

DALI PHANTOM K-60 LP

MARCH 2023

WHITE PAPER



DALI

IN ADMIRATION OF MUSIC



Introduction

Installing high performance speakers in ceilings and walls is not always straightforward, and a problem sometimes encountered is the limited depth available within drywall structures to accommodate traditionally engineered speakers and back-boxes. DALI is proud to introduce a solution: the PHANTOM K-60 LP. The K-60 LP, fully designed and engineered by DALI in Denmark, is a ceiling and wall speaker that uniquely combines class leading acoustic performance with extreme low profile dimensions, and no need for a back-box.

In other words; The DALI K-60 LP is the best sounding ultra shallow CI speaker on the market today.

The PHANTOM K-60 LP headline depth dimension, from the inside surface of its front baffle to the extent of its back plate is only 36,5 mm (1.43 in), yet its acoustic performance and sound quality is comparable to, and in some respects outperforms, that of conventionally engineered ceiling and wall speakers of a similar size.

Over the next few pages of this white paper we will describe and illustrate some of the remarkable DALI engineering and technologies that enables the K-60 LP to achieve its unique combination of high acoustic performance and low profile dimensions.

Re-thinking bass/midrange driver architecture

The conventional architecture of a bass/midrange driver is illustrated in Diagram 1 the voice-coil and magnet, often referred to as the motor system, is located beneath a curved conical diaphragm. Between the diaphragm and the voice-coil is the suspension (sometimes referred to as 'the spider') and around the periphery at the top of the diaphragm is the rubber roll-surround. If a driver is not constrained in terms of physical depth, the conventional architecture can work extremely well and numerous award winning and popular DALI speakers attest to that. If however physical depth needs to be constrained, a new architecture is required, and that is what we have introduced with the K-60 LP.

The K-60 LP bass/midrange driver architecture is a completely new development by DALI's in-house engineering team and was inspired partly by the architecture used in the smaller drivers developed for the award winning DALI KATCH G2 wireless Bluetooth speaker.

Diagram 2 illustrates the new K-60 LP driver's low profile principles. It incorporates three primary modifications to the conventional driver architecture that together enable a very significant reduction in overall depth, without compromising performance or reducing maximum diaphragm displacement:

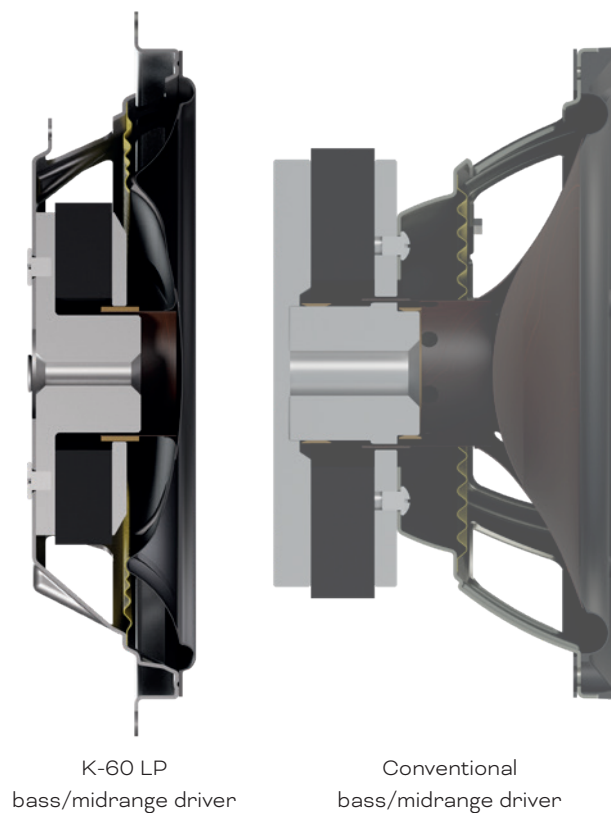


Diagram 1.
Conventional driver architecture

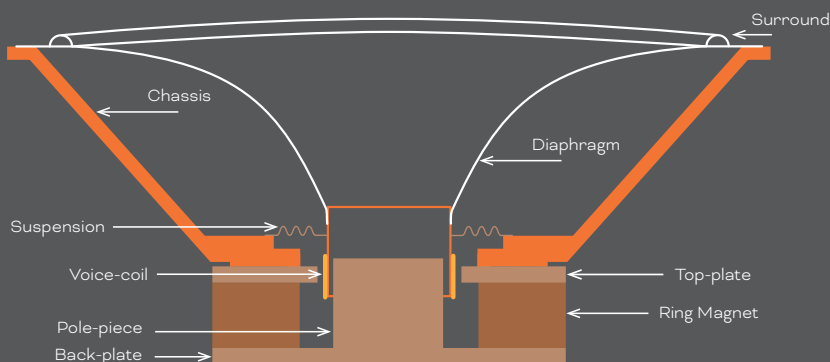
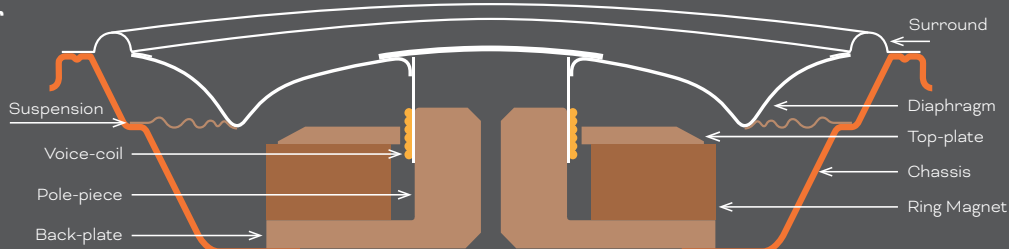
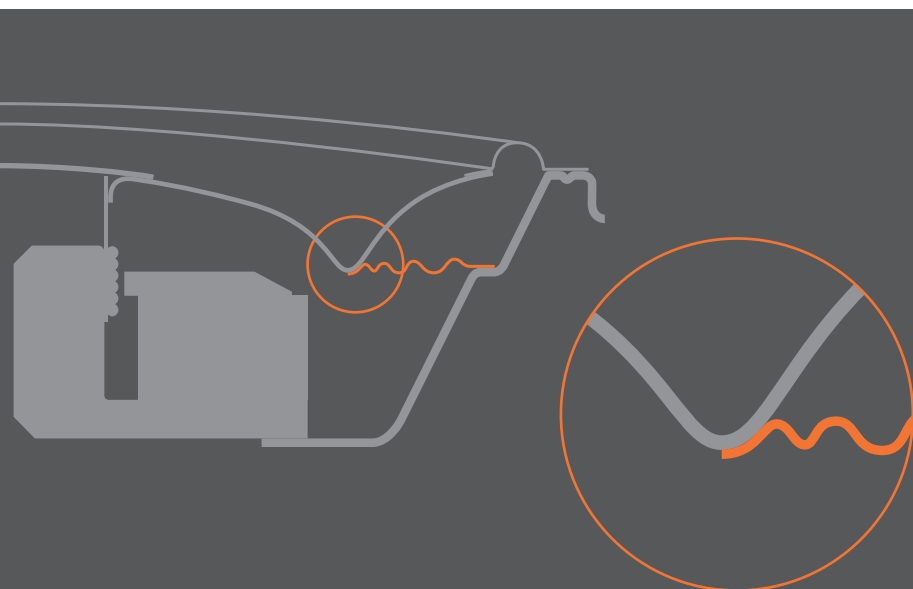
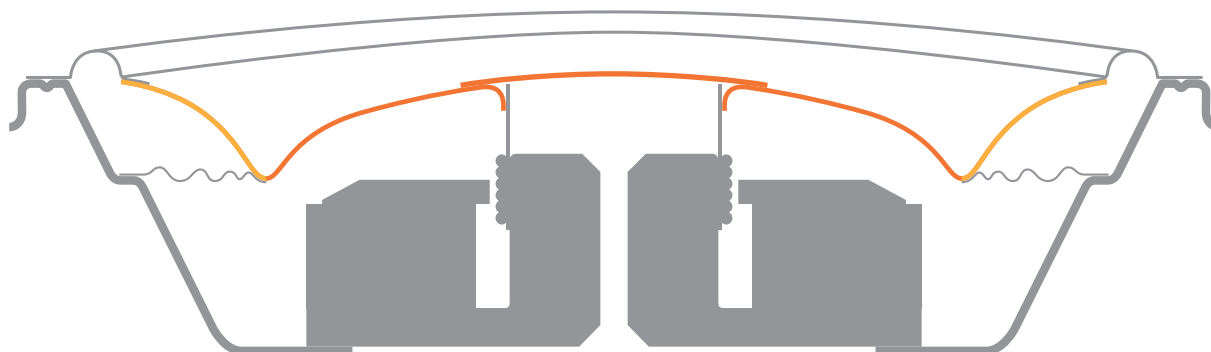


Diagram 2.
K-60 LP driver architecture

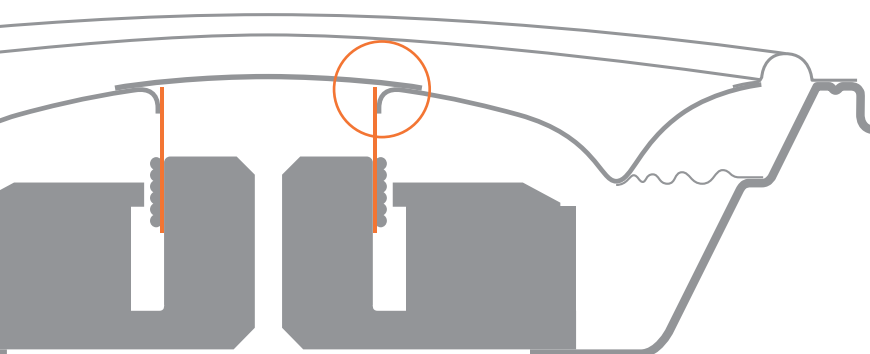


Firstly, the curved outer region of the diaphragm joins a large convex domed region towards its centre. The combination of a curved outer region and a central domed region provides structural rigidity equivalent to that of a conventional diaphragm, however it also offers much reduced overall depth.



Secondly, rather than attaching the suspension conventionally to the voice-coil former, it attaches to the diaphragm at the point where its profile changes from curved to dome. This change of suspension mounting location enables the motor system to be brought much closer to the underside of the diaphragm and so reduce again the depth of the complete assembly.

Lastly, rather than being attached to the bottom of a curved conical diaphragm, the voice-coil former attaches to the underside of the diaphragm dome. This again brings the motor system closer to the diaphragm.



The overall result of these architectural changes is a 150 mm (6 inch) bass/midrange driver with a depth dimension that's less than half that of a conventionally engineered driver, yet its acoustic performance in terms of frequency response, distortion, compression and

diaphragm behaviour is very much comparable. The new architecture makes it possible for the K-60 LP to be extraordinarily slim, yet retain the amazing sound quality that DALI is known for and take its place as the best sounding low profile CI speaker on the market.



Bass/midrange driver acoustics

A new bass/midrange architecture that offers reduced depth would of course be of little worth if the resulting driver's performance were to be compromised, however that's far from the case with the K-60 LP. The most obvious witness to its remarkable performance is the complex 3D form of its pressed and anodised aluminium diaphragm. The selection of aluminium for the diaphragm was necessary in order to achieve the stiffness and rigidity required considering the low profile driver architecture, but in addition to integrating curved and dome regions the diaphragm incorporates seven localised stiffening ribs to

provide further rigidity. The stiffening ribs also provide a channel for the voice-coil lead-out wires (a small detail, but it actually results in slightly increased maximum diaphragm displacement) and their odd number was chosen to help suppress diaphragm resonant modes. As a direct result of its complex geometry, the K-60 LP bass/midrange diaphragm remains pistonic over much of its working range and consequently reaches a level of subjective performance all but unheard of in any similar installation driver, let alone one that offers such low profile dimensions.



No back-box necessary



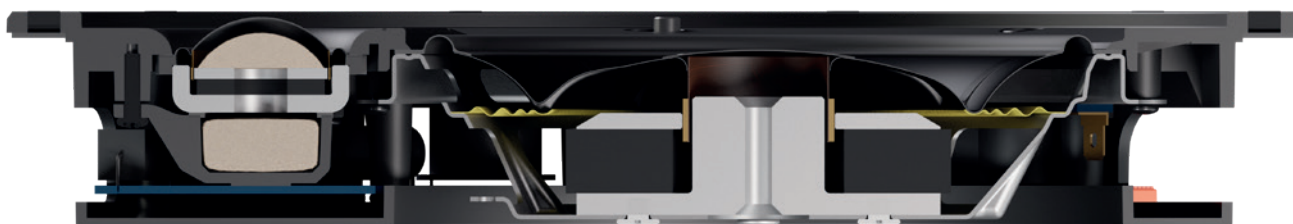
A further important element of the K-60 LP's low profile dimensions is that no back-box is necessary. Back-boxes potentially play multiple roles in ceiling and wall speaker installations: they define the air volume that the bass/midrange driver requires in order to meet its low frequency bandwidth specification, they can assist in reducing sound transmission to adjacent rooms, and occasionally they are required for fire safety compliance. If however, as in many installations, the second two back-box grounds are not relevant, a back-box can add installation complexity and consume precious installation depth.

So the K-60 LP is able to meet its low frequency bandwidth specifications with anything from no back-box at all, to one of 5 litres minimum internal volume. This however means that the low frequency characteristics of the K-60 LP bass/midrange driver had to be specifically engineered to work with a wide range of rear air-volume compliance. So the driver's suspension compliances (suspension and surround) are fine-tuned to provide the restraining force that would otherwise be the responsibility of the back-box air volume. And the K-60 LP driver also, despite its low profile format, is still able to reproduce significant low frequency volume levels from its remarkable ± 7 mm maximum diaphragm displacement.

The perfect problem solver

The ability of the K-60 LP to work without a back-box makes it a fantastic 'problem solver' for those situations where more conventional installation speakers are sometimes limited. For example, height channel speakers in surround sound systems where ceiling void space is restricted. Or the K-60 LP can be mounted in custom slimline on-wall

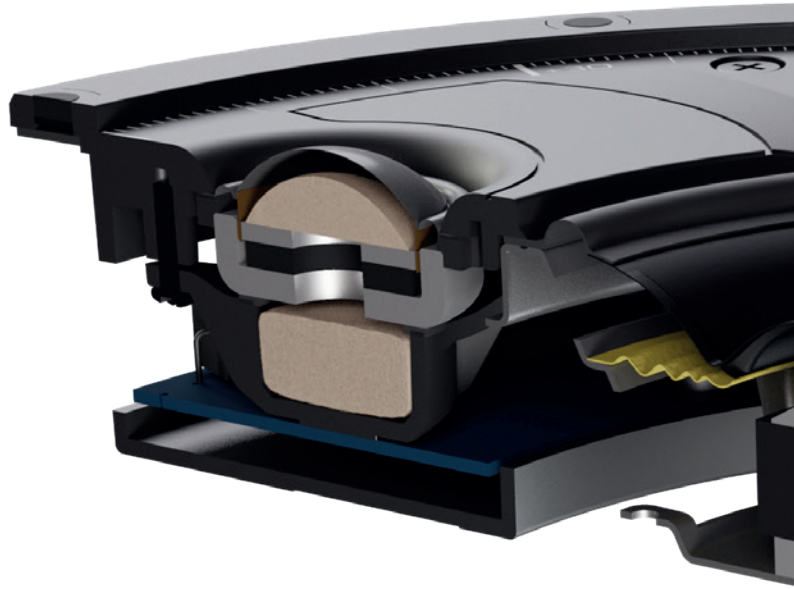
enclosures to create an unobtrusive stereo or side channel speaker where solid walls preclude the use of in-wall solutions. And where an installation requires drop-down ceiling speakers for example, the K-60 LP fitted with a back-box of between 5 and 7 Litres, can play that role too – with remarkable sound quality and simplicity of installation.



Tweeter perfection

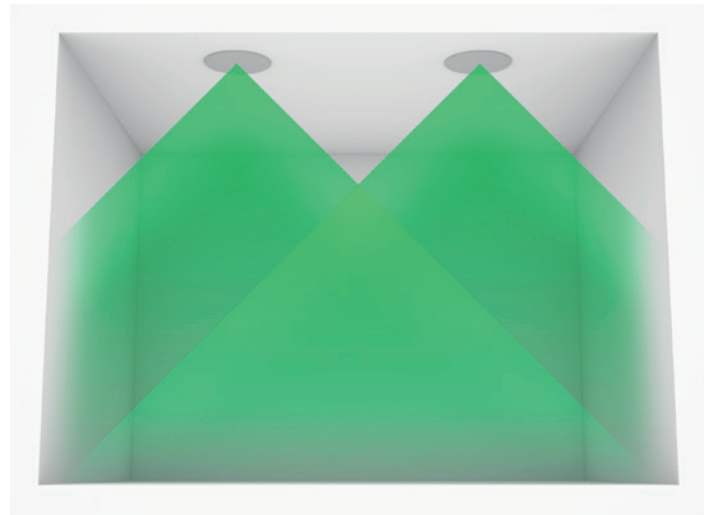
While the astonishing bass/midrange driver of the K-60 LP is its most notable technical highlight, its 25 mm soft dome tweeter is no less remarkable. The K-60 LP tweeter is directly derived from those used in DALI hi-fi models and offers much higher quality than would normally be found in similar installation speakers. In particular, and very unusually for a ceiling and wall speaker, the tweeter is fitted with a damped rear enclosure that serves to lower the fundamental resonance of the dome. The lower resonance enables the tweeter to operate further down the audio band and integrate more effectively with the bass/midrange driver at a relatively low 2 kHz crossover frequency. The tweeter magnet system, again unusually for a ceiling and wall speaker, is a neodymium-iron-boron item. The magnet is designed with a central hole to provide an air passage to link the tweeter dome with its rear enclosure. NeFeB magnets are more expensive than the traditional ceramic alternative, however their low weight and compact size bring significant packaging benefits to a speaker such as the K-60 LP. The tweeter dome is encircled on the K-60 LP front panel by a short curved waveguide that provides dispersion control and radiation impedance matching. And the dome itself is

an extremely fine and lightweight woven fabric item that's able to respond almost instantaneously to reproduce the finest musical detail. It dovetails perfectly with the subjective qualities of the K-60 LP bass/midrange driver and expresses all the qualities that are to be expected from a DALI speaker.



Driver integration and wide dispersion

The K-60 LP crossover integrates its two drivers via an asymmetrical 1st and 2nd order filter network with a 2 kHz crossover frequency. In addition to optimising the on-axis driver integration of the K-60 LP, the crossover topology is designed to ensure that off-axis listening is not characterised by subjectively uncomfortable changes of tonal balance. By their very nature, ceiling and wall speakers are often heard away from their primary axis, so ensuring wide and linear off-axis dispersion is important. This dispersion philosophy is fundamental to DALI's ceiling and wall speaker products and the K-60 LP expresses it fully.



EQ options

Hand in hand with its wide dispersion, the K-60 LP incorporates switched Normal and High+ high frequency EQ options; the High+ option is useful to compensate for very off-axis listening and ensures optimum dispersion in any listening situation.

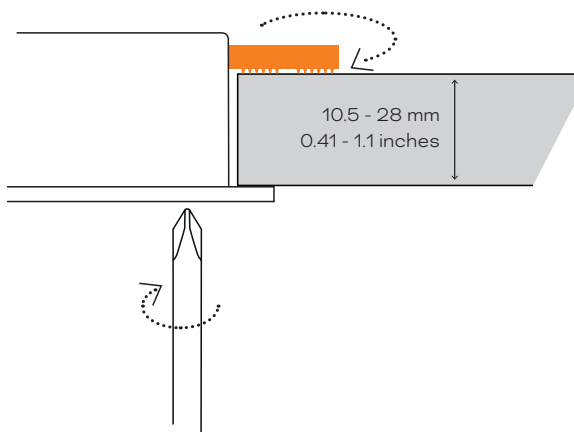
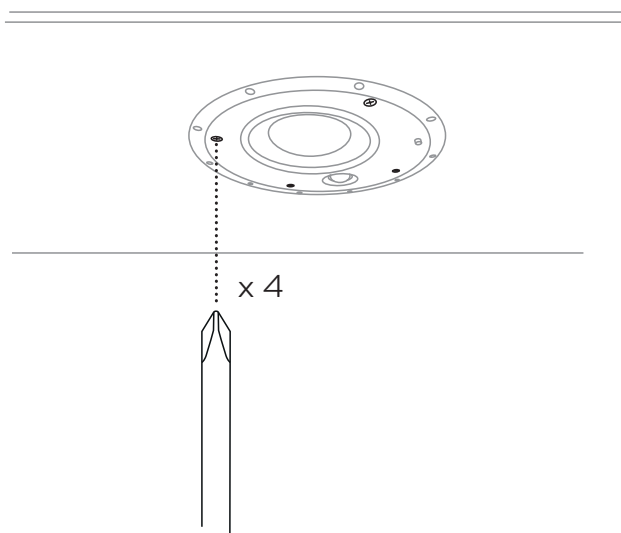
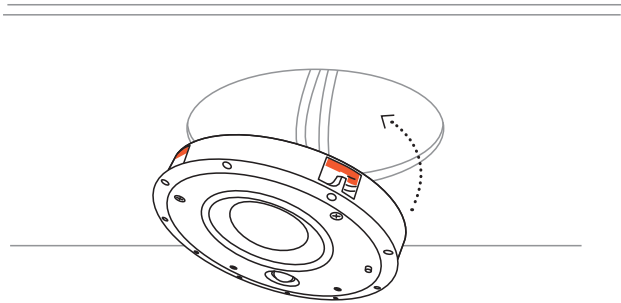


Thermal protection

In addition to its filter network components, the K-60 LP crossover assembly also incorporates a thermal protection device that attenuates the speaker to near silence if it is continually driven at too high a volume. The protection device is matched to the long term thermal power handling limits of the K-60 LP drivers, so while it will allow short periods of very high volume operation, it will be triggered if the volume remains too loud for too long. The protection device will reset automatically after a short time when the speaker input signal is switched off. This type of thermal protection is particularly useful in ceiling and wall speakers that can sometimes unintentionally be left playing at high volumes when a listener leaves the room, or are turned up in order to remain audible in an adjoining room.

Installation simplicity

K-60 LP installation



Installation of the K-60 LP is extremely simple. With a ceiling or wall aperture cut, using either the supplied template or with the benefit of an optional DALI pre-construction bracket, the K-60 LP can be simply connected to speaker cables via its high-quality spring terminals and lifted into place. The K-60 LP chassis and bezel construction combines reinforced ABS and pressed steel elements designed to provide great strength, rigidity and a feeling of confidence and security. Compass style direction indicators on the K-60 LP bezel can be used to align its primary radiation axis as required towards the listening area. Once in place a K-60 LP is secured through four dogleg clamps, swung into position and tightened via front panel cross-head screws. And despite the extreme low profile of the K-60 LP, its dogleg clamps can accommodate mounting panel thickness from 11 mm all the way up to 27 mm – more than two layers of standard drywall board.

Once installed and tested, the K-60 LP's elegant, low profile grille can be fitted in place. The magnetically secured grille attaches automatically once in close proximity to the speaker frame. The standard K-60 LP grille is finished in RAL9016 Traffic White – a true white without hints of grey or yellow. An optional black grille is also available for the K-60 LP and the mesh grille from the DALI PHANTOM E-60 can also be fitted as an alternative.

