, reproducing the funky jazz sound of saxophone player Bill Evans and his excellent band. As we expected, all experts present were very satisfied with the sound, which had already become clear shortly before the test when we compared the Alpha with another system from a similar category. Setting up the two small Alpha stacks and amps was so easy and fast that you might wish other manufacturers would take this concept as an example.

Summary

Despite its compact dimensions the Nexo Alpha System meets all requirements of a large-scale sound reinforcement system. The system's probably unique flexibility—from small stages via side and front-fill applications to speaker arrays for open-air shows with audiences of 100,000 people or P.A. systems in sports stadia—is simply impressive, as the Alpha offers a no-compromise solution for any of these applications. Flying hardware, system handling and workmanship are as you would expect when one of the world's largest and most experienced hire companies is given the opportunity to co-develop the system. From a technical point of view, the high-tech approach of Nexo's development department can be seen clearly: nothing is left to chance and there are no hidden weak points that could have found their way unnoticed into the end product. All of this is underlined not only by excellent test results but also by a neutral and pleasant sound. The price you've got to pay for this product is appropriate and acceptable if you consider what you get for the money. The fact that 1,000 stacks of this system have been sold worldwide in the first year of production is living proof that this well-designed system has found acceptance on the market.

Acknowledgments

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Text and measurements: Anselm Goertz Photos: Dieter Stork