

ZENSOR

TECHNICAL WHITE PAPER



IN ADMIRATION OF MUSIC



ZENSOR 1



ZENSOR 5



ZENSOR 7

INTRODUCTION

Since 1983 bit by bit DALI has become synonymous with manufacturing and marketing speakers of the highest standard at any price point. The road has been long, and our R&D engineers have spent thousands of hours refining products and technologies in their relentless search for improving the best. And they still do so every day.

So when we decided on introducing a new entry-level speaker series we were very much aware of the obligations associated with this task; it was of utmost importance to secure the implementation of core DALI values into this series. A challenging task, indeed. Nevertheless we believe that we have achieved just that, and we are proud to introduce the next true DALI speaker; the DALI ZENSOR...



ZENSOR VOKAL



The DALI ZENSOR series has been fully designed and developed at DALI's headquarters in Denmark

The idea with DALI ZENSOR was to introduce genuine - but affordable - hi-fi in a compact and stylish design.

DALI has a tradition of applying in-house refined technology in multiple products across the entire range. With ZENSOR we wanted to see how much of this technology we would be able to pack into our most affordable series, and how far this would take the performance at our dedicated entry-level. At the same time demands for an attractive visual appearance has grown stronger – also for products in this segment. Therefore the design process has been focused on developing a modern and lasting design expression.

This whitepaper will take you through the thoughts and technology behind the DALI ZENSOR series.

Enjoy!

INTEGRATES EASILY...

The design of the DALI ZENSOR family is very much in line with today's requirements to contemporary looks; aluminium details incorporated in the high gloss lacquered front baffle is the natural continuation of the sleek cabinet. The floor standing models even feature an aluminium base, allowing the speaker to 'hover' above floor level.

Our products must be attractive to look at – not only today, but also in 10 years time.

- The DALI ZENSOR series is designed to last.



The expression of the ZENSOR series clearly allows for blending into most of today's domestic environments.

SOUND DESIGN PRINCIPLES

The primary purpose of any loudspeaker is to convert the electrical signal from the amplifier into a realistic audio experience in the listening room. Any distortion or coloration of the original signal by drivers, enclosure, crossover, or other parts of the speaker is to be considered a degradation of the sound.

The ZENSOR series – just as other DALI loudspeakers – have been designed in accordance with our fundamental acoustic and electro-acoustic principles.

These principles are considered to be important guidelines. The R&D department's creativity and freedom to act are not limited in any way, however. Incorporating solid technical solutions DALI has designed everything from the curve of the cones, the weight of the voice coil, the number of screws on the driver to the aluminium base under the floor-standing speakers.

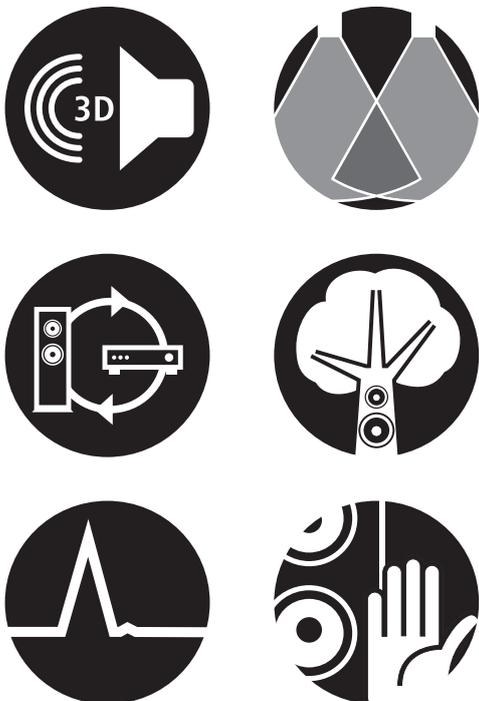
An example of our commitment to the Sound Design Principles is to develop speakers without dangerous dips in the impedance response.

Amplifier Optimized

Years of research has defined one of DALI's sound design principles, important to the relationship between the amplifier and the loudspeaker.

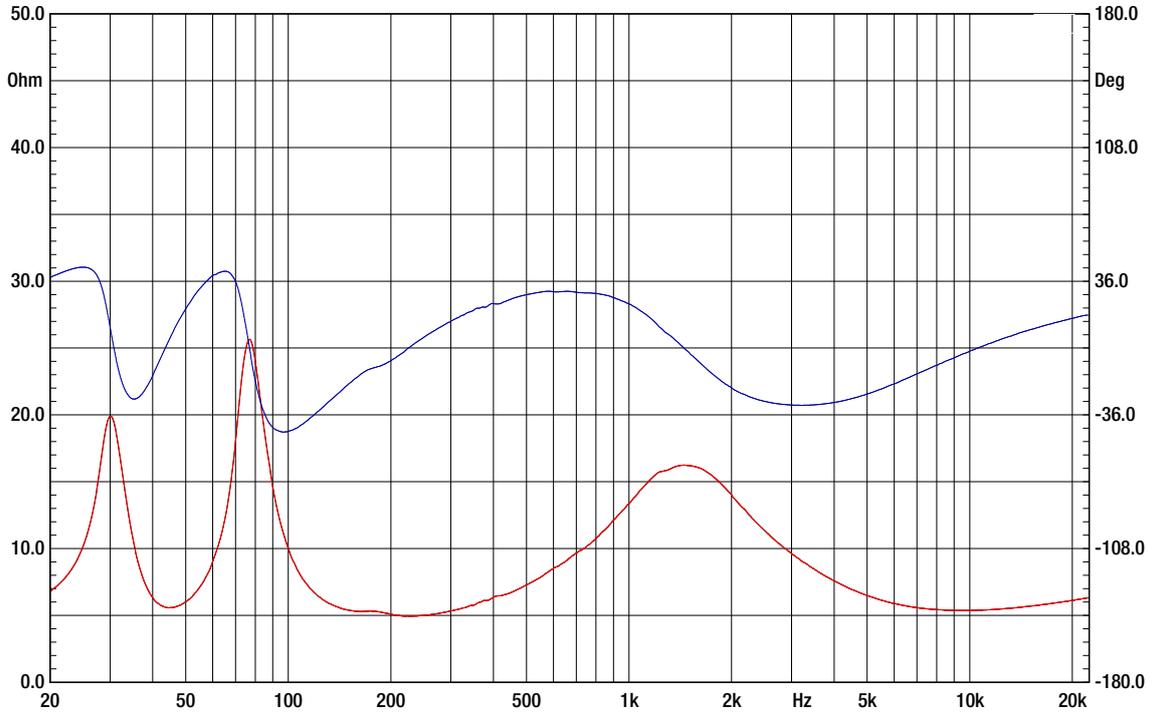
A smooth, even impedance allows for better working conditions for the amplifier. The result is a higher resolution. If the impedance of a loudspeaker changes at different frequencies, the amplifier encounters constantly varying resistance, making it much harder to follow the signal/music.

Therefore the ZENSOR series displays rather linear impedance - a stable load for the amplifier. This is achieved by fine-tuning every aspect of the speaker design, especially the woofer.

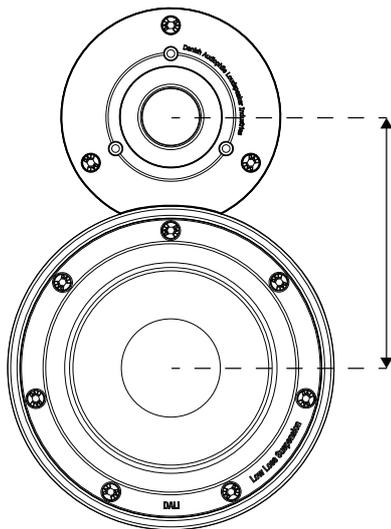


For more information about the DALI sound principles please visit www.dali-speakers.com

DALI ZENSOR 5 impedance



As an example of our commitment to making 'amplifier-friendly' speakers, the impedance of the ZENSOR 5 – just as the rest of the series - never drops below 5Ω , a stable load at a level which benefits smaller amplifiers and at the same time allows bigger amplifiers to shine.



The physical distance between the drivers are minimized for best summation of the woofer and tweeter output. Using DALI ZENSOR 1 as an example, the distance equals half a wave length at 3,000 Hz.

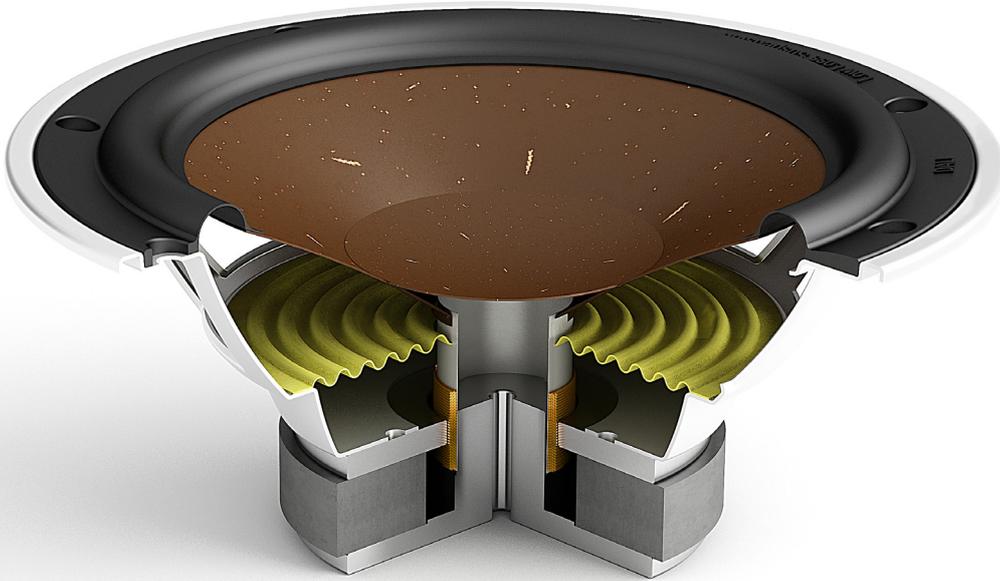
This also enables the very compact dimensions of the ZENSOR 1, standing only 274 mm high.

Wide Dispersion

DALI makes it easy to integrate your loudspeakers in any room. Both the driver materials and geometry applied in the ZENSOR series have been selected to achieve a wide dispersion pattern in the listening area. The same goes for the design of the crossover.

Thus you will experience a well-integrated sound, even when listening at a significant off-axis angle. And as you are rarely seated directly in front of the loudspeaker when listening to music this is important.

An added benefit is seriously reduced harmonic distortion and diffractions causing frequency distortion as these will always be stronger in an on-axis response. That is also the reason why practically all DALI speakers are not designed for toeing-in.



Cut-through showing the 7" woofer developed for the ZENSOR series.

WOOFER

At DALI we believe strongly in reproducing the recorded signal. No more, no less...

Consequently we believe in the necessity of reproducing not only the frequency contents in the signal, but also the dynamics in all its aspects – ranging from subtle micro details to high level bursts.

The ZENSOR speakers have been engineered accordingly.

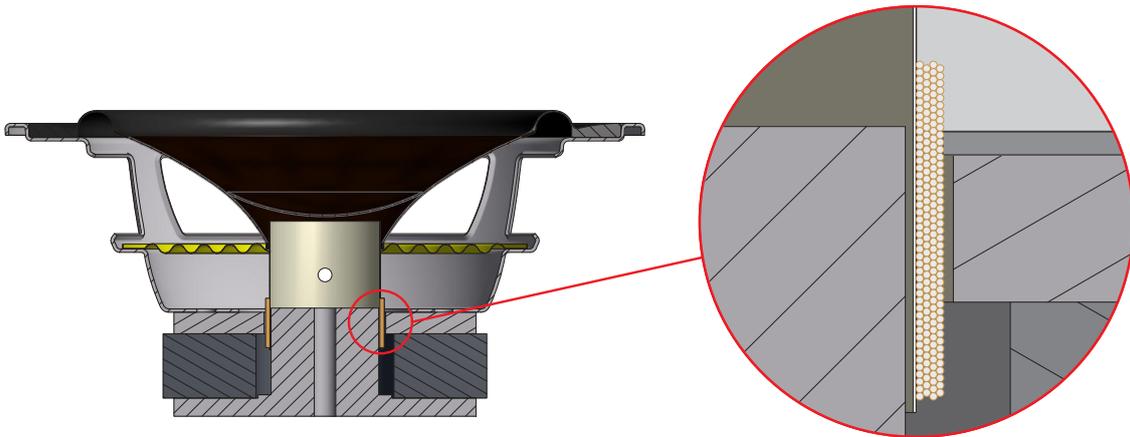
Like all DALI drivers dedicated to reproducing the delicate midrange frequency area, the ZENSOR woofer features wood fibre cones. This blend of a fine grain paper pulp, reinforced with wood fibres, creates a stiff, light-weight and well-behaving structure. In combination with a low-loss surround and spider suspension this cone reproduces the micro details in the signal - unfiltered and with high accuracy.

The cone area of the drivers in the DALI ZENSOR series is larger than the most common market standard. ZENSOR 1, 5 and VOKAL are equipped with 5¼" woofers. These woofers feature an effective cone area approximately 10% larger than traditional 5" drivers. The 7" woofer in the ZENSOR 7 is approximately 15% larger when comparing the cone area to the more common 6½" size.

A larger cone area allows the same sound pressure level to be generated utilizing a lower cone excursion. It also allows a higher maximum sound pressure level and – most importantly - it leads to an effortless reproduction of the dynamics in the music.

In order to achieve a rigid, vibration-free structure, it was of high priority to secure the woofers in the cabinet very firmly. And as the ZENSOR series feature very slim cabinets this was a serious challenge. Thus the larger cone areas have been implemented in the compact design by moving the screws inside the outer rim of surround. This compact build - and using 7 screws instead of the more commonly used 4 – 6 screws - ensures that the strong forces generated in the woofer motor system are effectively anchored.

At DALI we are continuously working on R&D technology projects – independently of product projects. One of these technology improvement projects is based on optimizing the motor system in our drivers – magnet system and voice coil.



The 4-layer light-weight voice coil design is applied to create a high motor force, enabling both powerful and precise sound reproduction.

With every product launch over the last years DALI engineers have managed to put a little extra engine power into the drivers at any given price point. This is all for the benefit of uncompressed sound reproduction, even during very dynamic passages in the music.

In the case of ZENSOR the voice coil development related to the woofers was a piece of engineering in itself. We needed a high B/L product (force factor) for a powerful and controlled bass reproduction in a small enclosure. At the same time a smooth and detailed midrange reproduction was crucial to separate the speaker from any competition.

The 4-layer voice coil used in the ZENSOR 1 boosts the B/L product by a solid 17% compared to the more commonly used 2-layer voice coils.

And worth remembering is also: A 17% higher B/L product reduces the electrical Q of the woofer with 27%. The result is a significant improvement in control of the entire moving system.

While a 4-layer voice coil is effective for a high force factor, the higher moving mass will often present a problem for the midrange response. Thus voice reproduction would be impaired.

Our solution for minimizing the weight was to apply a light copper clad aluminium wire. This rather costly solution applies an aluminium core and a thin-walled outer copper tube.

Combining the high conductivity/weight ratio of aluminium (205% the value of copper) with the superior contact resistance properties and better mechanical strength of copper, we get a light-weight voice coil with high conductivity capable of handling high peak signal levels.

The result is seriously improved bass control, well-controlled reproduction of micro details and great transient capabilities.

The ZENSOR VOKAL woofers feature an extra, reversed magnet on the backside of the magnet system. This is done for two purposes; to increase the B/L-product, and to reduce the magnetic stray field.



On the ZENSOR 1 the need for a high B/L-product was especially important in order to maintain superior control of the woofer in this limited cabinet volume. Therefore an extra magnet has been added to the motor of the ZENSOR 1 woofer.



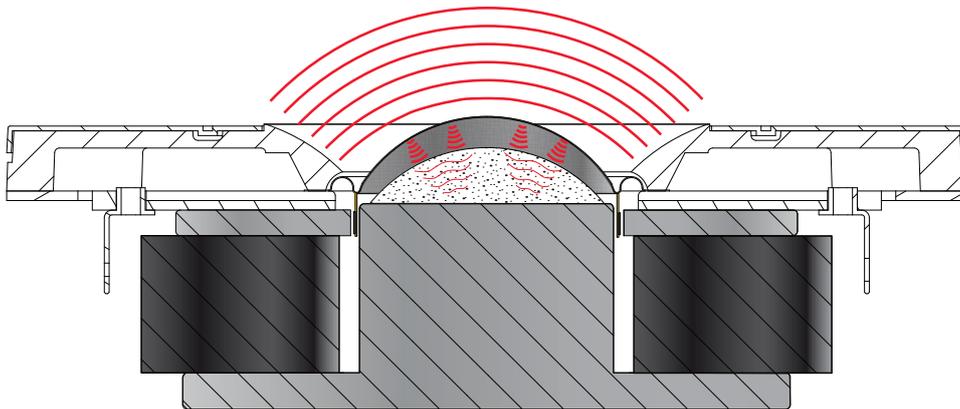
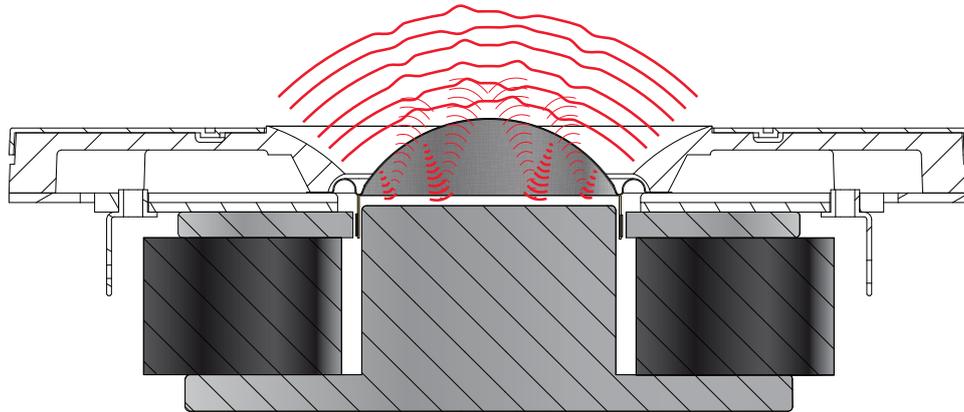
Ultra-light soft dome tweeter developed for the ZENSOR series ensures effortless and unbiased reproduction of the finest details.

TWEETER

Obviously the tweeter must be able to render high frequencies with high accuracy. This means very short excursions, but at high speed, - or rather - with high acceleration. Consequently a low moving mass and a strong motor is needed.



The ZENSOR tweeter is constructed on the basis of an ultra light-weight weave fabric. Compared to most soft dome tweeters in the market the DALI dome material is less than half the weight; 0.056 mg per mm².



In the right light this fine fabric will reveal the soft felt damping on top of the pole piece. This damping material eliminates unwanted reflections that may occur from a traditional flat-surface pole piece, applied in simpler tweeter constructions. This is another example of the meticulous care for construction details that – altogether - allow an unfiltered reproduction of all the details in the music.

To improve power handling, to reduce power compression, and to support a straight-line excursion of the voice coil the tweeter magnet system incorporates ferro-fluid. For long term stability in a saturated field, a high quality (220 gauss type) is used.

The geometry of the tweeter front plate near the dome has been optimised to create the optimal working conditions for the soft dome. The aim was

to combine an extended frequency response with wide dispersion and low coloration.

All of these goals have been reached by applying 3D CAD technology, decades of in-house acoustic experience and scientific calculations together with some of the good old fashioned ways: Machining prototypes, measuring the acoustic influence of any tiny adjustment, and last but not least: Listening to the result!



CABINET

The cabinets meet the expectations - and then some - in the DALI ZENSOR series.

CNC machined MDF board, dressed in a top-of-the-class laminate, forms the principal of the speaker. The floor-standing models feature strong internal bracing to reduce structural resonances.

In order to optimize timing the ZENSOR is fitted with acoustic damping material internally along the sides, top and bottom - but not on the rear side of the front baffle. The reason is that this creates a more direct contact between woofer and bass port. Thus there is only limited delay in the output from the bass port compared to the output from the driver itself. The audible result is a more precise bass and increased 'attack' in the midrange.

The front baffle is finished in a high-gloss black lacquer, complementing the aluminium details. Covering this you will find a removable acoustically transparent front grille.

High quality DALI terminals secure maximum grip on speaker cables, whether raw or fitted with banana plugs.

DALI ZENSOR is available in a choice of Light Walnut and Black Ash finish. Soon there will be a White Satin option as well.



DALI ZENSOR 1 placed in a stereo setup. This speaker features an integrated wall bracket to also facilitate mounting directly on the wall.

VERSATILITY IS THE KEY...

With speakers ranging from the compact ZENSOR 1 – H: 274 x W: 162 x D: 230 mm – to the solid ZENSOR 7 - H: 978 x W: 257 x D: 311 mm – the DALI ZENSOR family offer a speaker for most environments. Whether the listening room is small or large there is a solution to be found.

ZENSOR 1 is the perfect speaker in a compact stereo system, filling small or medium sized rooms with sound. Move it to a larger room and add a subwoofer – you now have a very capable 2.1 set-up.

DALI ZENSOR 1 is also the natural surround or surround back speaker in a 5.1 / 6.1 / 7.1 set-up. And as long as a subwoofer is applied for the LFE channel the ZENSOR 1 will be able to act as front speaker in a fairly large surround setup.

The ZENSOR 5 and – especially – the ZENSOR 7 will happily fill even large rooms with sound – with or without a subwoofer for assistance in the low frequency area. Obviously the ZENSOR 7 possesses an authority in the lowest frequency range, turning it into the natural choice for very large rooms or for applications where serious low frequency effect is a must. Both floor-standing speakers are designed to reproduce the fine details in a stereo signal as well as take up the role as the powerful and convincing front speakers in a surround set-up.

ZENSOR VOKAL is the dedicated center speaker in a surround set-up, and is engineered to match the timbre and tonal balance of ZENSOR 1, 5, and 7. DALI offers a wide range of subwoofers to complement a ZENSOR surround set-up. We strongly recommend the new DALI SUB E-12F, no matter which of the front speakers you choose, and no matter the size of your listening room.

ZENSOR SERIES TECHNICAL SPECIFICATIONS

	ZENSOR 1	ZENSOR 5	ZENSOR 7	ZENSOR VOKAL
Frequency Range [+/- 3] dB [Hz]	53 - 26.500	43 - 26.500	40 - 26.500	47 - 26.500
Sensitivity [2.83V/1m] [dB]	86,5	88,0	90,0	88,5
Nominal Impedance [ohms]	6	6	6	6
Maximum SPL [dB]	106	108	110	109
Recommended Amp. Power [Watts]	25 - 100	30 - 150	30 - 150	30 - 120
Crossover Frequencies [Hz]	2.900	2.400	2.400	2.400
Crossover Principle	2-way	2-way	2-way	2-way
High Frequency Driver	25 mm soft dome	25 mm soft dome	25 mm soft dome	25 mm soft dome
Low Frequency/midrange Driver(s)	1 x 5¼"	2 x 5¼"	2 x 7"	2 x 5¼"
Enclosure Type	Bass reflex	Bass reflex	Bass reflex	Bass reflex
Bass Reflex Tuning Frequency [Hz]	51,5	44,0	40,0	45,0
Connection Input(s)	Single wire	Single wire	Single wire	Single wire
Recommended Placement	Wall/shelf/ (Stand)	Floor	Floor	Shelf below TV screen
Magnetic Shielding	Semi shielding	No	No	Semi shielding
Dimensions (H x W x D) [mm]	274 x 162 x 220	825 x 162 x 267	978 x 205 x 312	161 x 441 x 281
Dimensions (H x W x D) [inches]	10.8 x 6.4 x 8.7	32.5 x 6.4 x 10.5	38.5 x 8.1 x 12.3	6.3 x 17.4 x 11.1
Weight [kg/lb]	4,2/9.3	10,3/22.7	14,9/32.8	6,8/15.0

All technical specifications are subject to change without notice.