KEF

INNOVATORS IN SOUND

T Series Technologies Explained

CONTENTS

INTRODUCTION

With a flat screen TV, you want speakers to match. Really flat. More importantly, you also want to fill the room with high definition 3D sound that's every bit as involving as what's on screen.

The best of home theatre

With KEF's new T Series, you get exceptionally slim profile speakers that generate all the intricacy, spaciousness and dynamic range of a high end conventional design.

You'd expect no less from KEF.
With some of the finest speakers in the world to our credit, ours is a 50-year success story of innovation that includes unrivalled experience of home theatre: our multi-award winning systems have for years been the standard by which others are judged.

No wonder even the most demanding listeners love the new T Series the first time they hear it – and when you discover the unique technologies crammed into each slender enclosure, you understand why…

The new T Series is aimed at delivering true hi-fi performance in ultra-shallow speaker enclosures to meet the demand for speaker systems to physically match the new generation of OLED and LED TVs.

• The T101 is the smallest satellite in the T-series range housing a 25mm (1 inch) tweeter and a 120mm (4 inch) midrange driver

• The T301 is the largest satellite in the T-series range housing a 25mm (1 inch) tweeter between two 120mm (4 inch) midrange drivers

PART 1 - T SERIES COMPONENTS

ULTRA SLIM BASS DRIVER

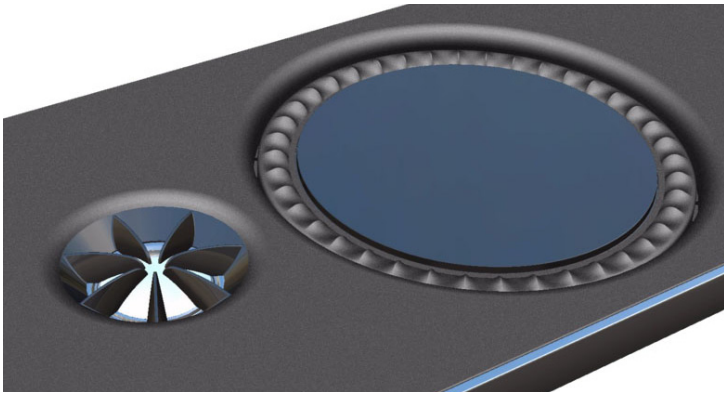
At the heart of the T101 and T301 satellites is the new Twin Layered MF Driver. This revolutionary low profile drive unit is incredibly slim (only 27mm deep). However, it delivers the performance of a drive unit several times its depth.

Twin Layered Radiating Diaphragm

The T-Series uses a Twin Layered MF Driver (patent pending). This is comprised of a moulded radiating diaphragm with integral stiffening ribs running radially and circumferentially. A thin layer of high modulus material on the rear of the ribs provides additional stiffness. This structure ensures the diaphragm moves pistonically within its working frequency band, whilst occupying a depth of only 5mm. This technology has been developed and optimised using finite element analysis.

Z-Flex Surround

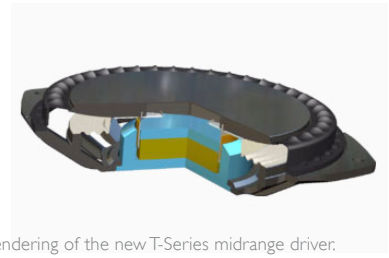
The T-Series Midrange Driver features a Z-Flex Surround. This revolutionary new design minimises mass-loading on the edge of the diaphragm helping maintain pistonic motion up to a high frequency. Its carefully designed undulations and supporting block prevent resonances whilst allowing simple motion such as the diaphragm moving forwards and backwards. The relatively flat and smooth form surface of the Z-Flex Surround minimises colouration to sound from the Tweeter. Finite element analysis was used heavily in the development of this new surround.



Concentric Suspension

Conventional midrange drivers have a cone, voice coil in a magnetic gap, and a suspension attached between them around the voice coil former. There must be enough space around the suspension to prevent it colliding with the other parts as the driver moves backwards and forwards. This sequential arrangement of the three parts plus clearances restricts the minimum depth of the driver. For many loudspeakers this is unimportant, but the T-Series Slim System Design demands a slimmer driver.

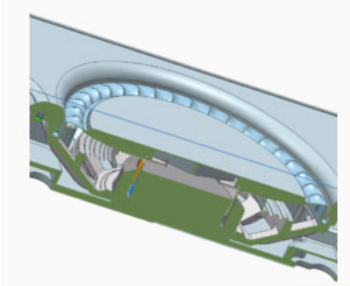
The T-Series Midrange Driver suspension has been designed for low build height. Its inner edge has a larger diameter than the former, so it sits concentrically around the voice coil. The main 'rolls' of the suspension are aligned with its outer mounting position on the driver chassis. The inner edge protrudes up to attach to moulded tabs on the rear of the diaphragm ribs. This protrusion is sometimes known as a 'cup', in a such a suspension the 'cup' allows for the difference in height of the mounting positions and prevents the suspension hitting the rear of the diaphragm. The cup is reinforced with a metal loop (patent pending). This prevents excessive bending as the diaphragm moves backwards which keeps the suspension stiffness symmetrical and high enough to limit motion. This minimises distortion and increases the power handling of the midrange drive unit.



• Cut-away CAD rendering of the new T-Series midrange driver.

• Prototype parts show the twin layered structure.

• Comparison of new T-Series driver (left) with a conventional driver of the same cone diameter (right).



• CAD cutaway showing the new T-Series midrange driver mounted into the T-Series cabinet.

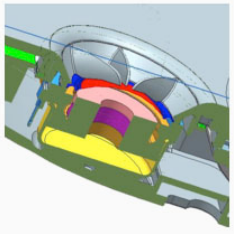
LARGE NEW VENTED TWEETER

In recent years KEF has made great progress in tweeter technology and for the new T-Series we have been able to use some of the technology we use in our high end products. The diameter of the tweeter has been increased to 25mm instead of the 19mm that is more usual on products of this kind. The 25mm size has the ideal compromise between high frequency extension and output capability which is why we use 25mm tweeters on our flagship Muon and Reference Series models.

Despite the very shallow depth of the loudspeaker we have been able to incorporate a venting system into the rear of the tweeter magnet system similar to that found in the KEF Reference Series.

Another distinctive feature of the tweeter is the Tangerine Waveguide which covers the dome which increases the sensitivity and dispersion at the very top end. We have also paid a lot of attention to the lower end of the tweeter to ensure that we have a low resonance which allows us to use the tweeter over a wider bandwidth and to use a simpler crossover design.

Many hours of careful analysis and design have resulted in us being able to put technologies into this design which in previous years would only have been found in the very highest-end loudspeakers.



• Detail of tweeter showing Tangerine Waveguide and rear venting.

• T-series Vented Tweeter and Tangerine Waveguide.

TOTAL SYSTEM DESIGN

Cabinet

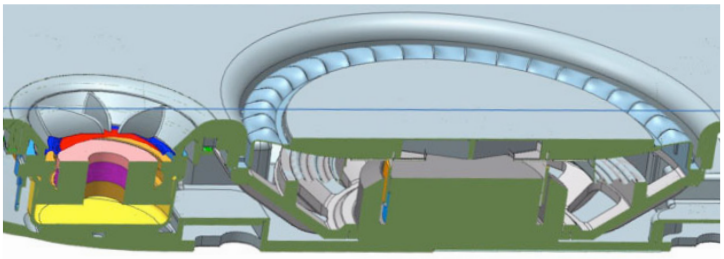
The cabinet structure for the T-series incorporates a number of clever features which help to retain the minimum build height. The speaker is easy to install and flexible in the way it can be positioned. As with all KEF speakers, special care has been taken to control cabinet resonances.

Minimum build height

The terminals have been fully integrated into the cabinet to avoid adding to the depth of the speaker. The T-series also features zero build height wall mounting connections. Some TVs and speakers advertise that they are slim design, but the wall brackets can drastically add to the depth when wall mounted. The T-series wall brackets only add 2.5mm to the product depth when wall mounted.

Flexible stands

The desk stand for the centre speakers allow you to have the centre speaker positioned vertically or tilted back by 5 degrees. This allows the speaker to be directed towards the listener, increasing the intelligibility of the critical centre channel.



Fully braced structure

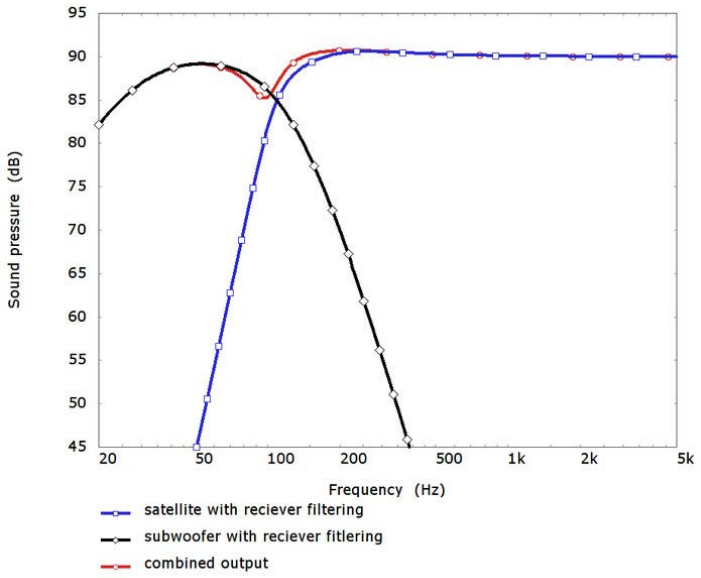
Cabinet mechanics is an important part of the system design and special care has been taken to ensure these new cabinets are acoustically inert. This is critical for maintaining the clean midrange produced by the new drive units. The drive units and cabinets have been designed together in such a way that the drive units brace the cabinets to stop any unwanted cabinet resonances that could colour the sound.

Subwoofer

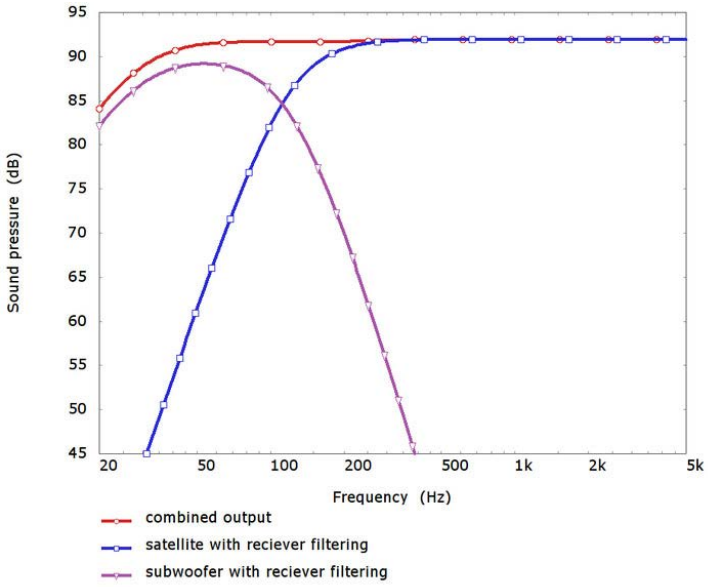
The T2 is a slim and sleek subwoofer ideally designed for use with the T-series. The strong and inert enclosure houses a 250mm (10in.) bass drive unit in a closed box configuration. This closed box configuration delivers tight and accurate bass ideal for music. The variable EQ allows you to tailor the bass output to delivery truly earth shaking bass for the ultimate home theatre experience. The T2 features an ultra-reliable, high efficiency 250W Class-D amplifier, which can play very loud and very clean - all day long if necessary.

The subwoofer is normally one of the largest speakers in a home theatre system and as such we have designed the T2 to be as slim as possible, allowing it to be positioned close to a wall or in the corner with no reduction in its performance. This allows you to maintain a clean, clutter free look whilst still delivering a level of performance that you would expect from a much larger subwoofer. The T2 also uses SmartBass™ "connect and go" technology for simplicity of set up. Our engineers have carefully designed the T2 to be as easy and practical as possible; just connect it to the mains and your AV receiver to be assured of optimum performance without the hassle of "tweaking".

All of this means that the T2 is an ideal subwoofer if you want a 'no compromises' performer without the hassle of a large box that just doesn't look right in your room; whether you are listening to your favourite music or watching the latest Hollywood blockbuster.



• A satellite designed for maximum bass when used on its own does not integrate well with a subwoofer.



• A satellite designed specifically for use with a subwoofer integrates well.

PART II - T SERIES TECHNOLOGIES

VENTED TWEETER

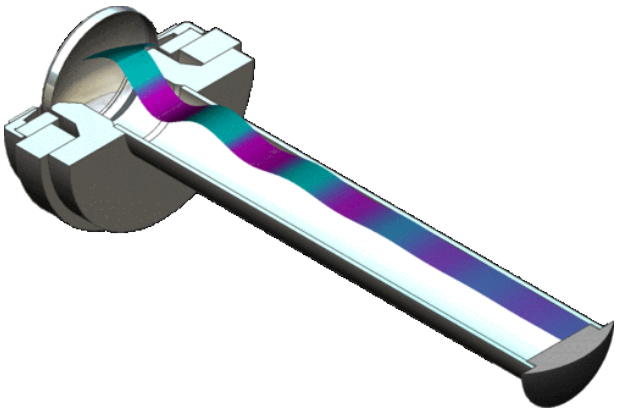
The T-Series has a Vented Tweeter. This increases the amount of air enclosed behind the dome to reduce distortion of the sound.

An Analogy

Imagine two mattresses made from the same type of foam, one thick and one thin. Most people would find the thick mattress more comfortable. This is because their weight on the thin mattress compresses it to the point that they can feel the hard bed slats beneath. The extra material of the thick mattress means it is not compressed fully and thus still feels soft and springy.

Air Behind the Tweeter Dome

The dome of a tweeter vibrates the air around it, in front of the dome this vibration is propagated away as sound, to the rear is an enclosed pocket of air. The dome pushing on the enclosed air experiences something similar to the person on the mattress. If the enclosure is too small the air undergoes large compressions and expansions. It will behave in a non-linear manner and cause distortion. This can be compared to the discomfort of laying on the thin mattress. In a larger enclosure the compressions and expansions are relatively small. The air in this case will act as a spring and the sound we hear will have much lower distortion.



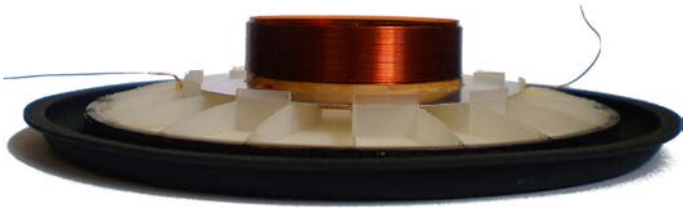
The image above shows the behaviour of the tweeter vent. Rear radiation from the dome travels down the duct and is gently absorbed in the acoustic damping material.

TWIN LAYERED MF DRIVER

The T-Series Midrange Driver features a twin layered radiating diaphragm. This technology (patent pending) allows the driver to be slim and flat whilst still maintaining pistonic motion up to a high frequency. The design has been optimised by finite element analysis.

Slim Driver

The Slim System Design means the the Midrange Driver can be only 27mm deep. The space required for the magnet assembly, and that required to allow 4mm of diaphragm excursion forwards and backwards, leaves only 5mm of depth for the diaphragm. A simple flat diaphragm geometry has very little inherent stiffness. Such a flat diaphragm would have structural bending resonances at low frequencies, which would affect the magnitude and directivity of the radiated sound field within the working range of the driver. Over the midrange driver's 95mm diameter a conventional cone or dome geometry of this depth would have very little curvature and thus again little inherent stiffness. The twin layered diaphragm design has high stiffness in spite of its restricted depth. There is no diaphragm resonance below 2kHz which is its operating bandwidth.



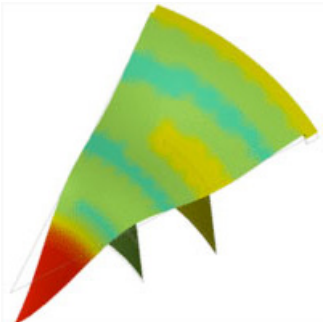
Perfect Baffle

Discontinuities in the loudspeaker baffle cause reflections and resonances of higher frequency sound waves. A deep cone midrange driver can therefore colour the sound of a nearby tweeter. The flat fronted T-Series Midrange Driver with smooth surround has minimal effect on the tweeter. This is a step towards creating the Perfect Baffle as seen in the KEF Concept Blade.

Twin Layered Structure

The radiating diaphragm is a thin walled moulding. The material is chosen to provide relatively high stiffness and damping with the ability to be moulded into thin sections (down to 0.3mm). Ribs extend perpendicular to the rear of the surface. These are positioned both radially and circumferentially. The radial ribs significantly stiffen the diaphragm to raise the frequency of its fundamental (circularly symmetrical) resonance. The circular ribs are located for attaching the voice coil former and suspension and brace the diaphragm structure. The twin layered structure has a thin layer of high elastic modulus material on the back of the ribs. This increases the diaphragm stiffness further to push the fundamental resonance above the working frequency bandwidth of the midrange driver.

The technology has been developed using finite element analysis (FEA) computer modelling. This allows very fine optimisation of the design geometry and materials to produce a very high performance loudspeaker driver.



• A flat diaphragm using conventional technology resonates severely.

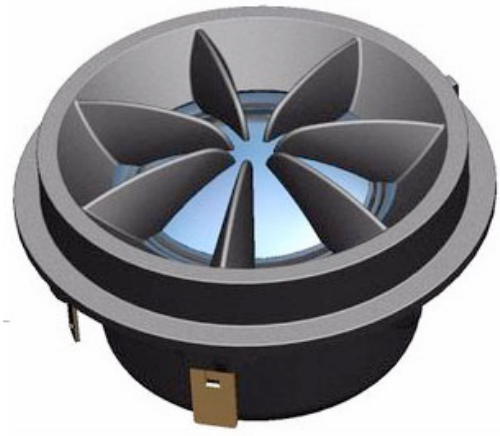
• A flat diaphragm using new twin layered technology behaves almost pistonically.

Ventilation

Gaps in the circumferential ribs and holes in the rear layer allow air flow through the structure. The straight radial ribs provide uninterrupted air channels. This prevents high air pressure fluctuations within the voice coil under the vibrating diaphragm.

TANGERINE WAVEGUIDE

The Tangerine Waveguide is a patented KEF Technology which is now used in a number of products throughout the range. The technology was developed from research work into compression drivers which are used in high power systems for concerts.[1] Compression drivers are very susceptible to acoustic resonances which occur in front of the tweeter dome. Whilst looking into the behaviour of compression drivers in detail, it was realised that the source of these acoustic resonances is also present in a normal direct radiating tweeter. The Tangerine Waveguide is designed to compensate for these problems thereby improving the coupling between the tweeter dome and the air.[2]



References

1. M. Dodd and J. Oclee-Brown, "A New Methodology for the Acoustic Design of Compression Driver Phase Plugs with Concentric Annular Channels," presented at The 123rd Convention of the AES, preprint 7258, Oct 2007.

2. M. Dodd and J. Oclee-Brown, "A New Methodology for the Acoustic Design of Compression Driver Phase Plugs with Radial Channels," presented at The 125th Convention of the AES, preprint 7532, Oct 2008.

SLIM SYSTEM DESIGN

Satellite speakers designed to match the current generation of plasma and LCD flat panel TVs typically have a depth of around 100mm (4 in.). The KEF KHT6000, for example, is one of the shallowest at a basic speaker depth of 85mm. However, the latest LED and OLED flat TVs are significantly shallower than this and there is a definite requirement for speaker systems of similar depth proportions but with true hi-fi performance.

Extremely slim system design

The key to reducing the depth of the T series satellites is a new ultra-shallow midrange drive unit which has a total depth of only 27mm (compared to 70mm for the KHT3000 Uni-Q from which it is derived). This is achieved without any reduction in cone area, so the acoustic performance of a true 4.5 inch unit is maintained. This new bass/midrange unit has allowed a total enclosure depth of only 37mm including the wall bracket.

Enclosures of such shallow dimensions require careful mechanical design to ensure the internal volume is fully utilized by the drive units with minimal acoustic losses and that panel resonances are kept to insignificant levels by suitable bracing. In addition, the packaging of the internal crossover network, acoustic damping materials, internal cabling and connections all require special attention so that the key acoustic parameters are not compromised and ergonomics are straightforward and logical.

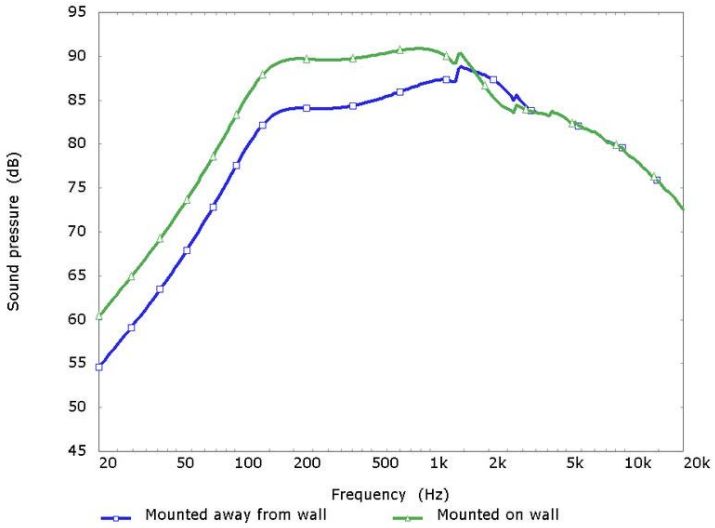
• The new T Series is designed to look right at home next to the latest thin screens.

• A comparison of a prototype satellite alongside the prototype HTS3001 satellite speaker.

WALL-MOUNT BASS EXTENSION

The sound of a loudspeaker will vary depending on where it is positioned relative to the walls of a room. Generally, loudspeakers sound best when they are positioned in "free space", for example, on a stand, more than 0.5m from any walls. This is what produces a natural sound, in the same way that the sound of someone speaking or playing a musical instrument will be best when they are well away from the walls and corners of the room.

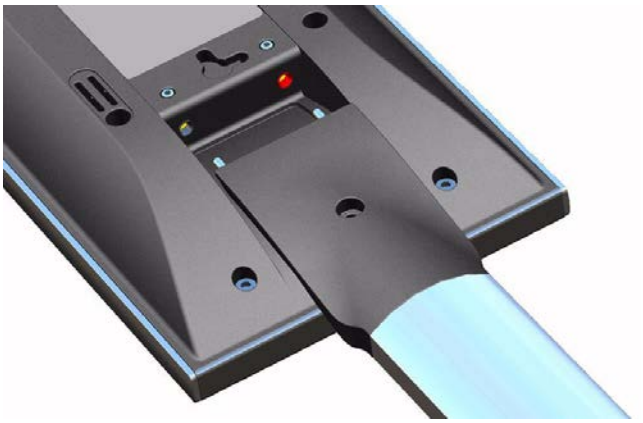
When a loudspeaker is positioned "on-wall" the sound changes in a relatively predictable way: the upper bass is enhanced and a dip appears in the midrange – this is what we instinctively recognize as the "wall effect". However, if we know that a particular speaker will generally be positioned "on-wall" we can correct for these effects and ensure that the speaker will sound natural in that position.



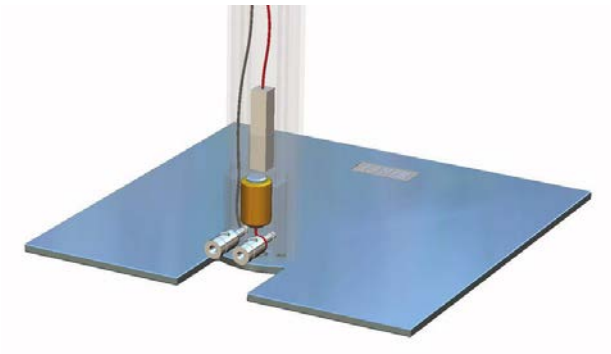
• Simulation showing the bass response boost wall effect.

Selecta-Mount

Because the T Series satellites are designed to match the new generation of super slim TVs and will generally be mounted "on-wall" using the supplied bracket or positioned very close to the wall on the desk stand, they have been specifically balanced for the "on-wall" location. However, for those occasions when they are used on the floor stand - when they will be a significant distance from the nearest wall – the KEF Selecta-mount system automatically adjusts the balance for an "off-wall" location. This is accomplished by a clever connection arrangement in the stands which introduces an extra filter section ahead of the speaker's crossover network to switch the speaker into its "free-space" balance.



• The floor stand neatly connects to the loudspeaker and automatically adjusts the satellite for optimum freespace performance.

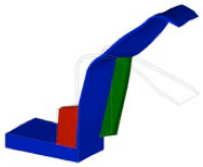


• Within the stand a small electrical circuit makes the response adjustments, terminals are located at the base for easy connection.

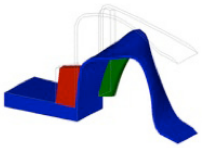
Z-FLEX SURROUND

An important feature of the T Series Midrange Driver is the new Z-Flex Surround. The surround is a critical component of any bass/midrange driver. The designer must carefully choose the material and shape so as to avoid irregularities in the midband response due to resonance in the moving parts whilst at the same time allowing sufficient excursion of the cone in order to reproduce bass frequencies. Most modern drivers use a half-roll design typically moulded from butyl rubber. The half-roll design can often perform well if carefully designed, however, KEF's computer modelling techniques have allowed us to investigate some more adventurous possibilities. The Z-Flex surround is the result.

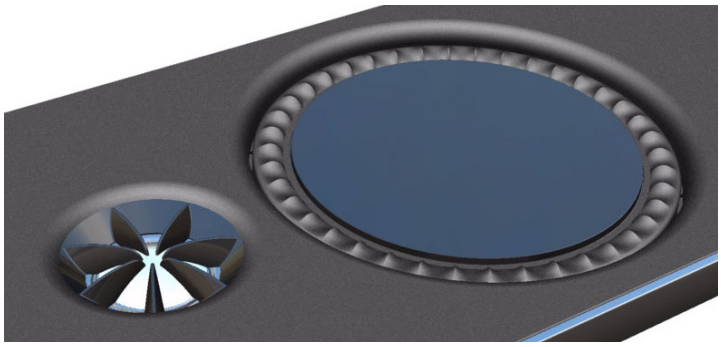
The images below show how the Z-Flex surround changes shape when the cone moves back and forth. This is quite unlike the motion that is normally seen with a conventional half-roll design.



• FEA model showing the Z-Flex surround deformation as the cone moves forward.



• FEA model showing the Z-Flex surround deformation as the cone moves backward.



Design Features

Unlike a conventional surround, the Z-Flex allows very fine control over the surround behaviour. There are three main features which are critical to the performance:

• The membrane sections which form the air seal

• The supporting blocks attached to the membrane

• The undulations on the front surface of the membrane

The membrane section is present to form an air seal, the size of the front and side walls are chosen to allow the driver to move to its full extent whilst minimising diaphragm edge mass loading. The supporting blocks and the front surface undulations are present to control the behaviour of the surround in the mid band. The positions, shapes and sizes of these two features fine tune both the mechanical impedance which the surround presents to the cone edge and also the dynamic behaviour of the surround itself. In essence, the Z-Flex will readily allow simple deformations, such as those occurring at low frequencies when the cone is moving some distance back and forward, but greatly resist complex deformations such as those which can cause problems in the mid-band. Conventional problems, for example the surround termination dip, can then be completely avoided by fine tuning the design.

Minimised Edge Mass Loading

A major benefit of the Z-Flex approach is that, for a given cone excursion, less of the surround moves and hence the surround contributes a much lower effective mass to the cone edge. The effective mass decreases with increasing driving frequency. This is important in minimising mass-loading of the edge of the diaphragm which would lower the frequency of the diaphragm bending resonances. The Z-flex surround therefore works in conjunction with the Twin Layered MF Driver technology to achieve pistoning diaphragm motion throughout the working band.

Perfect Baffle

Discontinuities in the surface of a loudspeaker's baffle cause reflections of the higher frequency sound waves. Features such as a large roll surround can therefore colour the sound of the tweeter. The smooth and low profile Z-Flex Surround, in conjunction with the flat fronted diaphragm of the Twin Layered MF Driver, have only a minimal effect on the acoustic waves being radiated by the tweeter. Perfect Baffle was a technology first introduced for the KEF Concept Blade Loudspeaker.

INNOVATORS IN SOUND

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