

DALI EPICON

WHITEPAPER



IN ADMIRATION OF MUSIC

INTRODUCTION

Over the years DALI has continuously been pushing the limit for what can be achieved in terms of performance and build quality. With the introduction and steady evolution of technologies such as the hybrid tweeter module and wood fibre cones the important high-end segment has been the inspiration for DALI's relentless research and development.

And at a certain point these efforts are converted into real breakthroughs in new technology, making it possible to achieve so much more than what was previously within reach. The time has now come for a new reference speaker from DALI – the DALI EPICON series.

Built on knowledge from almost 30 years of research, development, and manufacturing of speakers, and on results from experimenting with both new and known technology the EPICON series shows just how far DALI has come in our search for natural sound reproduction.

With a visual appearance that signals exclusivity and simplicity these speakers are for the most demanding of music and movie enthusiasts. And with a performance which is clearly DALI - taken one step further – we intend not only to meet these demands. We will surpass them.

This whitepaper will take you behind the scenes, revealing some of the science that goes into creating the magic sound experience distributed by this new series....

... the DALI EPICON ...

Enjoy!



PRODUCTS



The DALI EPICON series comprise of 4 models, closely linked together – yet specialized in their own field.

EPICON 2 is a 2-way compact stand mounted speaker fitted with revolutionary, new drivers - 6½” woofer and the state-of-the-art 28 mm dome tweeter.

The smallest of the floor standing models is the EPICON 6 which relies on a 2½-way system as – compared to the EPICON 2 – it features an

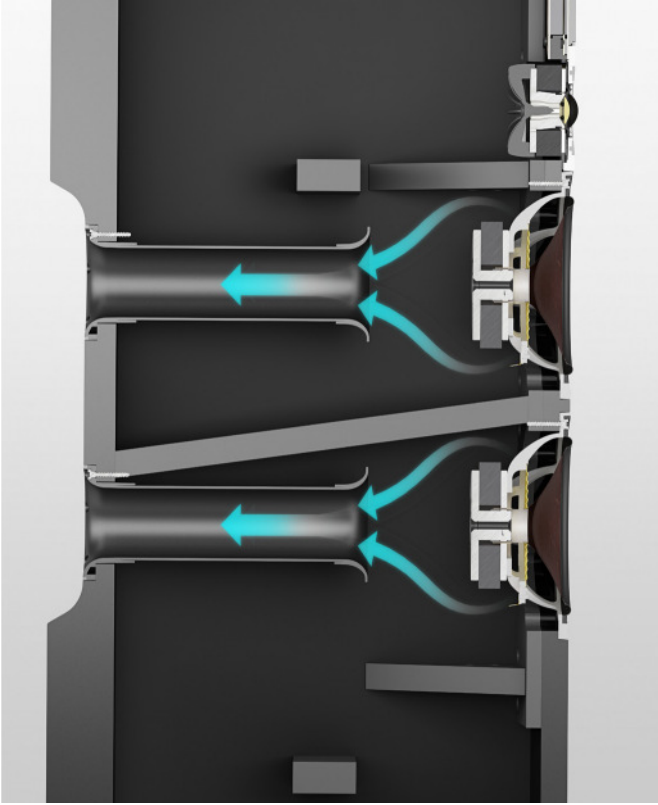
additional woofer kicking in below 600Hz. However, for the highest frequencies the EPICON 6 also incorporates a ribbon tweeter as part of the hybrid tweeter, in reality turning the speaker into a ‘2½ + ½-way’ construction.

DALI EPICON 8 is the largest floor standing model. It features a 6½” midrange driver, allowing 2 x 8” woofers dedicated for the lowest frequencies. Effectively this is a ‘3 + ½-way’ construction.

For multi-channel fans a center speaker has been developed – the DALI EPICON VOKAL. Incorporating 2 x 6½” woofers along with the hybrid tweeter module this speaker promises the same level of transparency and timbre matching with the rest of the series.

For the EPICON series DALI recommends the all-new DALI SUB P-10 DSS, a compact subwoofer relying on 3 x 10” drivers – one active and two passive.

CABINET



It has always been DALI's aim to minimize the delay between the driver and the bass port. The position of the bass ports close to the woofers create as direct a connection as possible. The less delay the better chance for optimizing timing – and the more accurate transient response you get.



Meticulous attention to CNC milling of the front baffle creates more space between the 7 screws, ensuring a free airflow behind the woofers. A detail supporting our low-loss design as well as our focus on timing.

Working both as an acoustic tuned 'spring' for the drivers, as well as getting rid of reaction force (resonant) energy, the cabinet is an important part of the entire speaker system.

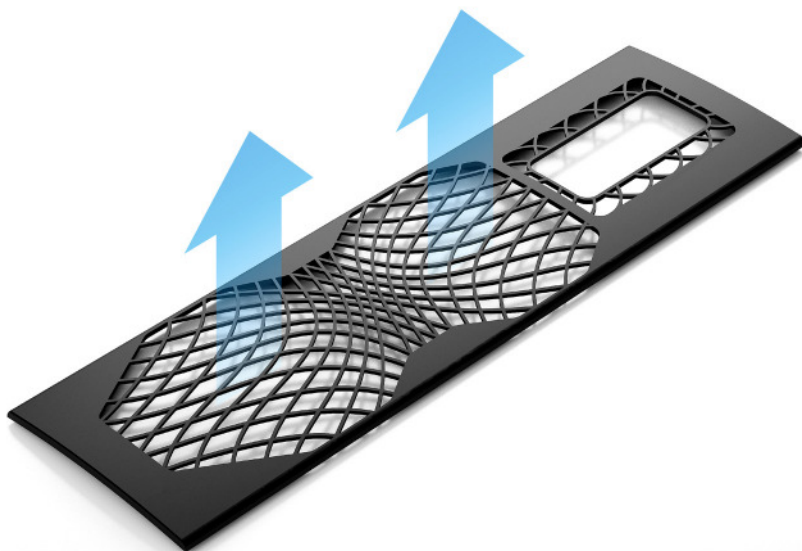
A rigid construction is necessary to optimize the working environment for both woofers and tweeter. The front baffle, sides and top of the EPICON speakers are heated in a process that allows us to press them into an organic shape. This design increases overall rigidity and severely reduces cabinet resonances. Furthermore standing waves are practically eliminated as there are no parallel surfaces reflecting sound waves.

Each side of the EPICON 2, 6, and 8 is constructed from 6 individual layers of MDF, all glued together. In the EPICON 2 and 6 these are anchored to the 53 mm multi-layer MDF backbone of the cabinet. To maintain control in the larger EPICON 8 the backbone is 63 mm thick. CNC milling process is applied for making the recess and holes for the bass ports and terminals in the backbone.

With a thickness of 33 mm the dual-layer front baffle ensures that energy from the drivers is radiated as acoustic energy, and not as vibrations in the cabinet. The curved shape of the front baffle is also a contributing factor in ensuring a stable acoustic platform.

Internally the cabinet for the EPICON 6 is divided in two identical sized chambers, allowing tuning of the cabinet to be done identically yet completely independently for each of the two woofers. Thus you will find two bass ports on the back of the cabinet located as nearby the woofers as possible. Both ports are convex tapered in both ends to minimize port turbulence.

At the very bottom of the cabinet, however, you will see that the hardwired crossover is mounted in its own enclosure as well - free from the dynamic variation of cabinet pressure inside the bass reflex enclosures.



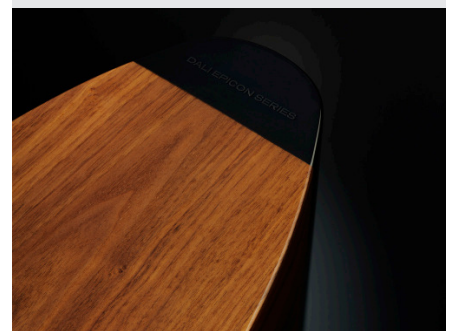
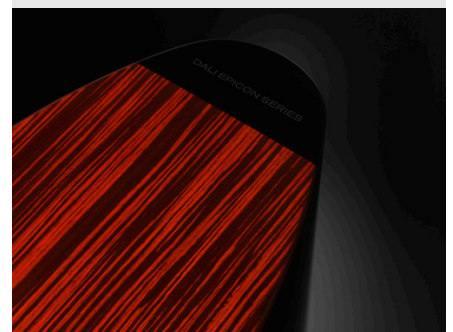
Even the layout of the grille pattern was subject to serious experimenting. There are no similar sized holes, the benefit being that the cloth stays silent on the grille itself. Multiple, identical holes would cause the cloth to vibrate on the grille as the airflow through each hole would be identical.

These partitions as well as the internal bracing have been very carefully positioned within the EPICON 6. Following DALI's philosophy of optimizing the timing in all aspects, a free airflow is crucial to the sound experience.

The DALI EPICON 8 is built in the same way. It features, however, an extra chamber for the midrange. This allows the driver to reproduce the critical

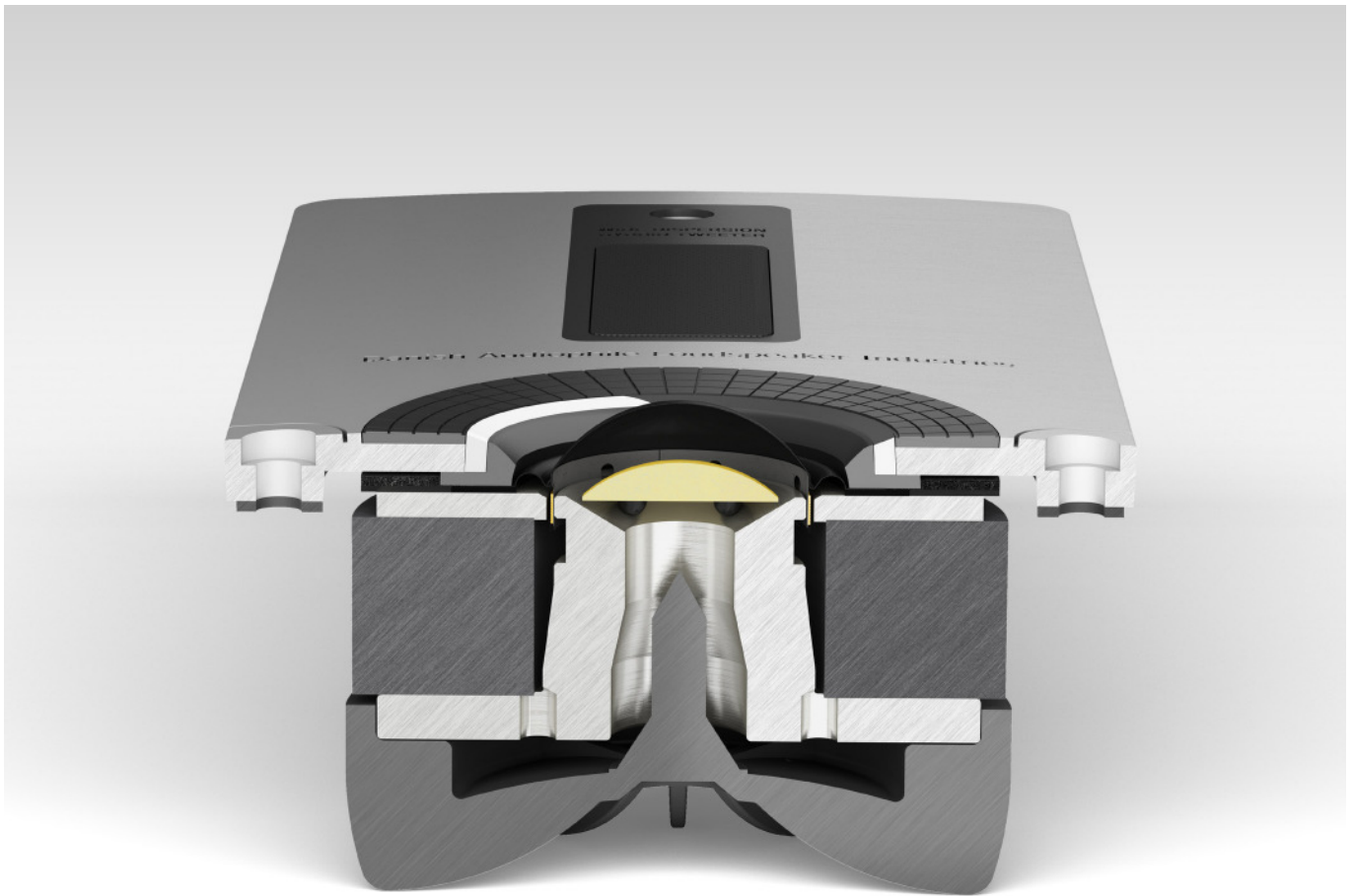
frequencies related to e.g. human voices without any interference from the rest of the system.

Both tweeters are well protected from any interference from within the cabinet. The dome as well as the ribbon sit in a common, solid, die-cast aluminium base plate, each with their own enclosure to make sure that no resonances will reach the sensitive parts.



Craftsmanship, perseverance and patience mixed with the highest quality real wood veneer and high gloss lacquer grants you the choice of Walnut, Black, and Ruby Macassar in the EPICON series.

The finish of the cabinet is real wood veneer which is lacquered for a total of 10 times. And in between, each layer is hand polished to ensure a deep, high gloss and elegant surface. 10 times of lacquer also ensures a sturdy finish with a thickness of almost 2 mm. That means that the entire CNC cutting for drivers, ports and terminals is done after the paint process to ensure perfect fit.



DOME

Low resonance frequency, high power handling, and exceptional headroom for high sound pressure levels and extreme excursions are all characteristics of the oversized soft dome tweeter. It is rolled in carefully around 2.5 - 3.1 kHz, depending on the model. And the dome is allowed to operate up to its high frequency limit well beyond 20 kHz without being rolled off in the crossover. Incorporating an ultra-thin magnetic fluid for cooling, the fluid has a very high flux saturation point for greater power handling. This also means superb control of coil movement - even at very high sound pressure levels. The

dome material itself is very lightweight, and actually so thin that the coating contributes with a significant part of the dome structural stiffness.

RIBBON

The ribbon tweeter features a broad frequency band and superb dispersion in the higher frequencies. Gently rolled in above 10 kHz, the ribbon reaches full contribution from 15 kHz to well beyond 30 kHz, far above the audible range.

Equipped with a rear chamber fitted with rigid bracing, the ribbon is shielded from the disruptive influence of the woofers. The DALI ribbon tweeter is a

true master in horizontal distribution of high frequencies, and a superb partner for the soft dome tweeter's unique ability to reproduce frequencies from 2.5 kHz upwards.

Both the soft dome and the ribbon tweeter are free of artefacts, e.g. resonances and high Q peaks within their working range. The Hybrid Tweeter Module features an extremely smooth and wide horizontal dispersion - one of our sound design trademarks. Even the detailing of the faceplate of the tweeter module is designed for optimal horizontal dispersion.

WOOFER



Since the introduction within the EUPHONIA series further refinement of wood fibre cones has been the target for numerous in-house experiments.

The result of this development process is the latest generation of the wood-fiber cones, including new cone impregnation process and a new post-assembly coating.

As we wanted to keep this treatment process, - all the assembly processes in general - within very tight tolerances, in order to reproduce the exact same performance as obtained in the laboratory, the establishment of in-house manufacturing of drivers was an important step.

With the background of in-depth loudspeaker driver design for years, and having engineers with loudspeaker drivers manufacturing experience in-house, DALI started up the process of establishing in-house production of drivers in 2009. Today we are proud to present the result: DALI EPICON woofers are not only developed - but also manufactured at the DALI headquarters in Denmark!

The vast majority of known types of mechanical losses are extremely non-linear and thereby adding level dependent distortion to the driver's reproduction.

At DALI we believe in designs based on low mechanical loss. Actually we were among the first to insist on controlling the frequency response by carefully balanced designs, even with very low-loss rubber surrounds that will reveal such problems in many well-known driver designs.

It is very easy to control the frequency response by adding lots of mechanical damping in e.g. surround and cones. But our approach is different: We do not want to use such non-linear mechanical effects to control, dampen or limit the movement of the parts that should reproduce the music. We want the amplifier voltage and current to be the factor to control the movement - despite the fact that it isn't easy to design low loss drivers.

Next we will look into the major culprit when it comes to distortion - the magnet system.



Wood fibres add stiffness to very light paper cone membranes, ensuring non-uniform break-up characteristics within the material. The result is a structural stiffness showing top-class behaviour. The wood fibre technology has proven to be a key in reproducing the finest details and dynamics in the music with very low loss of information.

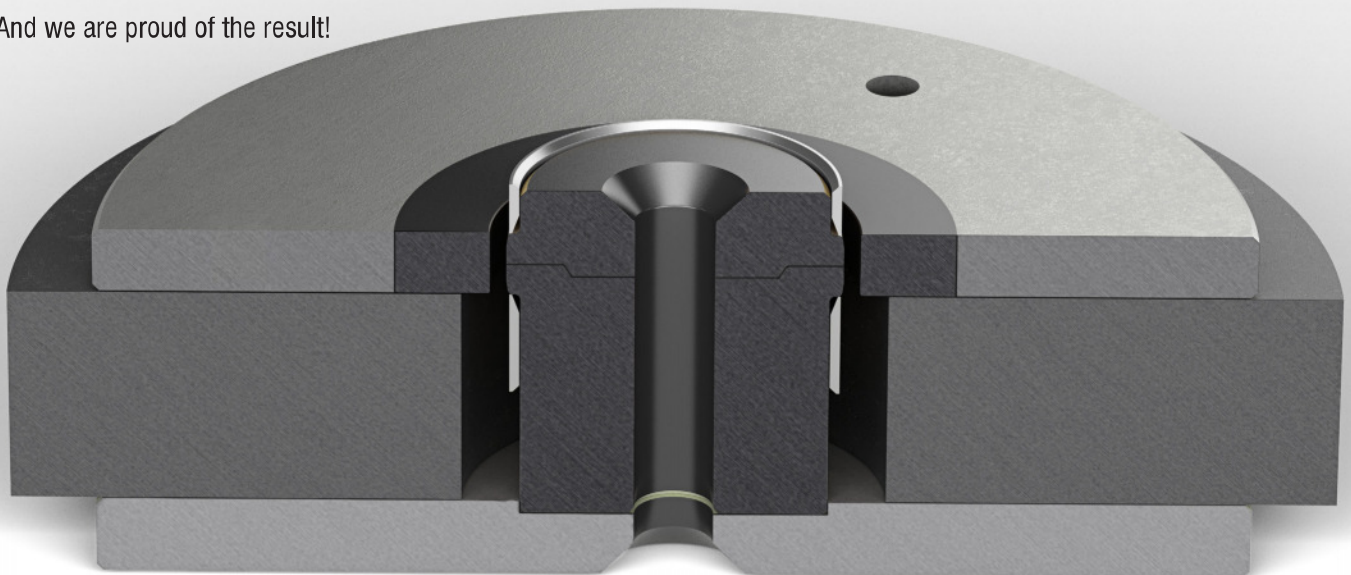
LINEAR DRIVE MAGNET SYSTEM

For years designing magnet systems has been a DALI specialty.

For the EPICON series we decided to challenge the highest market standards and to take magnet system design further than ever before in order to reduce distortion generated from less than perfect magnet systems.

New materials, new processes - and hundreds of hours of engineering were needed.

And we are proud of the result!



The Linear Drive magnet system design



The Tools

First of all we needed to understand the physics of the magnet systems in loudspeakers even better than before.

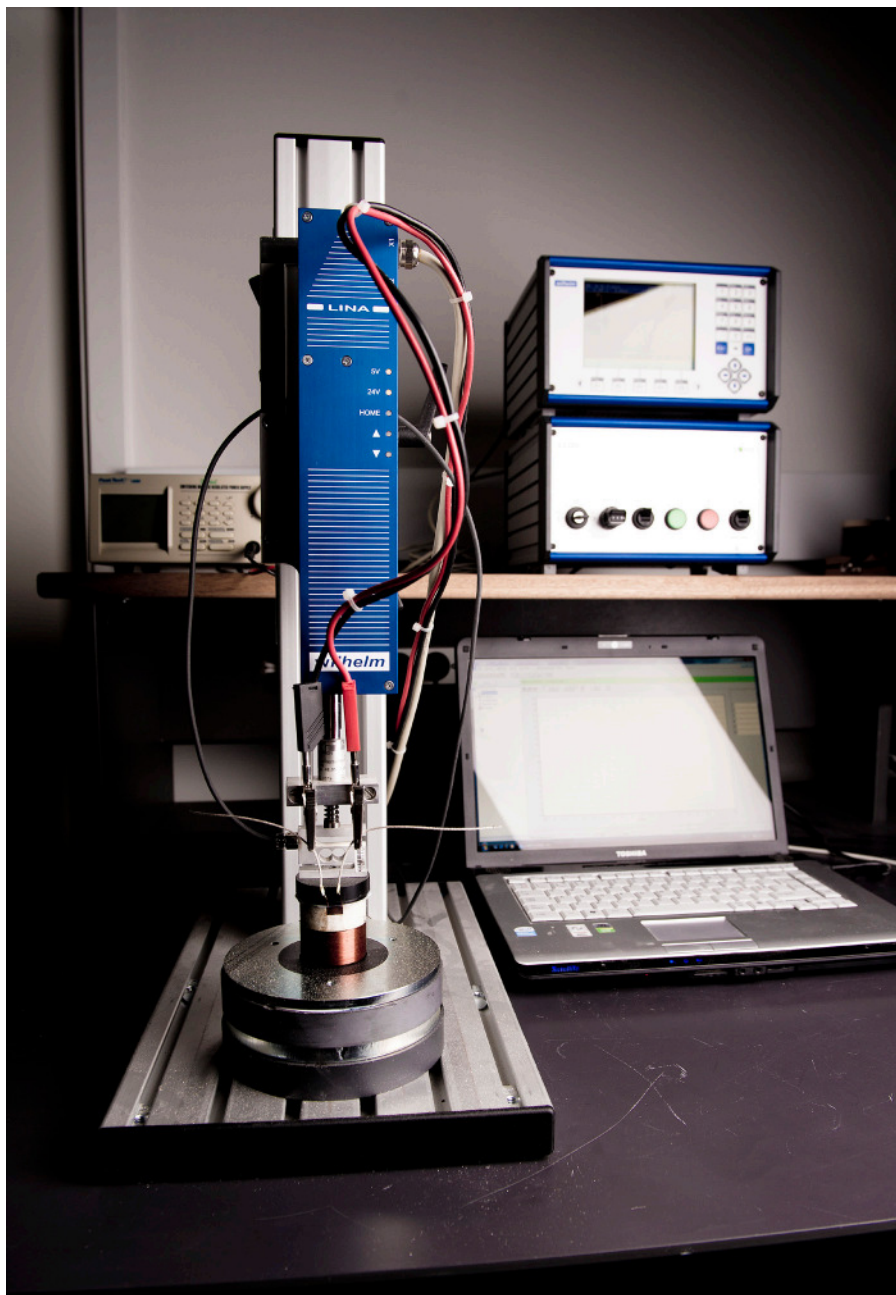
The DALI R&D engineers did not settle for using standard simulation programs and commercially available measurements systems.

Although well known Finite Element Programs like COMSOL are used for magnet system design, we have developed and added our own software for a better understanding of both DC

and transient physics in the motor system (voice coil plus magnet).

Likewise, a custom built measurement setup has been designed to give a direct and precise reading of the profile of flux density in the magnet gap, the force factor versus excursion, and the voice coil inductance as a function of the position.

These tools have enabled us to design and verify the motor system performance to perfection.



Force Factor

While many people know about the importance of the right BxL product (force factor) to generate sufficient power for adequate sound pressure levels and (even more important) the desired electrical Q of the woofer (the BxL product influences the Q_e in the power of two), little attention is often given to the potential improvements in a distortion reducing design.

The attention to the many factors in magnet system design is especially important in midranges and woofers, where excursion is long and current is high.

Symmetry and Stroke

Having tuned the design to the desired BxL value the first step is to ensure a symmetrical BxL curve with as long as possible a linear stroke. This design requirement is taken into consideration in most speakers in the market, except for very inexpensive designs.

But the quest does not finish here. It is important to reduce - ideally to eliminate - all non-linearities in the conversion of the output from the amplifier to the force that drives the cone.

Voice Coil Inductance Linearization

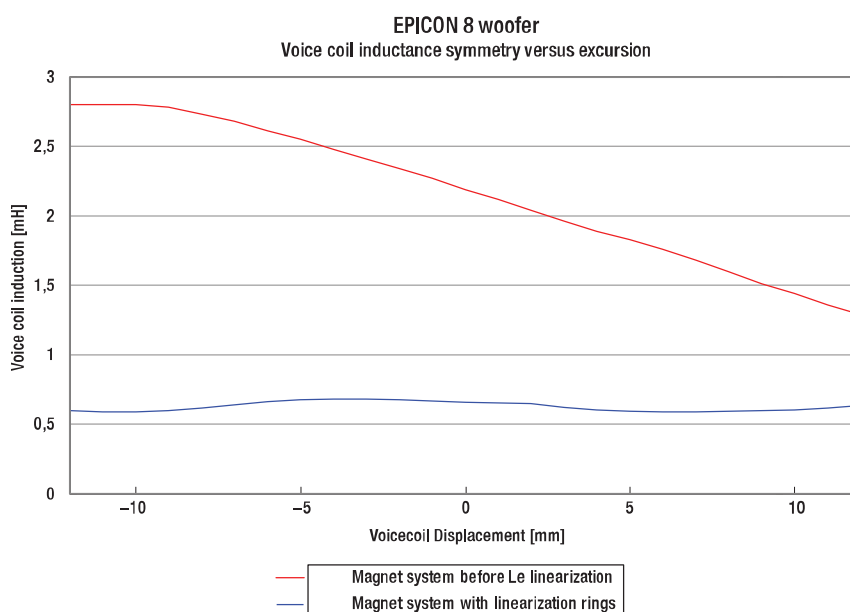
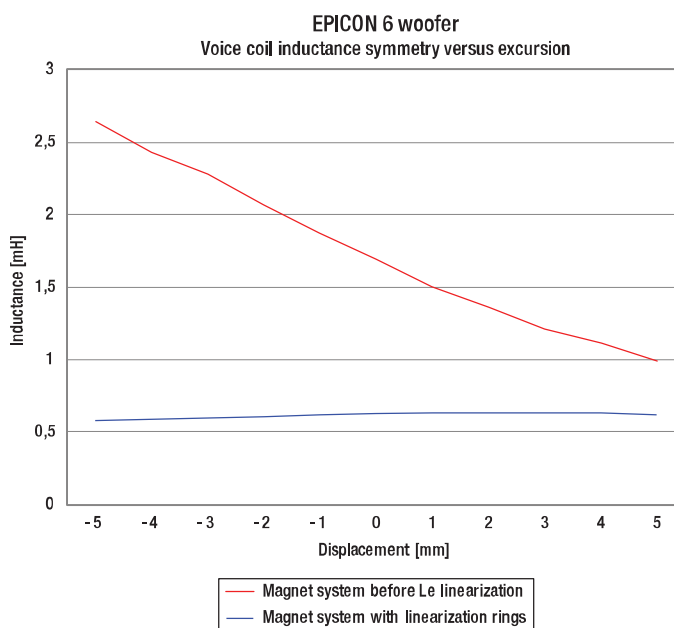
The output from the amplifier is a voltage swing, while the force generated in the motor system is a function of current.

Thus, the impedance seen by the amplifier needs to be stable. However, in most magnet systems the voice coil inductance depends on the position of the voice coil (the cone excursion).

When the voice coil moves towards the magnet system relatively more iron (the pole piece) is 'seen' by the windings of the voice coil, resulting in a higher voice coil inductance (L_e). This means higher impedance at higher frequencies when the cone (and voice coil) travels inwards.

The opposite effect occurs when the cone and voice coil travel outwards. Consequently a modulation of the crossover frequency is seen as a function of voice coil movement.

In the EPICON midrange and woofers, the voice coil inductance is significantly reduced and kept constant within small variations during the entire excursion by the use of two carefully dimensioned aluminium rings around the pole piece. The remarkable effect can be seen from the measurements to the right.



Voice coil inductance as a function of excursion is shown on the lower curve, compared to an identical design, only without linearization rings (the upper curves).

The EPICON 8 woofer is seen on the bottom illustration, and the EPICON 6 mid-woofer to the top illustration.

Current Immunity and Frequency Independence

Two problems even more difficult to solve than the voice coil excursion dependency are:

The modulations of the flux in the magnet gap, when current running through the voice coil windings generates new 'competing' flux in the magnet gap.

The frequency dependency of the electrical and magnetic properties of the iron parts.

The way to eliminate these two artefacts without compromising any of the above listed qualities was to use

new materials with electro-magnetic properties different from iron.

The answer turned out to be a Soft Magnetic Compound (SMC) material which offers exactly the right physical properties.

As this material needs quite advanced processing, DALI R&D engineers have worked together with a European specialist company outside the traditional loudspeaker industry to develop the design, and to manufacture the parts for the EPICON woofer magnet system.



The fine grain SMC material is an important building material in the materialization of the high performance EPICON magnet system.

Physical properties of SMC

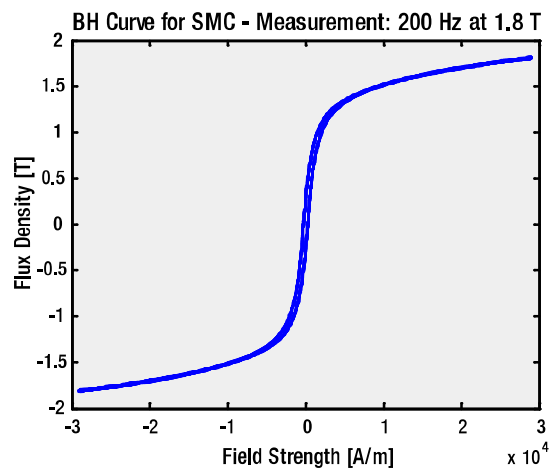
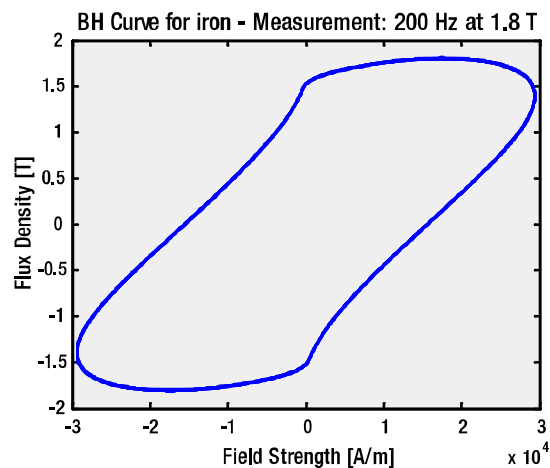
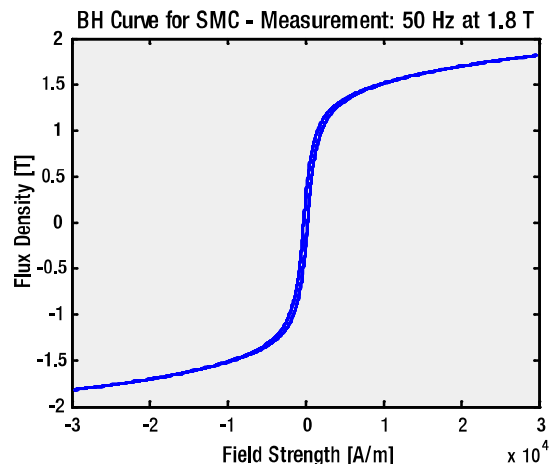
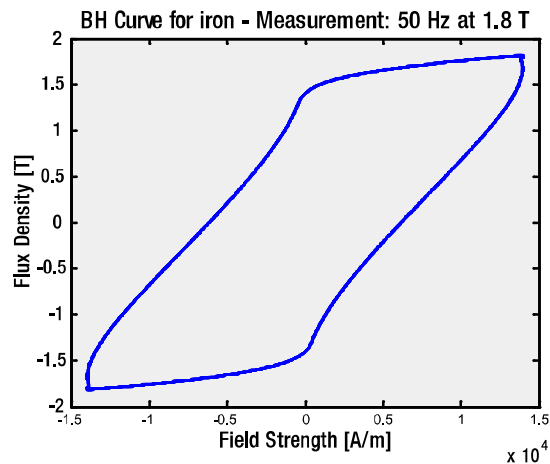
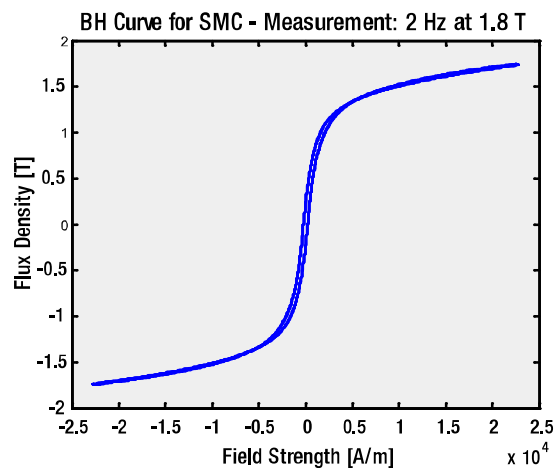
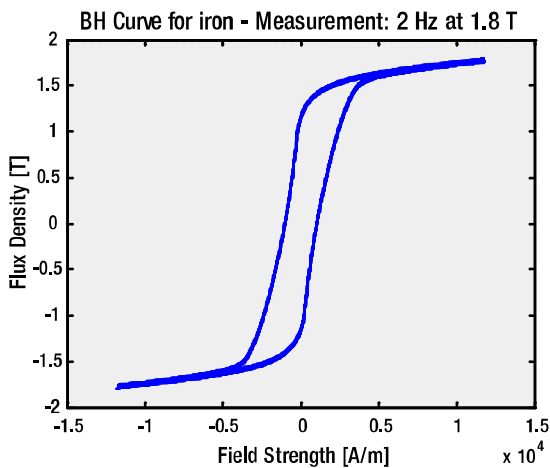
The nature of the hysteresis (magnetization curves) in pure iron is often only considered to be like text-book illustrations. However, this idealized situation is only the case when the frequency approaches DC.

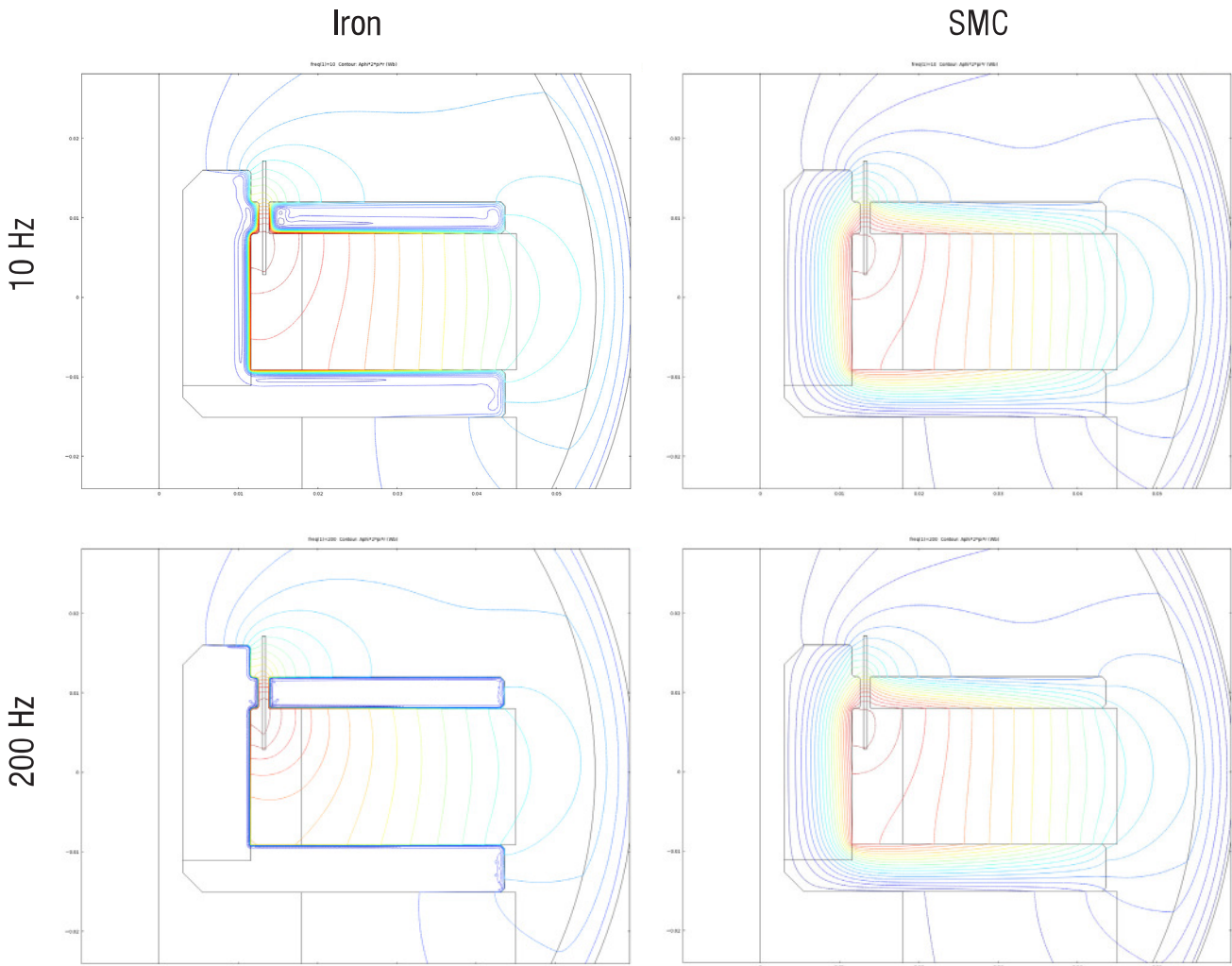
At higher frequencies (even at just 50 Hz) the shape of the hysteresis curve changes to something far from the well-known curves.

The use of SMC for critical parts in the magnet system changes this frequency

dependency of the hysteresis curves dramatically.

Another important aspect of the frequency dependency is the way the iron in the magnet system is "seen" by the voice coil versus the scenario using SMC.





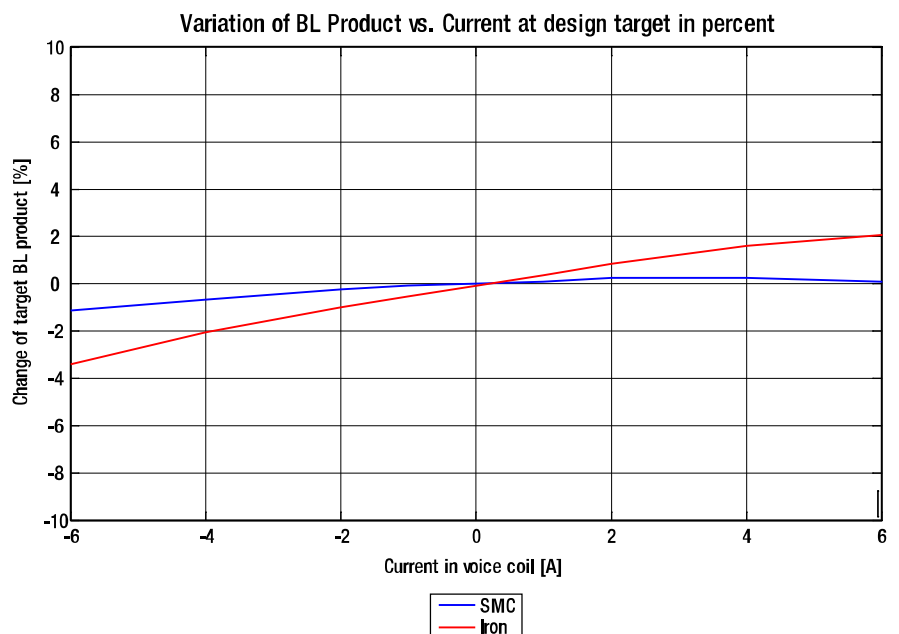
The above illustrations shows the flux lines generated in the magnetically conductive parts of the magnet system (iron or SMC).

Current linearity

In a standard iron-based magnet system, the current in the voice coil will modulate the flux in the magnet gap.

Modulation of the flux in the magnet gap is a cause of distortion, and far from the ideal situation: A stable, un-influenced, un-disturbed static flux as the working environment for the voice coil.

(The modulation will be most significant if a relative small or weak magnet is used, as the iron near the magnet gap will be less magnetically saturated, thus you get a part of the way to a stable flux by choosing highly saturated magnet system).



However, a real substantial reduction of the current-generated flux modulation, can be only obtained by using electrically non-conductive materials near the magnet gap, - as this part of the magnet system is (by nature of a magnet system design) very close to the voice coil.

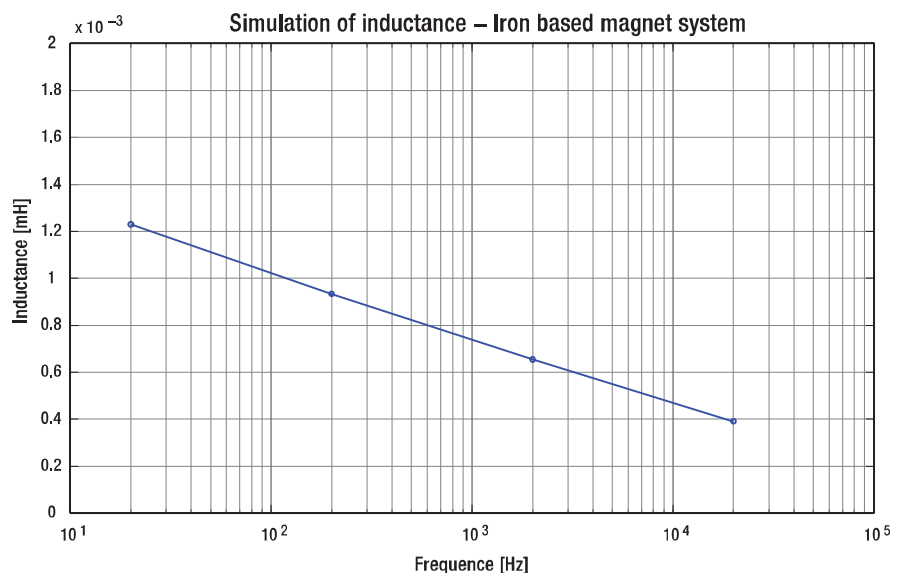
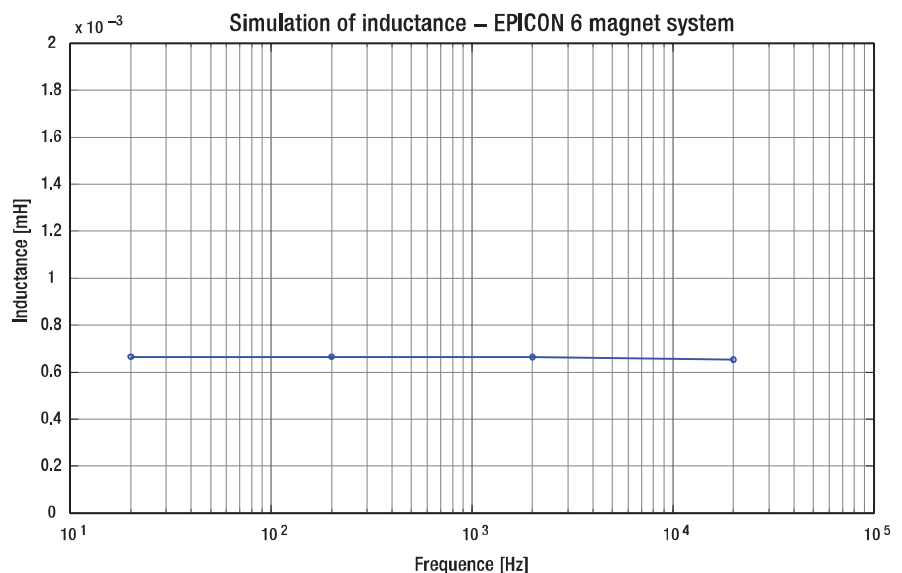
The SMC material used in the EPICON midranges and woofers offers exactly the right properties: Very high magnetic conductivity and very low electrical conductivity (approx. 1/10.000's of iron).

On the illustration on previous page is shown the comparison of the magnetic flux in the magnet gap of a EPICON 6 mid-woofer (the blue line) compared to an identical magnet system design, only build on pure iron parts in the magnet system (the red line). The only difference is the presence of SMC near the magnet gab in blue-curve version. All dimensions, ferrite quality, voice coil size etc. are identical in the two different magnets system designs.

The SMC-version is significantly less influenced by the current in the voice coil, reducing the distortion from current generated flux variations accordingly.

The electrical non-conductive nature of the SMC material eliminates the induction of modulating magnet fields in the magnet gab.

On this page is shown the influence on the BxL-product (force factor) in a traditional soft iron based magnet system versus the same physical design built with SMC components.



Furthermore, the SMC material offers very frequency linear magnetic properties. This means that the voice coil inductance - and thus the conversion of the amplifier voltage

output to current through the voice coil - and force factor is constantly kept way beyond the working area.

The Result of Linear Drive Magnet System Design

While more expensive to build, significant improvements compared to former available loudspeaker motor designs have been developed and implemented in the EPICON woofer magnet system.

We have chosen to name the design Linear Drive as the motor system is linear with respect to excursion, current and frequency.

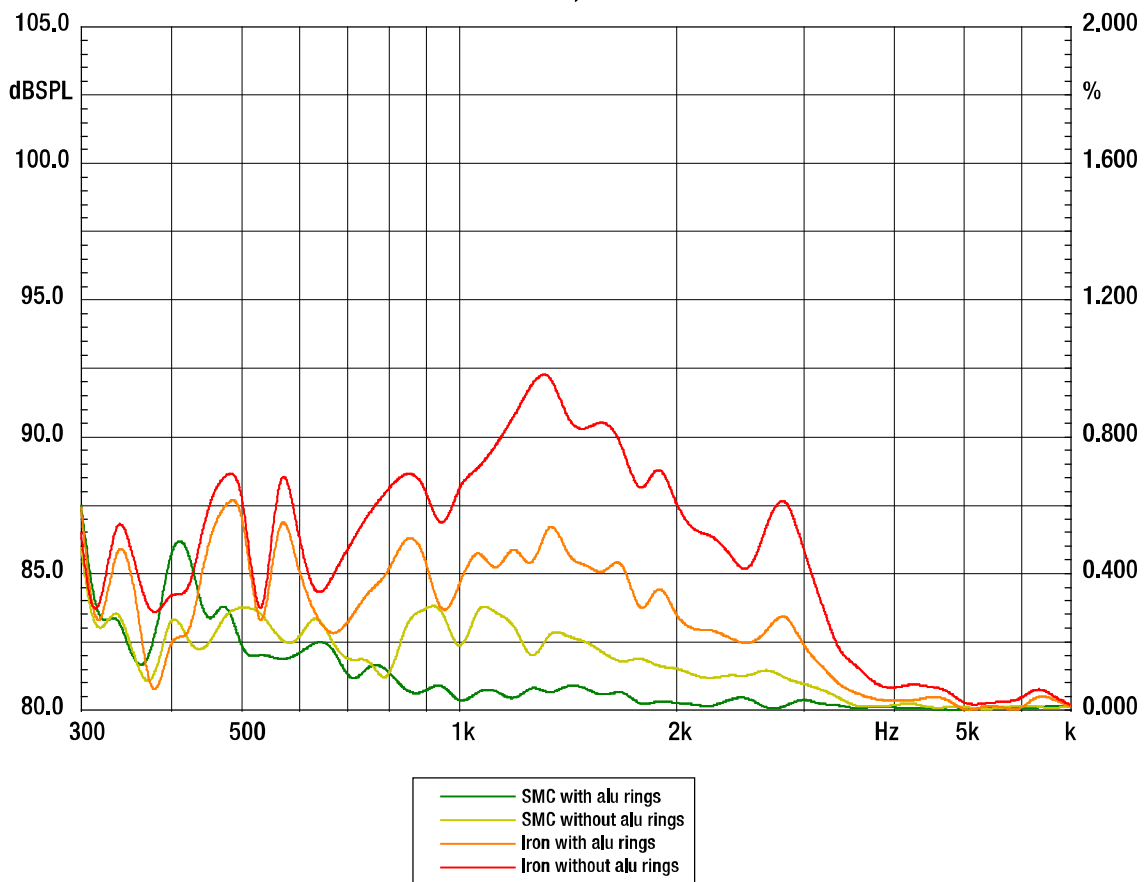
The reduction of distortion is both very clearly measurable and indeed audible. The sonic superiority has to be experienced, while the below curves indicates the excellence of the EPICON magnet system designs.

The illustrations show comparison between 3rd order harmonic distortions measured on identically built drive units, with the only exception being the materials used in the magnet systems.

While voice coil inductance linearization rings and SMC alone make large improvements, the combination (applied in a carefully engineered geometry) reduces the distortion to a very low level.

We believe that the EPICON sets new standards for loudspeaker driver performance.

EPICON 6 woofer, 3rd order distortion



SIGNAL PATH

All EPICON speakers feature a dual set of terminals on the back, allowing for both bi-wiring and bi-amping. For single-wiring/amping the speakers come with a set of terminal links made from gold-plated copper for maximum connectivity.

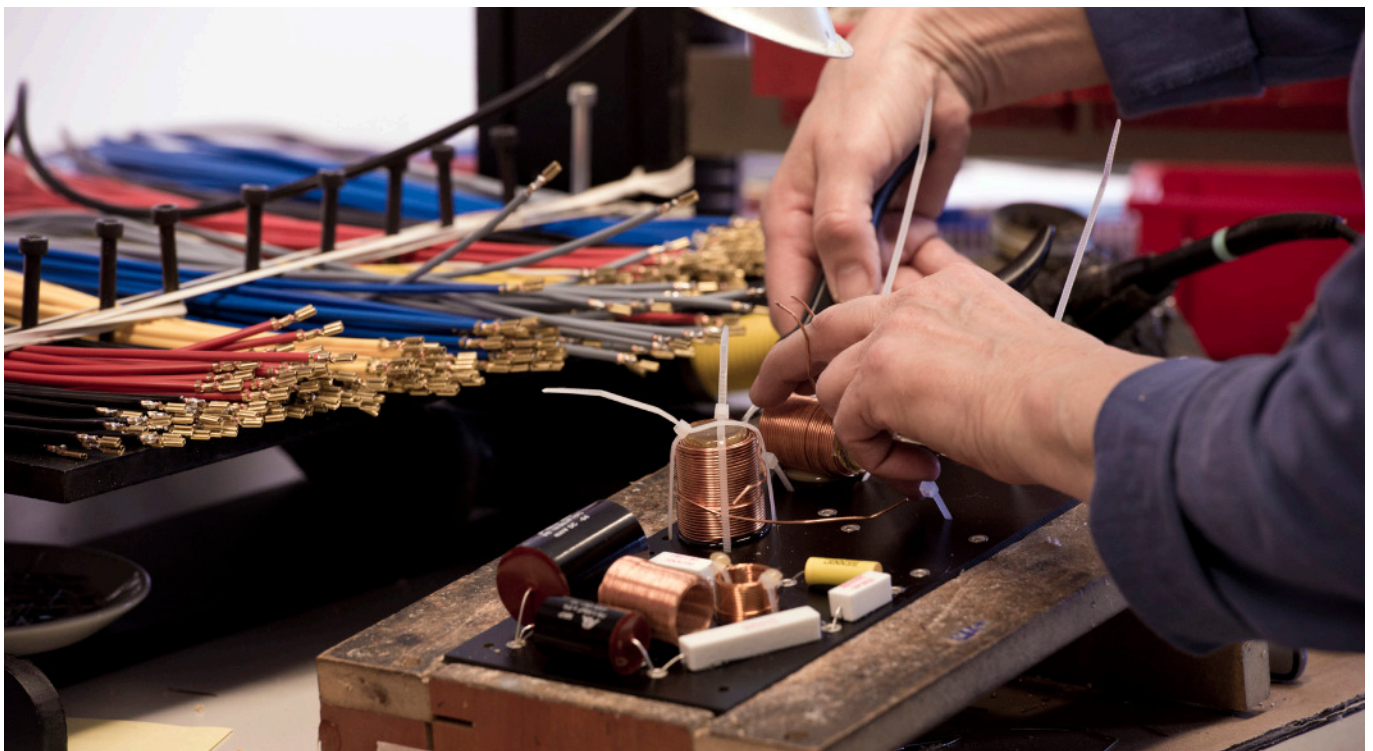
The sturdy gold-plated terminals are DALI-designed. A design which has been applied and refined in our high-end series over the last many years. They accept fork cable lugs, bare wire, and banana plugs. The recess in which the terminals are mounted has been shaped to help guide the cable into the terminals.

Inside the speaker the signal travels through DALI's proprietary Cordial

III cable, originally developed for the DALI Megaline speaker. 37 strands, each \varnothing 0.32mm, wound in 4 layers (1+6+12+18) to achieve the best from both worlds; solid core and stranded cable, respectively.

A no-compromise cable with concentric windings for superior mechanical stability, and almost eliminating any micro-induction effect within the individual strands. The polyethylene isolator also helps decrease dielectric absorption.

The Cordial III cable is applied in all internal wiring, except for the connection from crossover to the ribbon tweeter. This connection is handled by the Cordial I cable – a thinner cable dedicated to the very high frequencies.



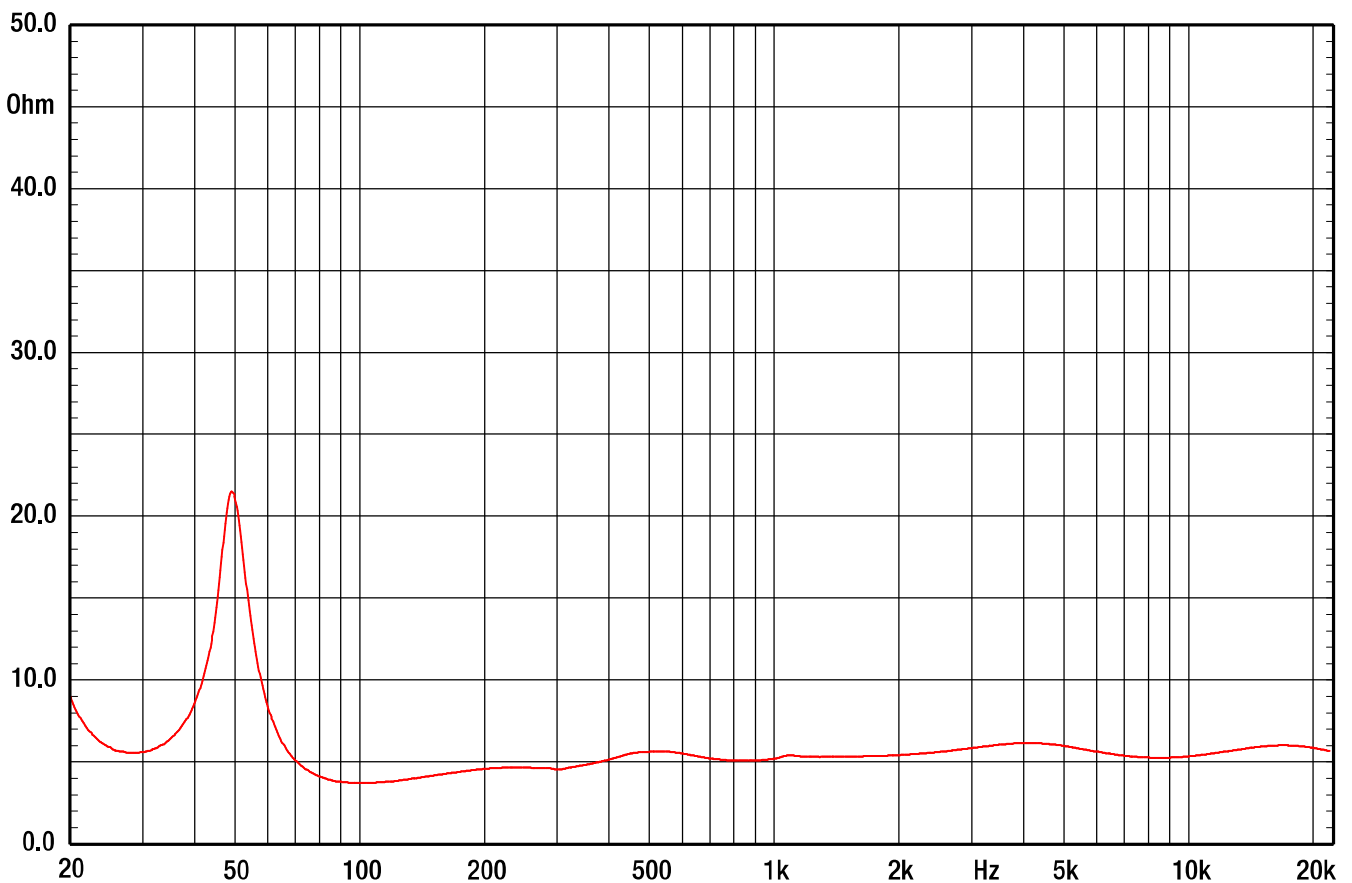


The EPICON loudspeakers are capable of extremely detailed and precise reproduction of the signal generated by the amplifier.

And, a better amplifier performance will most likely reveal new levels of the EPICON performance potential, we take great care in creating optimized working conditions of the amplifier. With exceptionally flat impedance across the audio spectrum, EPICON loudspeakers present an easy load to the amplifier for significantly reduced amplifier distortion.

With high quality amplifiers, working in the optimized load of the EPICON, the music signal will simply be reproduced through an extremely good reproduction chain.

DALI EPICON 8 Impedance response



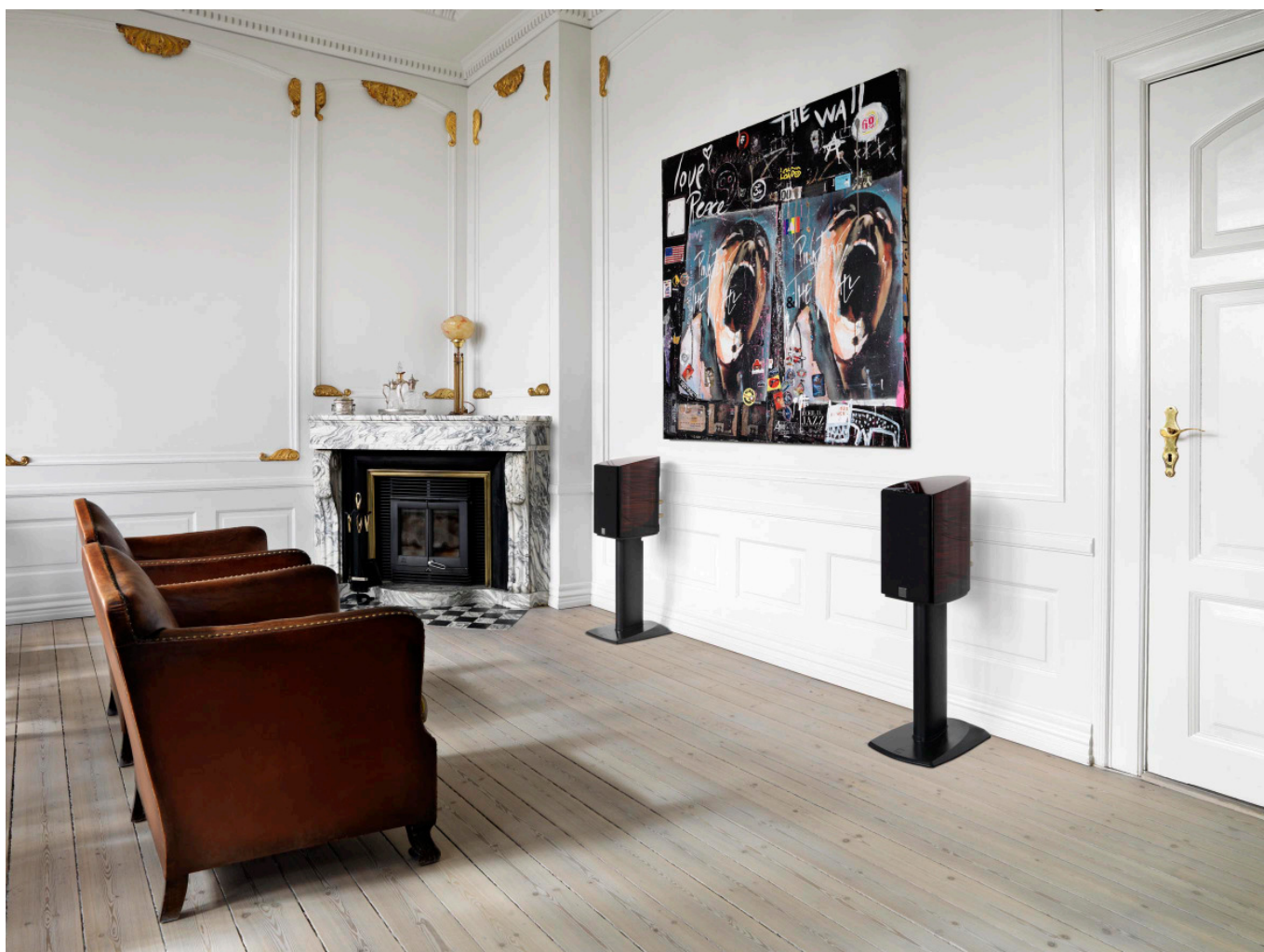


A note from the chef...

Adhering to DALI's low-loss sound principle the crossover must be as simple as possible. Naturally this requires the best 'raw material', e.g. drivers and cabinet. In EPICON this is exactly what we have. And each component in the crossover has been handpicked for its specific abilities after hours and hours of measuring and listening.

The crossover is hand-soldered for shortest distance and best contact point. Even though the crossover sits in its own chamber, sealed from fluctuating air pressure, a solid MDF board still constitutes the platform, virtually eliminating any resonances.

Wiring running from the crossover to the drivers is sealed where it enters the different chambers in the cabinet. Furthermore it is held in place by internal bracing to reduce the risk of vibrations being picked up. For termination DALI relies on spade lugs for long-lasting, low-distortion contact points.



The EPICON speakers are all supplied with a detachable front grille to allow for flexibility in appearance. For a clean look, and for easy and secure mounting/dismounting of grilles, both the cabinet and the grille feature concealed neodymium magnets. With the grille in place the EPICON radiates powerful elegance, and without it clearly signals acoustic superiority. And all in a design which will last a lifetime.

APPLICATIONS

EPICON 2 demonstrates perfectly what this new series is all about: Minimal signal degradation... or put bluntly: Transparency and revelation taken to an - until now – unseen level!

This speaker demonstrates a highly linear and coherent response, and integrates well with small to medium-sized rooms. The woofer roll-off is slow, and the speaker reaches deep into the lowest frequencies. All in all, in most setups this will sound like a much larger speaker than it really is.

Within its working range the EPICON 2 will fully match the performance quality of its larger siblings, the EPICON 6 and 8. This is the new compact speaker for the purist seeking high-performance sound.

In essence the EPICON 6 extends the frequency range both up and down, compared to the EPICON 2.

Featuring the DALI hybrid tweeter module the dome is now handling between 95-99% of the high frequency information – the rest is reproduced by the ribbon tweeter. The

sensation of air, transparency, and effortlessness is evident.

The dedicated woofer in the EPICON 6 carries the responsibility for the higher sensitivity and power handling compared to the EPICON 2.

Consequently it couples well to larger rooms, and will not disappoint in any aspect of its sonic performance.

Essentially the EPICON 6 combines the simplicity of the EPICON 2 with the power of the EPICON 8.

Maintaining the transparency and level of detail was important in the development of the EPICON 8. Though larger than the rest, this speaker presents both micro- and macro-dynamics with an authority which is hard to believe.

A more complicated speaker in the development, but also a rewarding speaker which will never let you down. The dedicated midrange driver blends in seamlessly with both the hybrid tweeter module and the two woofers.

Listening to the EPICON 8 is like driving slowly in a supercar; it feels great at 80 kph, but you're just waiting for that stretch of empty road ahead...

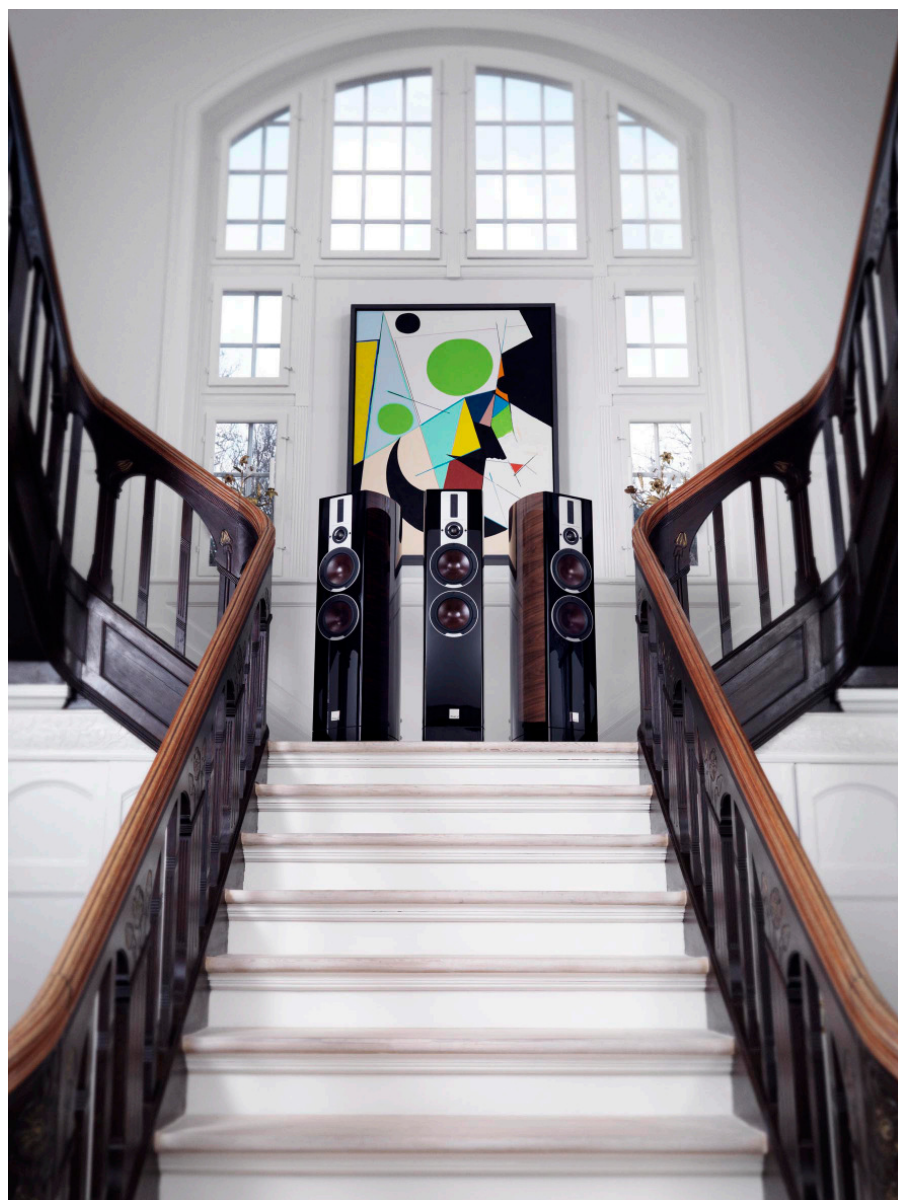
50% of the acoustic energy in a normal movie comes from the center channel. The EPICON VOKAL is up to the real challenge.

Meticulous timbre matching and the same ability to render finer details exactly the way they were recorded is an EPICON trademark. Here, e.g. the effortless reproduction of human voices is what sets DALI EPICON VOKAL apart.

EPICON VOKAL will match any of the three main speakers, and it will benefit any setup where the realism and realistic sound pressures are required.

Common to all the EPICON speakers is that they work well in both 2.0, 2.1, 5.1 or other multichannel systems.

However, common to all of them is also that the new, ultra-low level of distortion in this series puts up some new demands. Electronics suddenly become an even more important part of the value chain. Like it or not... when connecting a pair of EPICON speakers to your existing system you will likely be able to hear details on the recording OR from your cables/electronics which you did not notice before.



The sonic clarity and transparency of EPICON demand high resolution electronics with sufficient power output. Thanks to the well balanced combination of high sensitivity and very linear input impedance, EPICON will not load the amplifier in an unnecessary complicated or tough way. This will offer the owner a fair chance of selecting amplification with the absolute highest level of audio performance. The DALI engineers strongly advise you to look for "agile, responsive quality watts" rather than many hundreds of "biceps watts on steroids".

Once you finally sit down and make your personal review of the EPICON sound performance you may very well end up reviewing the quality of the amplifier and all that comes before it, including - of course - the quality of the actual recording.

Provided all these links of the audio chain are doing their job the way they should, we guarantee DALI EPICON will deliver nothing less than an EPIC performance!

EPICON TECHNICAL SPECIFICATIONS

	EPICON 6	EPICON 8	EPICON 2
Frequency Range [+/- 3] dB [Hz]	35-30,000	35-30,000	47-30,000
Sensitivity [2.83V/1m] [dB]	88.0	89.0	87.0
Nominal Impedance [ohms]	5	4	4
Maximum SPL [dB]	110	112	108
Recommended Amp. Power [Watts]	50 - 300	50-500	30-200
Crossover Frequencies [Hz]	700/2,550/15,000	550/3,100/15,000	3,100
Crossover Principle	2½+½-way	3+½-way	2-way
High Frequency Driver	1 x 29 mm soft dome 1 x 10 x 55 mm ribbon	1 x 29 mm soft dome 1 x 10 x 55 mm ribbon	1 x 29 mm soft dome
Low Frequency/midrange Driver(s)	2 x 6½"	2 x 8" / 1 x 6½"	1 x 6½"
Enclosure Type	Bass reflex	Bass reflex	Bass reflex
Bass Reflex Tuning Frequency [Hz]	32.5	28.0	43.0
Connection Input(s)	Bi-wire / Bi-Amp	Bi-wire / Bi-Amp	Bi-wire / Bi-Amp
Recommended Placement	Floor	Floor	Stand
Recommended distance from rear wall to speaker's rear side [cm]	>25	>35	>25
Magnetic Shielding	NO	NO	NO
Dimensions (H x W x D) [mm]	1025 x 232 x 441	1225 x 264 x 485	386 x 214 x 366
Dimensions (H x W x D) [inches]	40.35 x 9.13 x 17.36	48.23 x 10.39 x 19.09	15.20 x 8.43 x 14.41
Dimensions with base (H x W x D) [mm]	1059 x 320 x 459	1262 x 353 x 497	-
Dimensions with base (H x W x D) [inches]	41.69 x 12.60 x 18.07	49.69 x 13.90 x 19.57	-
Weight [kg/lb]	29.8/65.7	47.5/104.7	10.3/22.7
Accessories	DALI SPIKE SET, DALI TERMINAL LINK SET, Base plate, Polishing cloth, Rubber feet, Manual	DALI SPIKE SET, DALI TERMINAL LINK SET, Base plate, Polishing cloth, Rubber feet, Manual	DALI TERMINAL LINK SET, Polishing cloth, Rubber feet, Manual

All technical specifications are subject to change without notice.