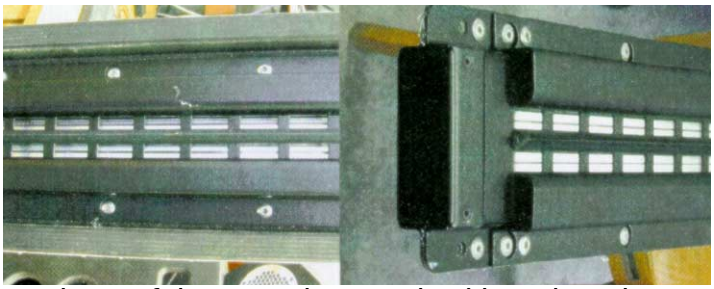
RADIA PRO SYSTEMS L.L.C.

The Z-Line loudspeakers from RPS, thanks to their special design, provide solutions for architecturally demanding tasks. Aside from that, they have many acoustically interesting qualities that are useful for complicated sound reinforcement solutions.

The company Sonus in Baden-Baden, an RPS Master Distributor, with the unusual company identity of " think tank for acoustics" is a company with a mission and goal to develop complete solutions in direct cooperation with architects, installers and the end-users for sound reinforcement projects. The Sonus product offering is quite broad. Aside from loudspeakers, the company provides conference systems, networks, processors, microphones, etc.. It is in loudspeakers where Sonus is unique in its offerings with its unconventional models that at first look don't look or behave like conventional loudspeakers. One of these unconventional loudspeakers is the Z-Line Series for which Sonus is the European distributor and partner for Radia Pro Systems, an American manufacturer.

Z-Line

Radia Pro Systems from Nevada offers a series of different variations of this so named Planar-Magnetic-Loudspeaker. These loudspeakers differ from a conventional electro-dynamic loudspeaker in that there is no mechanical assembly consisting of separate parts like voice coil, moving spider, cone and surround to reproduce audible sound. These planar magnetic loudspeakers have just one mechanical moving part, namely a membrane that consists of a very thin polymer film, to which a conductive aluminum circuit is printed. The magnetic field is generated by many small magnets. This specifically oriented magnet field induces a current through the conductive circuit.



Views of the transducer unit without housings

Conventional loudspeakers display a distinctive weak point. Only at lower frequencies the radiating area (cone) is vibrating as one unit. When it comes to the higher frequencies, the radiating area exhibits more or less strong partial vibrations that discolor the tonal quality of sound. Here the whole membrane vibrates in response to directly applied mechanical force that is evenly distributed along the entire vibrating surface. This even distribution necessitates a consider-

Illustration 1

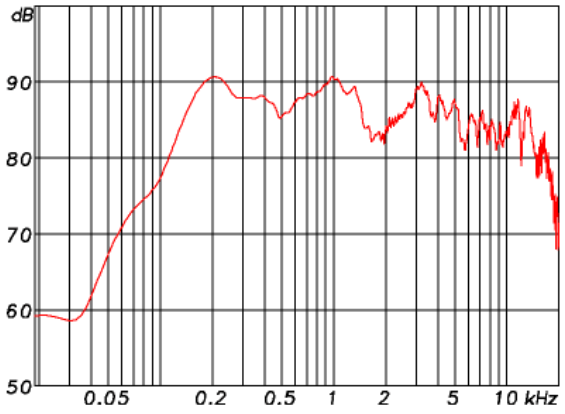


Illustration 2

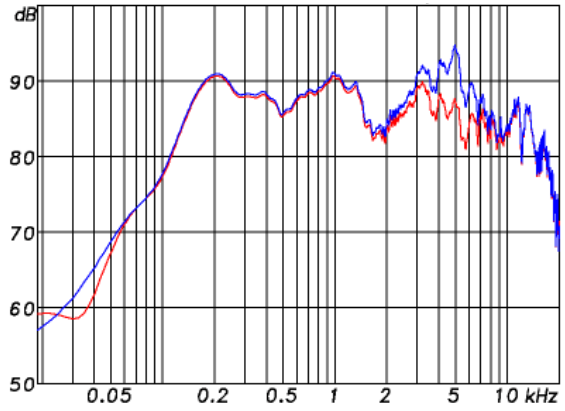


Illustration 3

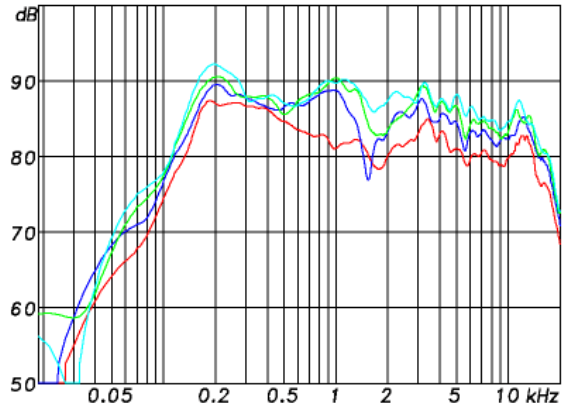
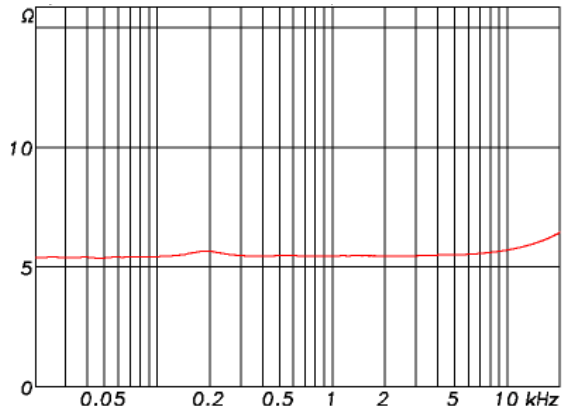


Illustration 4



ably larger quantity of permanent magnets to generated the magnet-field. The actual active part of the membrane is 5 cm wide and 190 cm long (Z-190). One individually magnet has the length of 75 mm so that the total magnet count of the 6 rows of a Z-190 is 150 individual ferrite magnets. The entire unit is assembled using two half-shells of steel so that the magnets are fixed in their position and the membrane is stretched between the two steel shells. For the critical production of these loudspeakers, the advantage is that the magnets can first be put in rows into the two steel shells. After this is done, the membrane is stretched and fastened between the half shells. The whole unit is then riveted and the Z-line element is ready. This element of the Z-line comes in lengths of 190, 130, 100 and 70 cm, as indicated by the model numbers. Depending on the project, the elements can be placed end to end to form any length requirement.

Dipole Transducer

The free moving membrane generates sound both front and back of the element. If used in this way, it is a true di-pole device. For some projects this may be an advantage. The normal use of the elements is to place it in an enclosure or flush mount in a wall or ceiling so that sound emanates only from the front and the rear sound is enclosed or absorbed by sound absorbing material. It is recommended that the enclosure volume be large enough to optimize the designed low frequency of the element. In our test for the Z-190 we used an enclosure of 45 liter (1.59 cuft) net volume, resulting in a resonant frequency of 195Hz. We can then say, that for every meter (3.28 ft) of element a net volume of 25 liter (0.88 cuft) of enclosure is desired.

Cylindrical Wave

At first look, the Z-line could be quickly thrown together into a pot with all other conventional loudspeakers. In respect, this is right, but the Z-line is really a line source transducer and has all the characteristic uniqueness of a true line source and should not be confused with conventional column-type loudspeakers incorporating many small drivers. To this end, we will take a small trip into the World of Acoustic. Sound

through air can take many shapes and spread in many directions. This propagation is mostly a function of the source. A point source for instance, such as a sphere generates a sound wave in all directions and is true for all point source devices. For a frequency of 100Hz with a wave length of 3.4 m a 40 cm cone is still a point source device. For a frequency of 10kHz with a wave length of 3.4 cm a 25 mm dome tweeter is also a point source.

Should you like to achieve certain directional characteristics, that is constant over as wide as possible frequency range, then the usual way is a horn type device, that emits no spherical wave but a cylindrical wave.

In comparison, one look at a line-source, that is theoretically and ideally infinitely long and infinitely narrow, emits no spherical wideness but a cylindrical wave. The performance of a point source distributes sound over a spherical surface resulting in a 6dB loss of level for every doubling of the distance. A cylindrical wave source, on the other hand, results in only a 3dB loss of level for every doubling of the distance.

What does all this mean with regards to this loudspeaker discussed here? With a membrane of 5 cm wide and 190 cm long the Z-190 behaves, in the vertical, as line-sources when the wavelength is small in comparison to the 190 cm. Measurements can confirm this for frequencies above 500Hz. The sound distribution changes slowly to the form of a spherical wave. After a certain distance of the source, the cylinder-wave also loses its form and begins to look like a spherical wave. This is called the transition from the near-field of the device (source) to the far-field.

After a simple calculation, for wave sources in form of the Z-190 , that this transition at 1 kHz takes place after approximately 10 m and at 10 kHz only after 100 m. This distance can be calculated with a simple equation, that is: length of the line source, here 1.9 m, to the square divided by the wavelength (i.e. for 1 kHz: (1.9 m) 2/0.34 m x 10.6 m). As long as the continuing sound wave is a cylinder-wave with the height of the line

Illustration 5

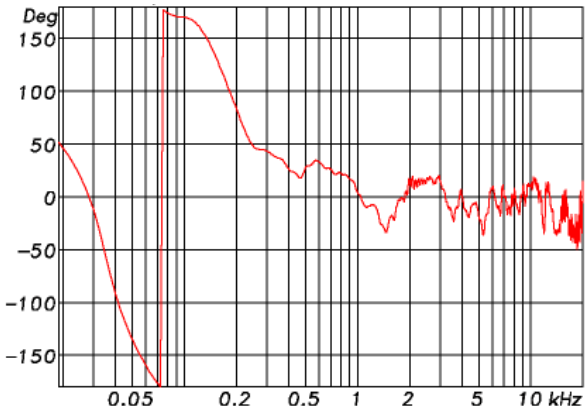


Illustration 6

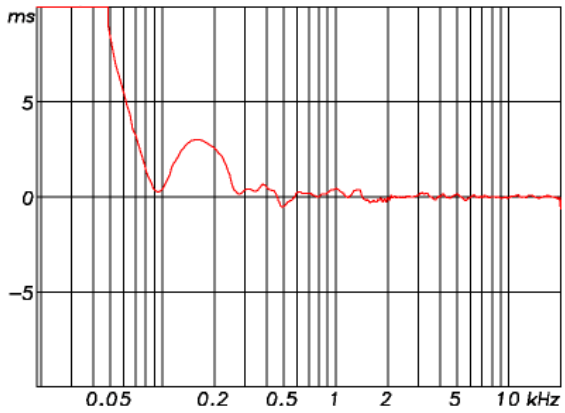


Illustration 7

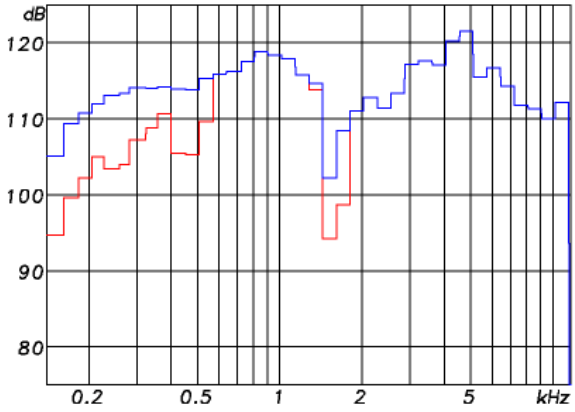
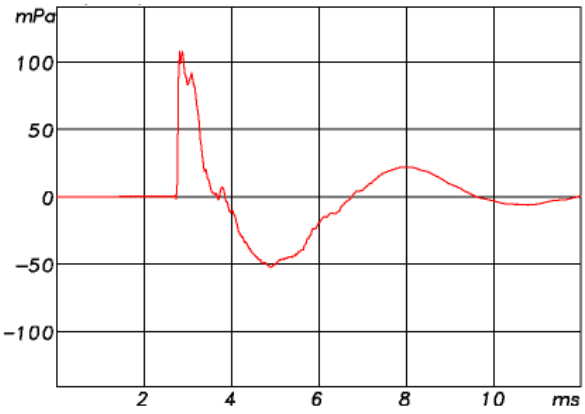


Illustration 8



source and experiences no noticeable vertical widening. In the horizontal area the loudspeakers show a largely normal behavior. Also after this principle, the PA-System V-DOCS by the French physicist Christian Heil with his company L-Acoustics. Here a combination of conventional chassis and high frequency drivers shaped and guided by a processor also display a long line source behavior.

Applications

The main central points for the Z-line loudspeakers remains:

- Narrow vertical and very clean distribution pattern.
- Loss of level, in the free-field, of only 3dB with every doubling of distance.
- An almost ideally flat and extremely light membrane.

With an effective membrane surface all of 950 cm2, the Z-190 can reproduce frequencies as low as 100 Hz and can be used as a full-range device in many applications. Supplementing the Z-190 with a sub-woofer, frequencies below 100 Hz is achievable.

Typical applications for the Z-Line are anywhere where high-quality sound reproduction is desired. As an example, a highly reverberant meeting room with very little or no sound absorbing material on the floor and ceiling. Environments such as this make speech intelligibility very difficult. The Z-Line loudspeakers, because of their cylindrical dispersion, would avoid the unnecessary coverage of these non-absorptive areas and diminish reflections. Additionally, the 3 dB loss for every doubling of distance from the source, will improve speech intelligibility.

For very big rooms several Z-Line elements can be lined up one after the other, resulting in a non-stop line-source, installed under a ceiling for example. Applications are many, especially under the aspect, that the Z-Line can be installed very inconspicuously, architecturally friendly and ease of handling. With a discreet material disguise covering the elements installed in a wall or

Use of Z-Line loudspeakers in conference rooms

free-standing in a room, the Z-Line solves many aesthetic problems. No significant disadvantages or compromises when using the Z-Line. Completely the opposite, even in very high-end applications and because of their sonic quality is the Z-Line the preferred loudspeaker. Different than conventional loudspeakers, the Z-Line operates as real cylinder-wave-source up to highest

Set up as a slim column

Illustration 9

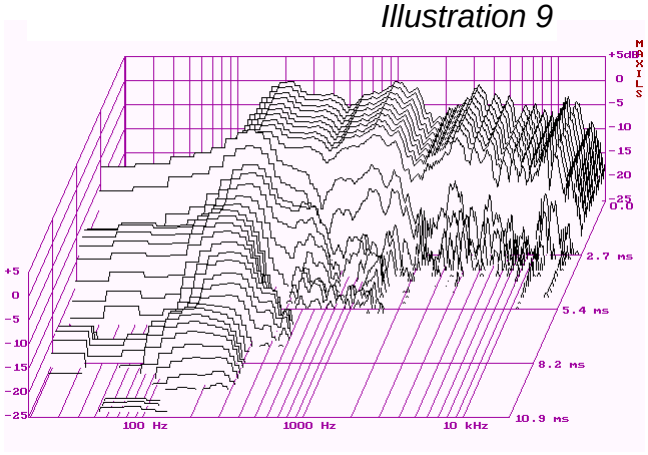


Illustration 10

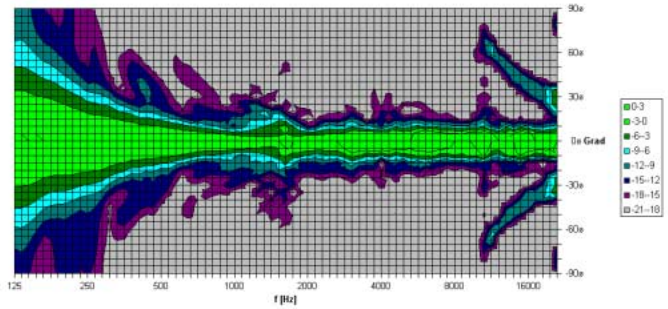


Illustration 11

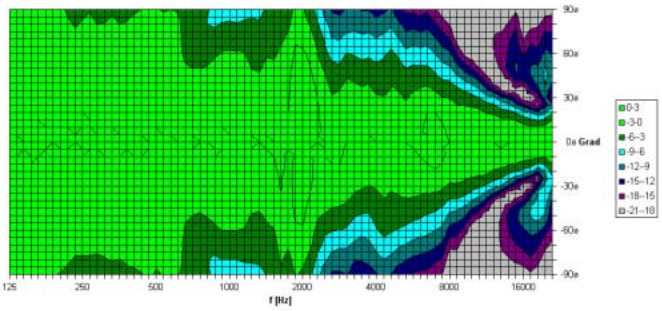
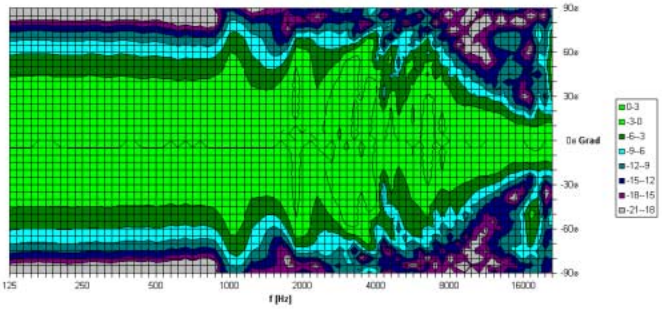


Illustration 12



frequencies. Multiple (single) point source loudspeaker systems aligned in a row behaving as a line source only when the wavelength equals the cross section area of the radiating membranes and results in detrimental interaction between the point source devices and displays no similarity to a true line source or cylinder wave.

Measurements

For measurement purposes, a pair of Z-190 were mounting in two slim enclosures, each with 45 L net volume. Measured in free-field at a 3 meter distance the frequency response is as pictures in Illustration 1 as well as Illustration 2. At 200 Hz a small peak is shown due to the enclosure resonance and is typical of a closed enclosure. In Illustration 2, two measurements are shown, the blue indicates the pure device, and the red curve is together with a passive filter compensating for the easy peak at 5 kHz. The phase response is represented in Illustration 5. With the exception of the phase rotation through the hi-pass behavior an almost straight course is displayed, that can be regarded as characteristic for a line source transducer.

Similarities can be found, without electronic aids, only with electro-static transducers. Accordingly, perfectly step resonance is evident, please see Illustration 8. Illustration 4 shows the impedance of the Z-190, where with exception of a small resonance peak and a minimal inductive content above from 10 kHz an ideal and constant 5.5 ohms is evident. For power amplifiers is the Z-190 a very easy load for it is purely resistive. Another interesting test series is shown in Illustration 3, where the Z-190 was measured at a distance of 1m, 3 m and 4 m. The measuring program determined the distance from the loudspeaker to the microphone automatically and calculated the sensitivity to 1 W/1 m under the assumption of a sphere wave transducer. I.e., with a doubling of the distance of 1 m to 2 m and then to 4 m, the 6 dB loss is mathematically added in order to achieve the 1 m distance. Therefore 4 identical curves with same sensitivity values for the 4 measurement points should be evident. That is not so however, as one recognizes in Illustration 3. Calculated after this

method, the apparent sensitivity climbs with increasing measurement distance, that we already mentioned, is due to the cylindrical dispersion. For deeper frequencies is this effect less and the curves come closer together.

Lastly, a look at the decay spectrum in Illustration 9, where primarily the enclosure resonance at 200 Hz is indicated and some other very small parasitic resonances, whose cause not readily identifiable is. Altogether, the decay spectrum makes a good point and impression, that no sonic problems can be expected.

Dispersion Behavior

For this purpose, the Z-190 was placed in a horizontal and subsequently, in a vertical position on a rotating table. In the vertical position it shows an extremely wide directional characteristic that begins below 500 Hz and widens as the frequency increases. It is worth mentioning again, that the Z-190 exhibits a wave front equal to the height of the element. One can easily confirm this by moving ones ear in close proximity up and down the 190 cm element without any sonic changes or level loss at the higher frequencies. The Illustrations 11 and 12 show the horizontal characteristics in an enclosure and open as a di-pole element. In an enclosure, the di-pole characteristics are no longer evident. The Z-Line performs just as a conventional loudspeaker with a membrane cross section of 3 cm.

Maximum Sound Pressure Level

By all appearance and all that has been said above, it may appear that the Z-Line has a low sound pressure level. This is however, not the case as shown in Illustration 7. The 950 cm2 membrane is capable of delivering very high sound pressure levels. Below 200 Hz the sound pressure level is somewhat lower, but in the middle frequencies the sound pressure level is 115 dB with a small dip at 1.6 kHz. Above 600 Hz the two graphs for 3% and 10% are mainly the same. The reason for that is that the 10% distortion was not reached in this measurement, because the amplifier power was limited to 800 watts.
Martin Greis from Sonus explained the large performance capabilities of the Z-Line as primarily due to the unique and highly sophisticated gluing process that bonds the aluminum conductor to the thin membrane. This maximum sound pressure level measurement was of great surprise to us in our test of the Z-190 and not at all expected.

Sonic Impression

A listening test was performed of the Z-190 and a very reflective and problematic room was selected. The two Z-190's were combined with two sub-woofers and driven by a digital controller, that provided for cross-over function at 120 Hz at 48db/Octave and system EQ. This combination proved exceptional and would have certainly impressed any high-end-freak. The acoustical deficiencies of the room were left in the background because of the direct sound field even at greater distance from the loudspeaker and the detrimental reflections were not evident. The playback was exact and tonally good. Even without sub-woofers, the Z-190's displayed their performance and can be used alone when large bass reproduction is not needed.

Results

With the Z-Line, Sonus as the Master Distributor for all of Europe, has an uncommon but exceptionally excellent loudspeaker in their program, usable in acoustically unfriendly environments with better than average results. As a line source with 1.9 meter length it produces a real cylindrical waveform, starting at about 500 Hz up to the highest reproducible frequencies. It also has a near perfect frequency response and an ideal and smooth phase response and high SPL with very low distortion. These combinations make the Z-Line a true problem solver and is priced right.

Text and Measurements: Anselm Goertz
Photos: Anselm Goertz and from archives.
Translation to English: Gary Rilling