TANNOY®

Tannoy's Dual Concentric™ by Definition

The term "Dual Concentric™" is defined by Tannoy as a coincident point source, where the low frequency cone acts as a seamless, direct extension of the high frequency waveguide, yielding a constant directivity pattern with linear amplitude and phase response on both the horizontal and vertical axis.

Tannoy's Concentric Sound - What to Expect

An acclimation period is needed when a Dual Concentric™ is first installed in your system, unless you are already in the know. This is due to the inherent blended power characteristic with frequency for a single-source drive unit of this type. Here we have a 310 mm - 12 inch driver working up to a relatively low (for mid driver) 1.1 kHz crossover point, low enough for a good distributio of energy over a 90 degree angle. Aboe 1.1 kHz the concentric horn tweeter in the centre continues the range precisely, the main cone flare providing a closely matched distribution, and thus maintaining smooth on- and off-axis responses. Such a power trend has a distinctive sound in the listening room and differs from the commonly-found alternative where the crossover, from a smaller bass/mid unit, is set at around 3 kHz, above which point that 90 degree window increases abruptly to almost 180 degrees as the usual 25 mm - 1 inch dome tweeter takes over. Designers work hard to smooth out the reslting power transition but it's difficult to wholly disguise this. It may leave more than a trace of nasality and hardness in the sound, and add drama to transients, a bit of extra percussive attack and excitement; but this in reality is an exaggeration. Since nearly all speakers are made this way, we are more or less adjusted to this kind of sound. This is why a truly neutral speaker such as the Quad ESL63 electrostatic can sound "dull" and "lacking attack" by comparison. Tannoy's Dual Concentric™ sound also falls into this category and listeners may need a little time to appreciate its instrinsic tonal accuracy.

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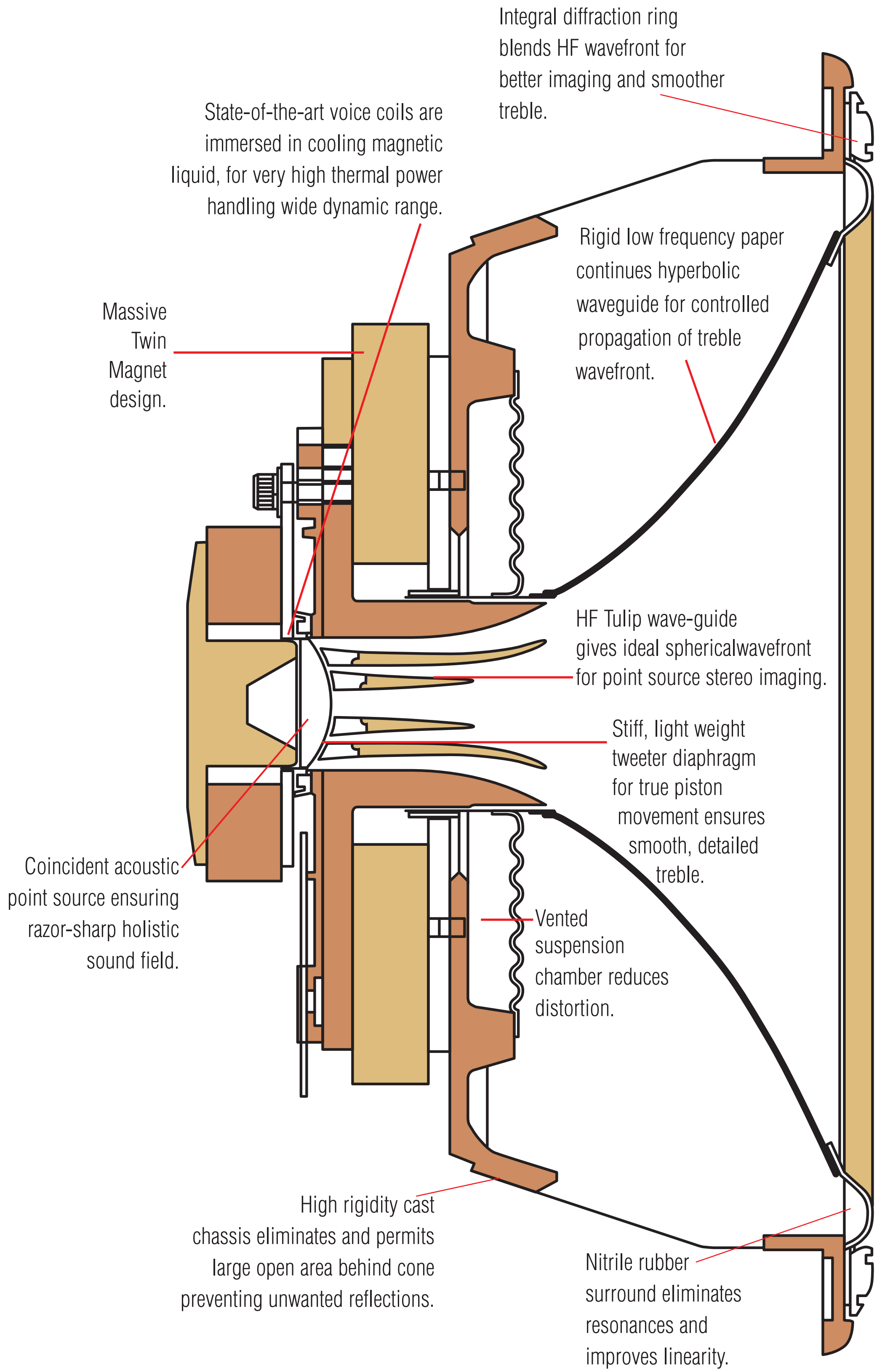
TANNOY®

DUAL CONCENTRIC™



INTRODUCTION

For over 40 years Tannoy has been manufacturing Dual Concentric drive units and loudspeaker systems. Over that time the loudspeaker industry has developed increasingly sophisticated drive units and horn systems to control the way sound is dispersed into the world. They have tried, in part, to duplicate the inherent advantages of the true point source – the Tannoy Dual Concentric.

Tannoy has continued to develop the Dual Concentric concept, even when other more overtly ‘modern’ products such as the constant directivity horn were capturing the headlines.

It is popular to say that loudspeakers haven’t changed at all in the last half century. But there have been a huge number of incremental improvements produced by better understanding of the nature of sound propagation, the use of vastly improved development tools and computers, and the use of ever more sophisticated materials and manufacturing techniques. As well as sounding so much better, today’s drive units have the power, reliability and SPL capabilities of a dozen of their earlier predecessors.

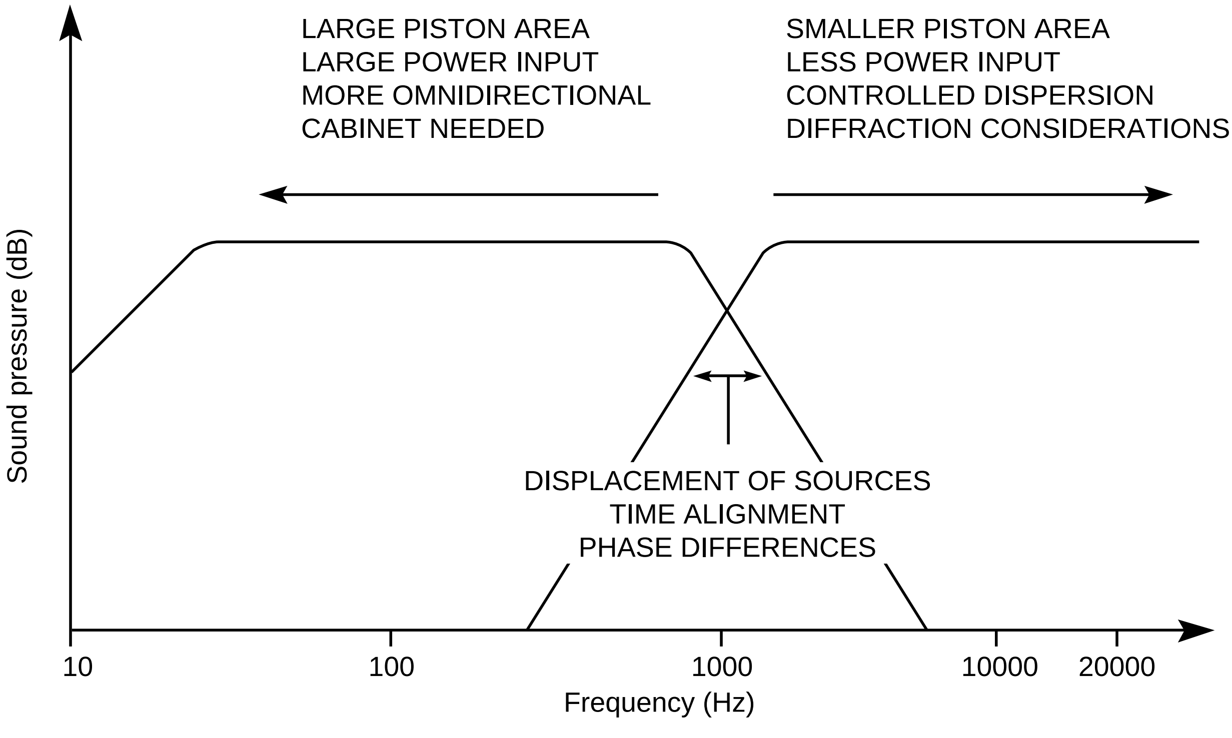
Whilst standing the test of time, the Tannoy Dual Concentric has not stood still. Tannoy has been constantly improving the capabilities of the drive units, and recently our engineers returned to first principles and designed an entirely new drive unit. This new unit applies Tannoy’s long experience and advanced understanding of loudspeaker and acoustic theory taking the Dual Concentric into the next century.

In this White Paper some of the inherent advantages of using a point source, and why the Dual Concentric is seeing a renaissance in the contractor industry, are explained.

ONE SOURCE IS BETTER THAN TWO

In the ideal world manufacturers would like to produce a single drive unit that copes with all of the frequency range. But the laws of physics being what they are, a driver that works well for low frequencies will not work well for high frequencies and visa versa. So separate drive units are used for different areas of the frequency band. Most manufacturers have developed completely different drive units and placed them in a single box or in several boxes to create a full range system.

Unfortunately as soon as you break the audio signal into separate sections and transmit it from different points in space all sorts of problems occur.



- Covering the whole audio spectrum requires different approaches at different frequencies for optimum solutions.
- A seamless joining together at crossover is essential.

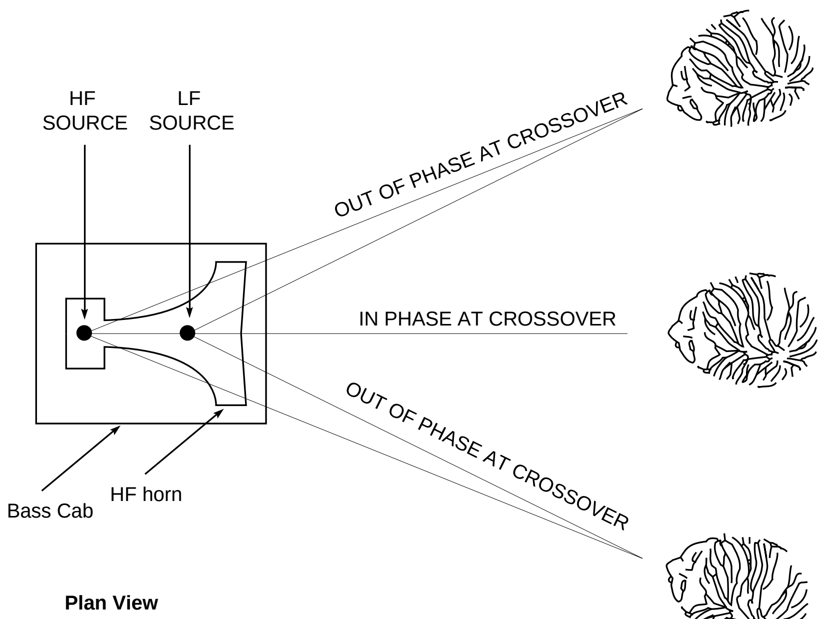
Interference over the critical crossover area

Over the crossover area, both HF and LF drive units are producing acoustic energy. Since the drive units are a little (or sometime large) distance away from each other, the signal path to the listener from the HF and LF drive units will be slightly different. The sound from the more distant driver will take slightly more time to reach the listener than from the nearer one.

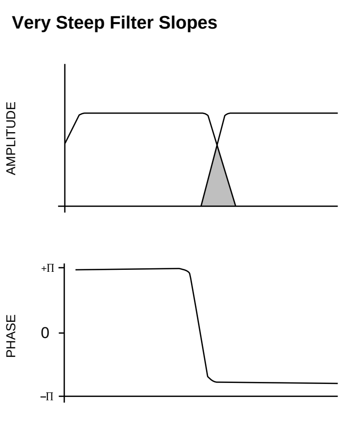
In one seat, the sound from the two drive units will be in phase with excellent perceived level, but in a nearby seat they could be out of phase and the level will be down or even reduced to zero over a narrow band of frequencies. Consequently when separated HF and LF drive units are used, the sound coverage in the crossover area will always be somewhat inconsistent.

One way to get over this is to use very steep crossover slopes, so the crossover area, where both drive units are working, is minimised. However, steep filters can create phase errors and other electronic artefacts generating more problems than they solve.

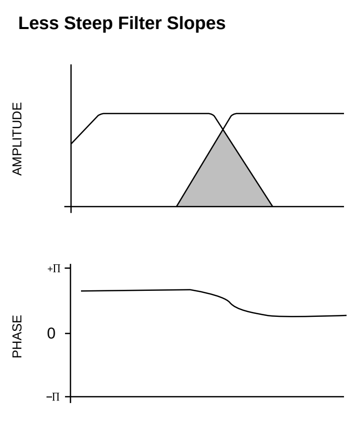
Phase Error Changes with Position



Very Steep Filter Slopes



Less Steep Filter Slopes



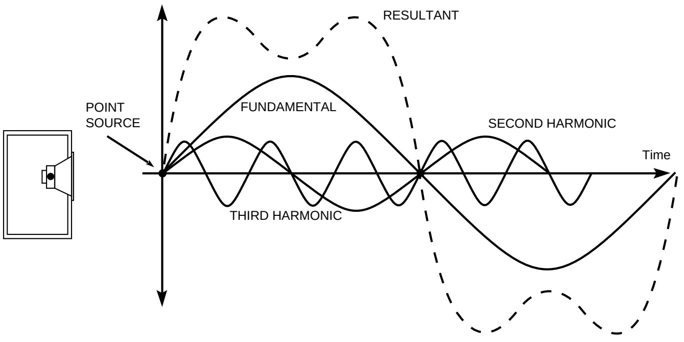
- A true Point Source gives the same sound from seat to seat.
- Dual Concentrics can use simpler, better sounding and more efficient crossovers.

Harmonics

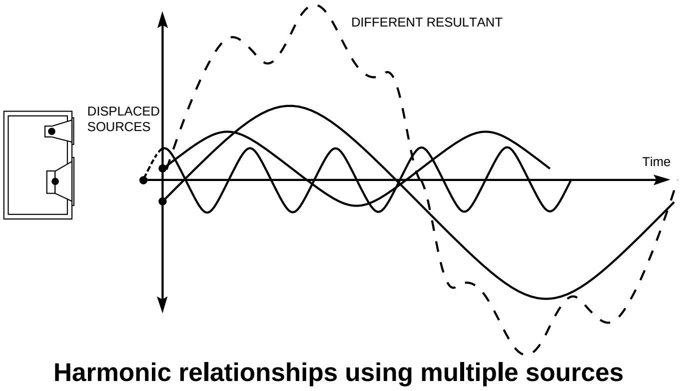
Every sound created in the natural world has harmonics that give us clues to the type and quality of the signal source. The harmonics of a single note may extend beyond the limits of hearing.

A fundamental note, with fundamental frequency lying within the range of the LF driver, will have many harmonics reproduced through the HF driver. If these are separated, either in time or space, then in most listening positions the fundamental of the note will be heard at a slightly different time to its harmonics, which does not lead to the most accurate reproduction of the sound.

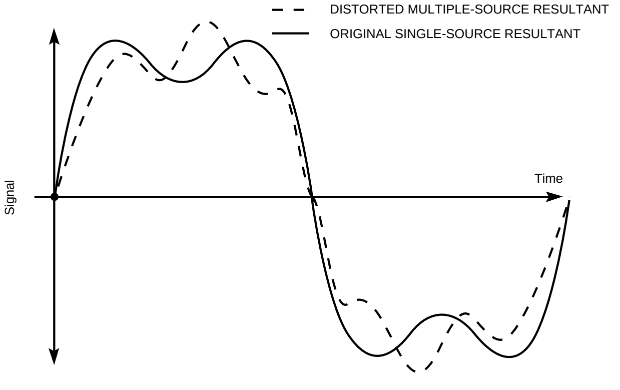
The Tannoy Dual Concentric Preserves the Harmonic Structure of Complex Sounds



Harmonic relationships preserved using a single point source



Harmonic relationships using multiple sources



Original versus distorted resultant

- Dual Concentrics have better harmonic alignment.
- Better harmonic alignment results in a clearer, more intelligible, more natural sound.

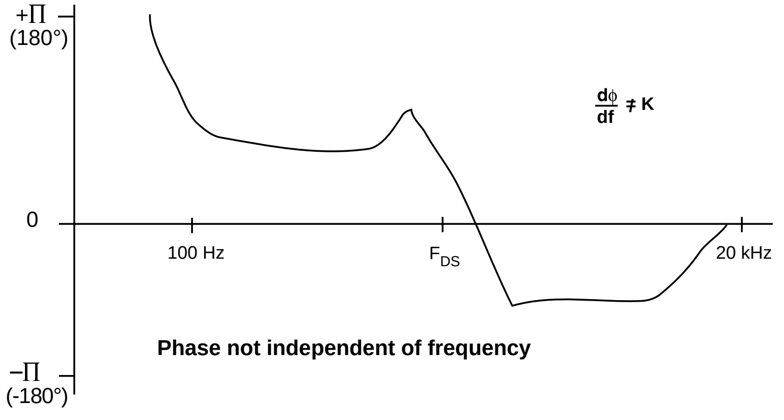
Constant Time Delay

A single pulse of sound, such as a drum beat can be considered a combination of many acoustic elements up and down the frequency spectrum. A loudspeaker system should behave as a constant time delay with every element of the audio spectrum being delayed by the same amount as it passes through the driver and crossover.

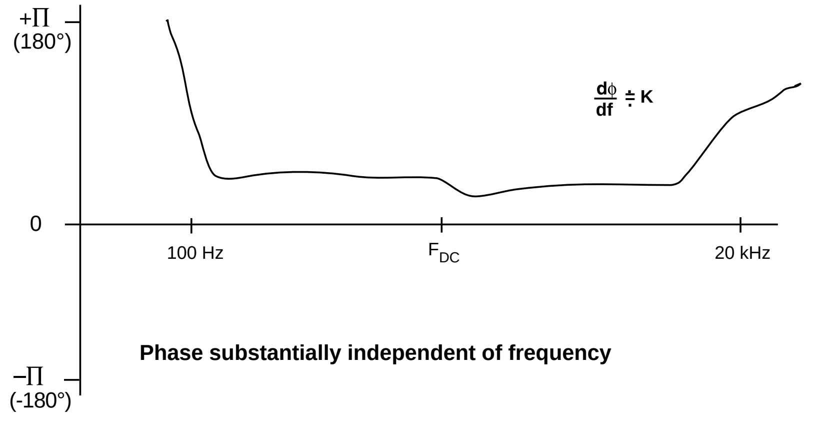
If, as is often the case with complex crossovers and separate drive units, the delays are different for different areas of the audio spectrum then these elements will be heard slightly staggered. The 'crack' of the stick hitting the drum skin from the 'thump' of the lower frequencies produced by the drum skin vibrating will be heard as separate events.

This can only be partially resolved by introducing delay processing to re-align the elements. Additional processing, with its associated signal degradation, is made unnecessary by using a Dual Concentric.

Phase Response of a Typical Discrete Non-Aligned System



Phase Response of a Typical Tannoy Dual Concentric System



- An integrated Dual Concentric approach provides a constant time delay.
- Constant time delays over the frequency spectrum give better overall sound quality and transient performance.
- Constant time delay behaviour removes the need for separate HF delay lines that need careful and time consuming on-site adjustments.

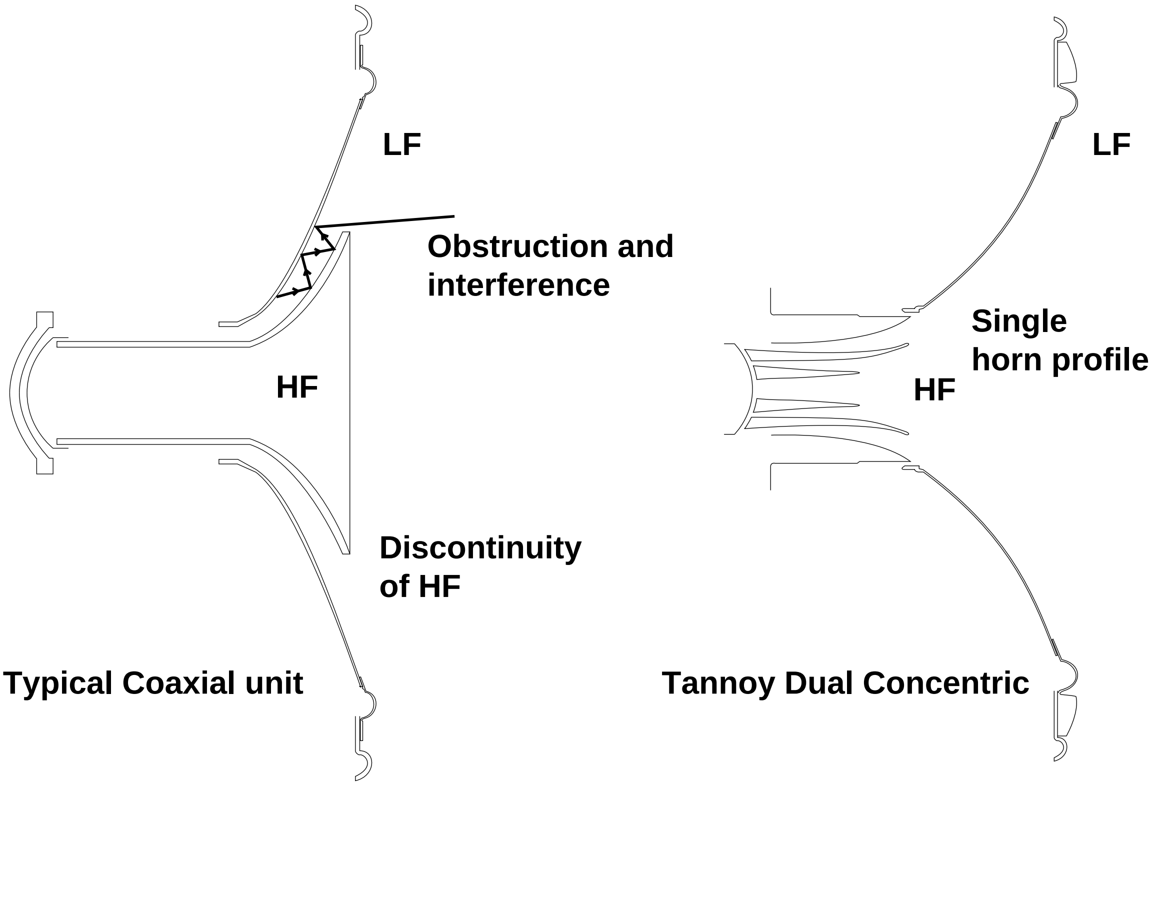
Attempts to emulate the Dual Concentric

There have been two trends in system design to try and emulate the single source approach. The first is to bolt the HF horn in front of the LF or MF sections. This places the two sources in the same axis but only in two planes – one driver is still in front of the other. To integrate the signals, some form of delay has to be applied to one unit to make it coherent with the signals coming from the other unit. This is costly to do well, making the crossover very complex – and complex crossovers can affect sound quality or use up power that could be better used powering the driver.

As well as creating problems within the electronics, placing the HF driver and horn directly in front of a low frequency driver produces a whole set of non-linearities caused by the LF waves being masked and reflected back onto the driver cone.

Engineers are increasingly concerned with the acoustic effects of relatively acoustically transparent obstacles such as the grilles. Placing a large solid HF driver or a less solid (and more resonant) horn with all the associated mounting hardware directly in the way of the LF driver is not a satisfactory engineering solution.

A Tannoy Dual Concentric does not suffer from reflected energy storage or mid-range shadowing

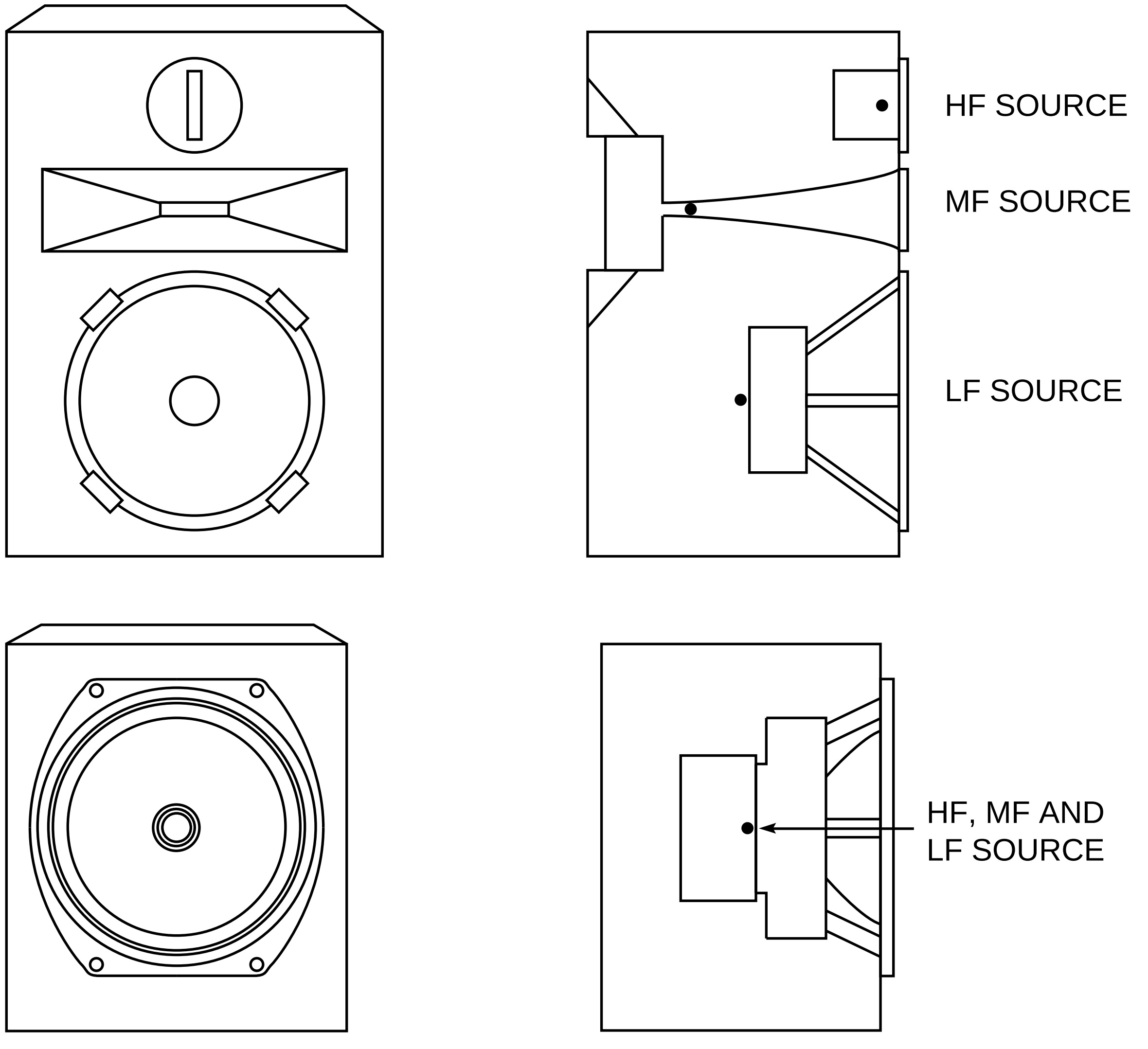


- A Point Source driver simplifies nearly every aspect of a system installation.
- The Dual Concentric is the only practical way of creating a full frequency range Point Source driver.
- Other ways of approaching the Point Source goal suffer from identifiable drawbacks.

More attempts to emulate the Dual Concentric

Another trend in system design is to create systems from full-range cabinets, rather than separate bass, mid and HF cabinets, which were the fashion in the 70s and early 80s. For both hire and installation work the convenience of the compact full range cabinet, inherent in the Dual Concentric approach, is becoming increasingly appreciated. But bringing the drive units closer together in smaller boxes offers only partial solutions to the problems of time domain, phase, directivity, crossover complexities.

A well designed Dual Concentric drive unit resolves these problems by being a true point source.



- Compact, full range boxes are the system design route for the 90s.
- Even in a small box, separated drive units cannot emulate a true point source unit, they will still suffer from all the problems of being of non Dual Concentric design.

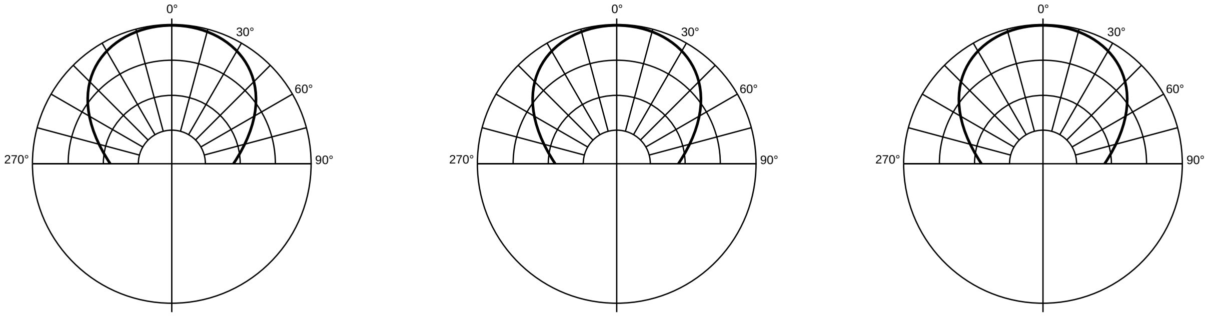
ONE DRIVER – ONE DIRECTIVITY

A lot of energy has gone into the design of constant directivity horns that control the acoustic dispersion from the HF driver. This is important to maintain an even coverage at all frequencies over the target area.

Controlling the directivity also allows the sound from the speaker to be more accurately targeted to where it is needed. Targeting keeps the sound where you want it, and away from the walls and ceiling. This cuts down the amount of high level reflections that cause at best, reduced intelligibility, and at worse, resonances and feedback.

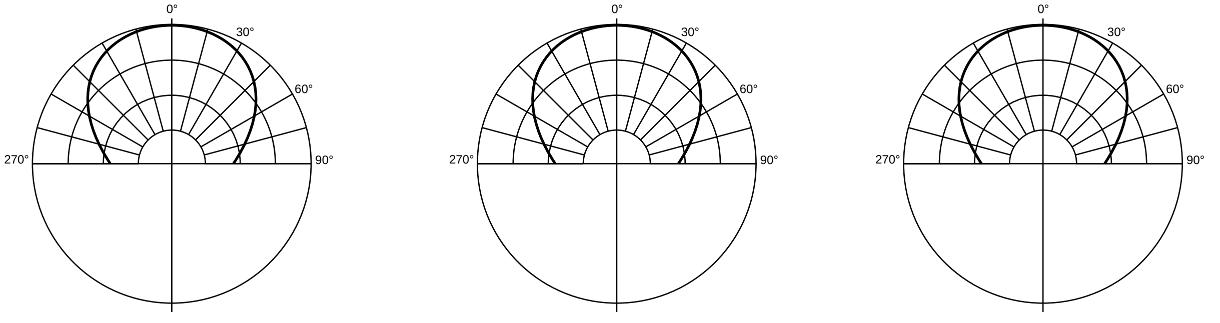
In this age of tighter controls on working conditions it is also important to keep sound levels down in work areas. Levels that are acceptable on a discotheque floor, will not be acceptable in the nearby bar area where staff are working all the time.

Dispersion pattern for Constant Directivity



1kHz 5kHz 10kHz

Dispersion pattern for Non-Constant Directivity



1kHz 5kHz 10kHz

- The ideal system is one where the sound dispersion is well controlled, and does not dramatically alter with frequency.
- Dispersion control must be achieved without introducing problems in other areas

Two drive units – two directivities.

At very low frequencies all systems radiate omni-directionally. From a few hundred Hertz and above, dispersion control can be introduced by mechanically and acoustically adjusting the radiated wave-front.

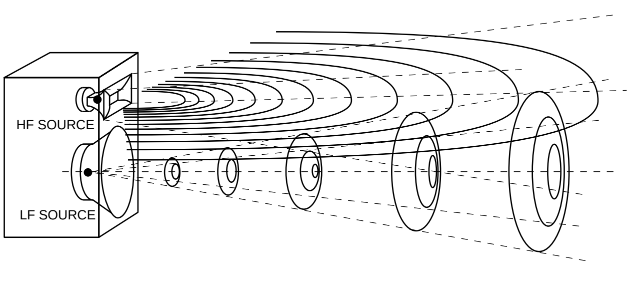
The problem with most two or three-way speaker solutions is that while the HF is correctly controlled with a constant directivity horn, the mid and mid/low frequency speakers are left to fend for themselves. Consequently the radiation pattern for the high frequencies is completely different to the radiation pattern produced by the lower frequency drive units.

With different dispersions at different frequencies, the off-axis frequency versus amplitude response will be quite different to the on-axis response. The difference in sound balance will also not be consistent. It will depend on where you are sitting, and what frequencies are being handled at the time.

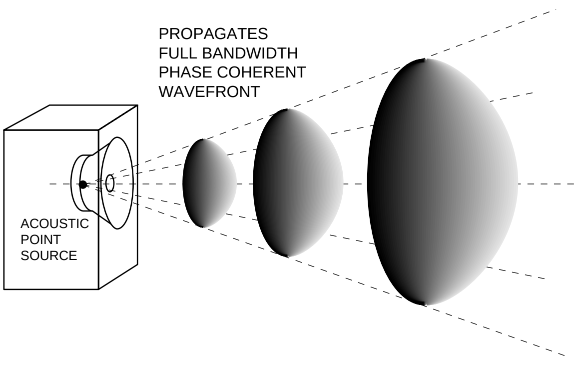
Also with widely differing dispersion patterns the amount of energy being radiated into the room varies enormously with frequency. Peaks and troughs of energy aggravate the unpredictability of a room's performance, making it impossible to introduce equalisation that meets the requirements both of on-axis response and even room energy performance.

By designing the Dual Concentric as an integrated full range driver, Tannoy can produce a consistent conical directivity pattern uniquely across a much larger portion of the frequency range. Except for the very low omni-directional frequencies, what you get on axis is an even response; what you get off-axis is the same even response. The energy going into the room is controlled, for natural and highly intelligible sound reproduction.

Typical Discrete system with horn HF



Typical Tannoy Dual Concentric



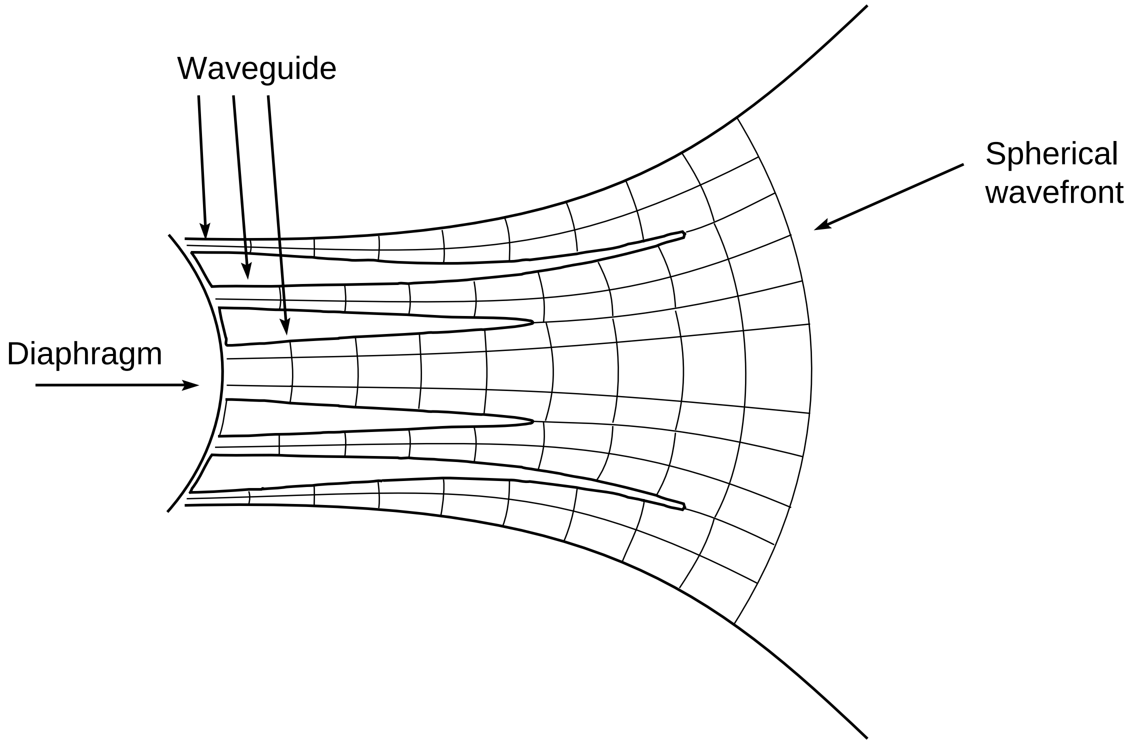
- With a Dual Concentric the dispersion is smooth and consistent down to the point at which the speaker starts behaving omni-directionally.
- Varying dispersion aggravates room response problems making it more difficult to set up the system.
- Uneven dispersion gives unpredictable sound balances.
- Controlled, even dispersion gives greater intelligibility in difficult reverberant rooms.

Spherical Wavefront Generation

The Tannoy Dual Concentric high frequency waveguide ensures that spherical wavefronts and a good acoustic directivity match with the low frequency driver. In this way there are no discontinuities in the dispersion characteristics of the cone driver and the HF horn, in the critical crossover area. This is simply not possible to achieve with separated drive units.

Spherical radiation provides a perfectly even and predictable dispersion symmetrically in both horizontal and vertical planes. It controls the sound precisely to where you want it, and ensures that the coverage is the same over the majority of the frequency range.

Truly Spherical Wavefront Generation

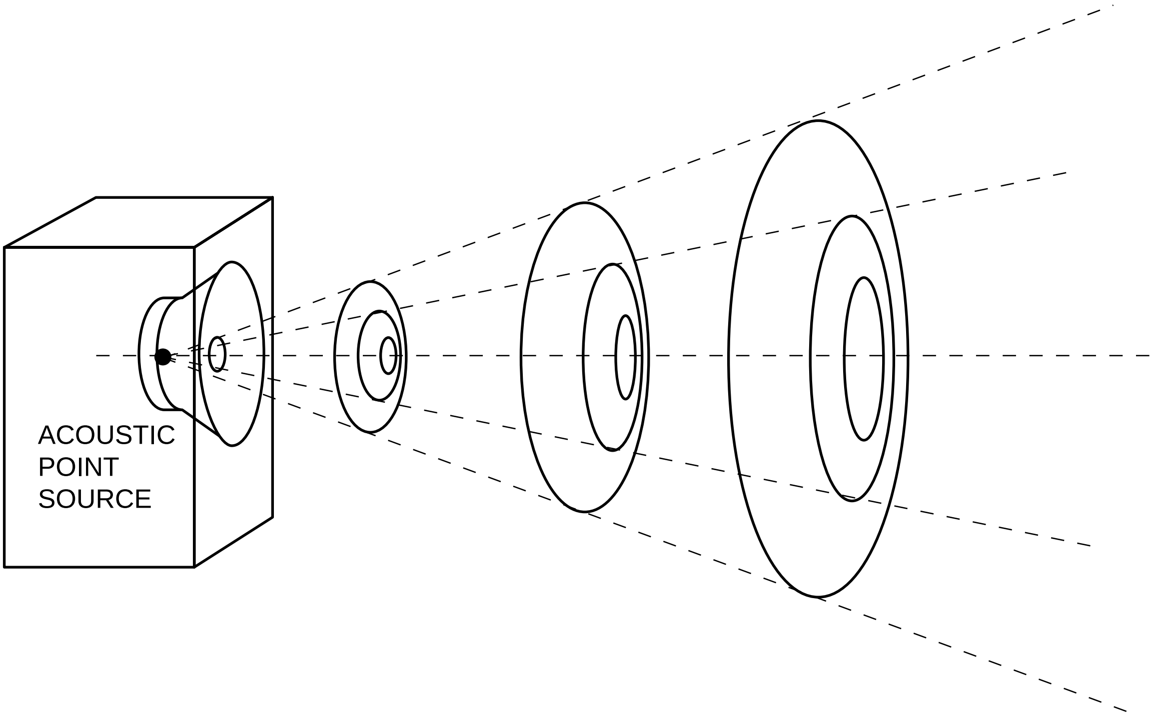


- The Dual Concentric has a spherical dispersion for consistent performance vertically and horizontally.
- The Dual Concentric's spherical dispersion is symmetrical.
- On-axis and off-axis performance remains consistent across the frequency spectrum.
- The audience hears the same high quality performance wherever they are.

Better control where you want sound

With essentially one directivity pattern across the low/mid, mid and high frequency spectrum, the amount of energy being placed anywhere within the speaker's coverage area will be consistent. With a true conical dispersion, coverage will not seriously vary with frequency.

Typical Tannoy Dual Concentric



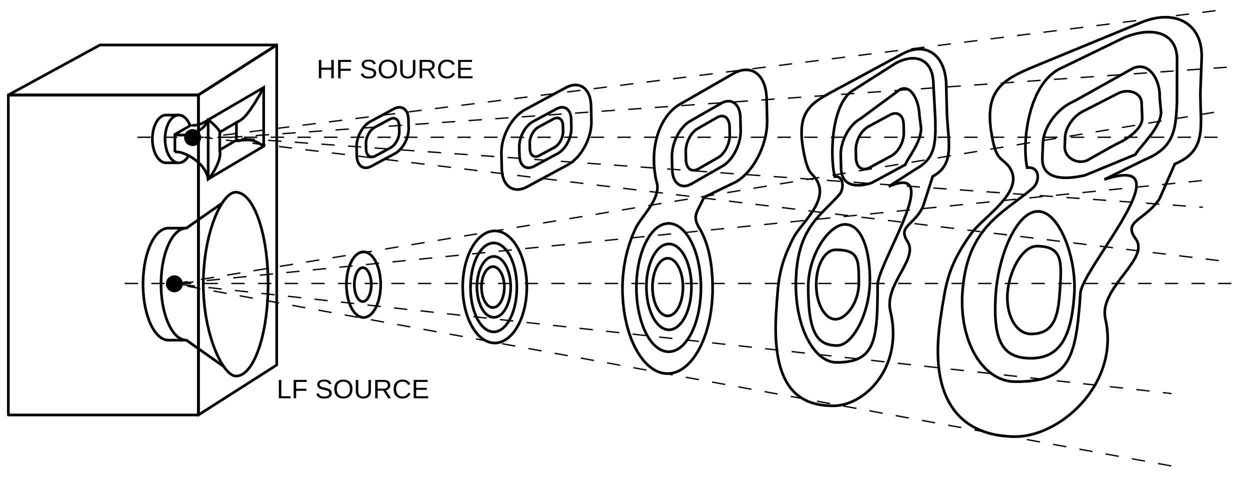
- Even dispersion means even coverage.
- Sound quality is consistent across the floor area.
- Designing the HF and cone drive units as a single system resolves dispersion disparities at the crossover area.

The problems of sound where you don’t want it

It is impossible to stop some sound radiating onto the walls and ceilings. With a radically changing dispersion characteristic, a speaker system that measures quite flat on-axis may be putting substantially more energy into the surrounding area at one frequency and considerably less energy into the room at another frequency. This causes intelligibility problems in most rooms.

An uneven power radiation can aggravate existing room related problems. If peaks of energy radiation coincide with room peaks then there is an increased likelihood of feedback. This reduces the overall amount of gain that can be obtained from the system. Even with relatively well behaved rooms and spaces, an uneven power response, especially from component based systems where the reflections will also have erratic phase relationships, will reduce intelligibility. Unless the off-axis power response is even, there will be no direct or predictable relationship between the on-axis response and the total amount of energy being put into the room at any given frequency.

Typical Discrete System with controlled dispersion HF units



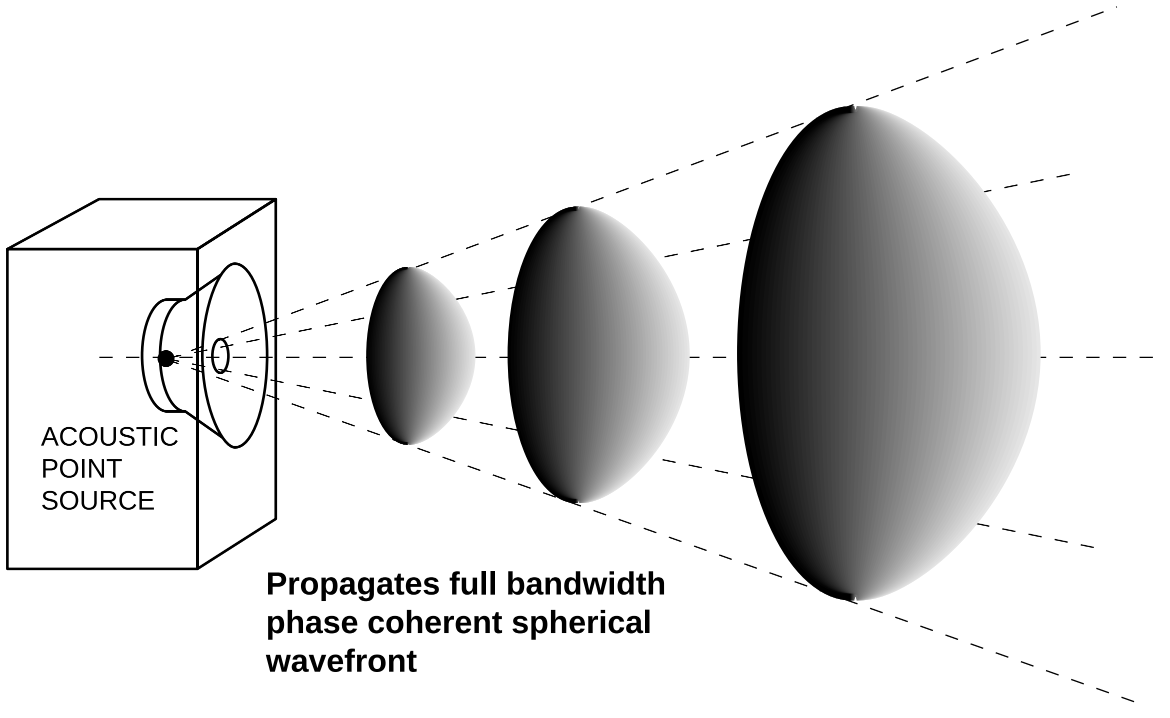
- Erratic off-axis dispersion increases room related problems.
- Discrete systems become more prone to feedback, with lower overall gain and intelligibility.

Resolving the problems of sound where you don't want it

With the Dual Concentric you know that for the mid/bass upwards in the audio spectrum the loud-speaker will be putting a similar amount of energy into the room. With this consistent control of acoustic radiation, a Dual Concentric performance is less likely to be affected by the peculiarities of the room or where it is positioned in that room.

There are several significant advantages of even power radiation. Gain before feedback can be increased and intelligibility maintained. Using a Tannoy Dual Concentric the amount of equalisation, with its associated power losses, and phase and distortion problems, can be reduced significantly.

Typical Tannoy Dual Concentric



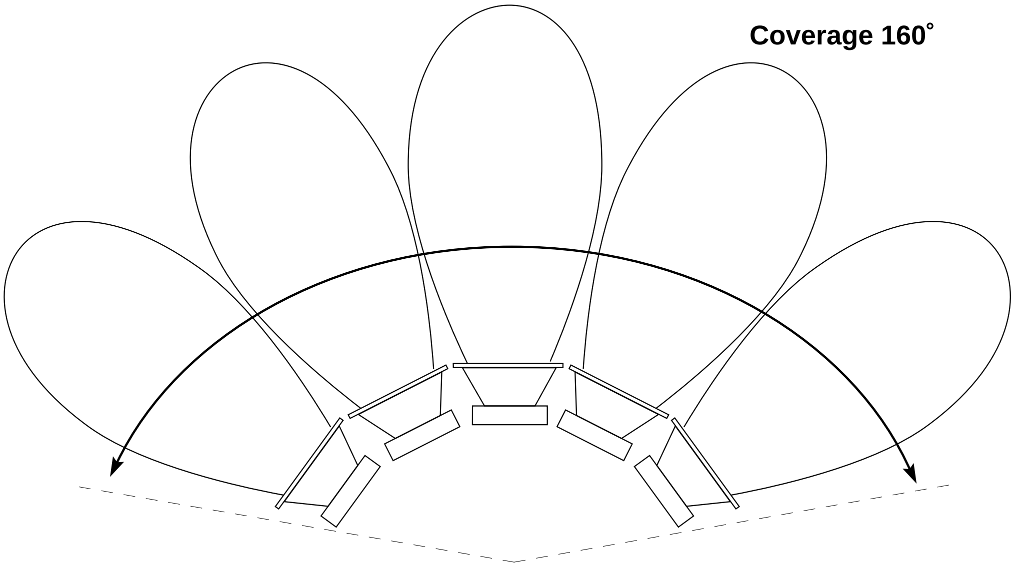
- Even off-axis dispersion reduces room related problems.
- More flexibility of placement, less feedback, higher gain.
- Less EQ makes for a better sounding, more efficient system.
- Less time spent EQ'ing the system.
- Less money spent on equalisers and amplifier power.

Wider dispersion – fewer speakers

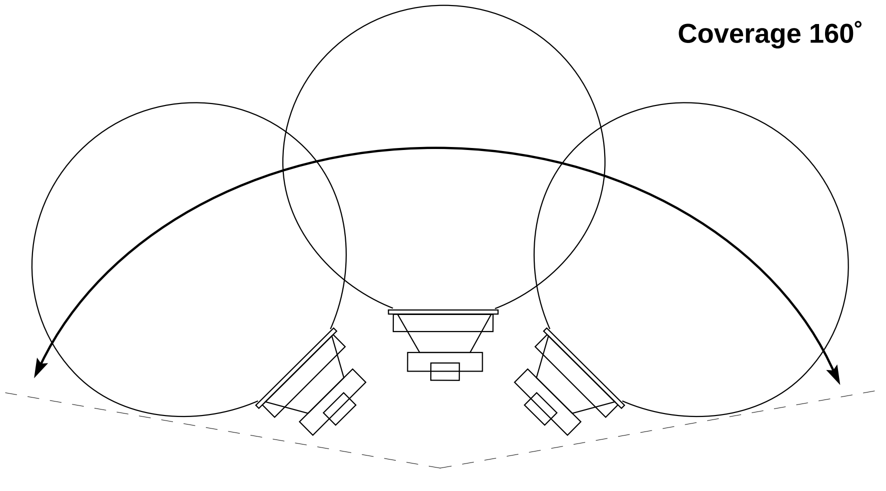
The Dual Concentric dispersion characteristic gives a fairly wide yet always fully controlled spread of sound. Except for the largest auditorium systems, most applications require loudspeakers to be short or medium throw because the problems are not so much ones of overall high SPLs but of getting adequate coverage for the whole floor area. A wide dispersion is desirable to reduce the number of speaker systems needed to cover a specific area.

So in many installations, fewer Dual Concentric systems are required to cover an area, but without sacrificing smooth and accurate overall coverage.

The Tannoy Dual Concentric covers broader areas of the listening environment



Two-way or Typical Coaxial - 5 drivers needed



Tannoy Dual Concentric - 3 drivers needed

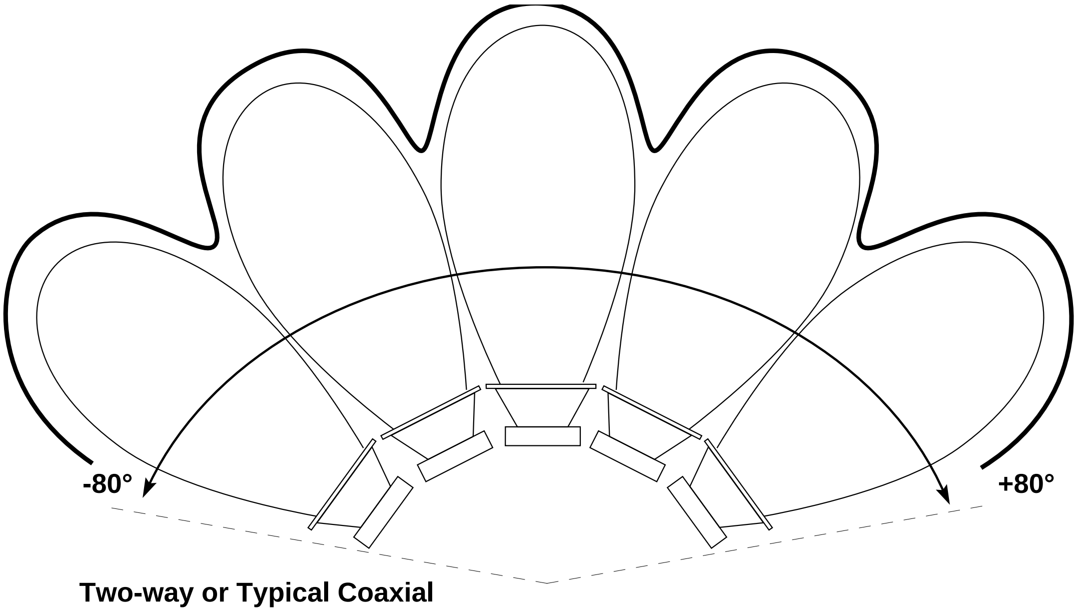
- Controlled wide dispersion means even coverage over large areas.
- Wider dispersion means fewer boxes to cover an area – lower systems cost with fewer loudspeakers, less wiring and lower installation time.

Fewer lobes – fewer problems horizontally

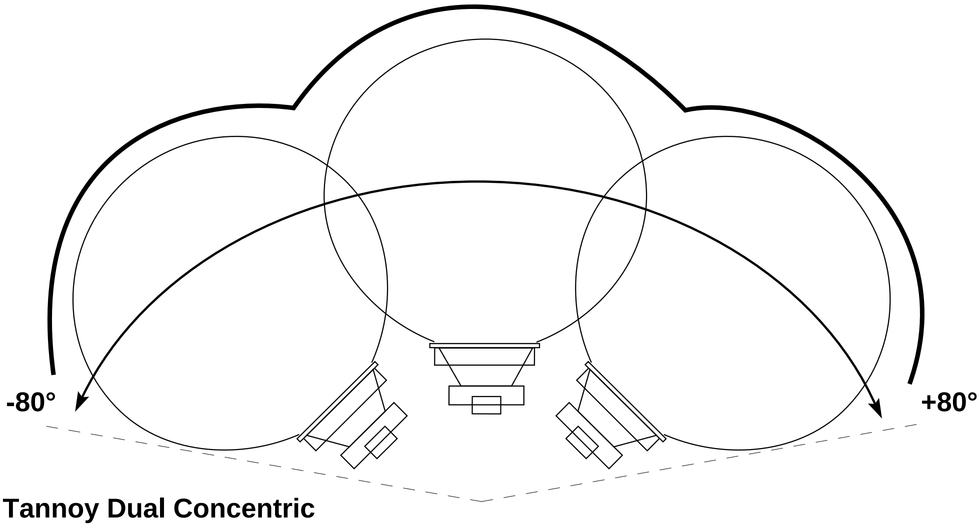
When several speakers are used in an array, there is an additional important advantage of using cabinets with a true point source driver. In arrays of the same cabinets there will always be some interference between the signal sources. This causes lobes with peaks and troughs of level that, as well as giving uneven coverage, also increases the likelihood of feedback. This means the amount of gain that the system has before feedback will be restricted.

A carefully created array of Dual Concentrics, produces considerably fewer lobes, giving better coverage and potentially greater gain.

Horizontal Lobing Reduction



Two-way or Typical Coaxial



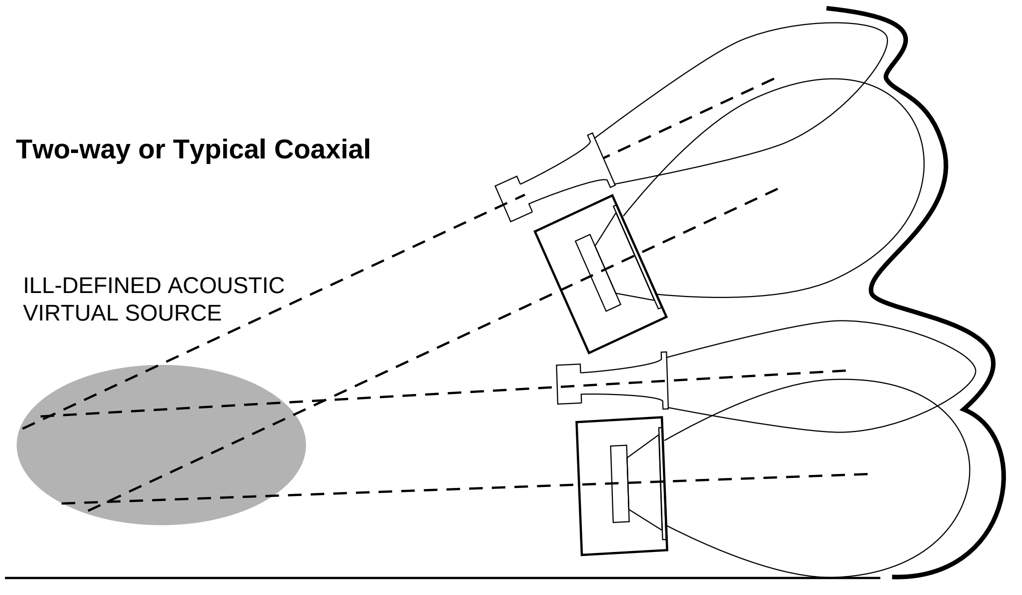
Tannoy Dual Concentric

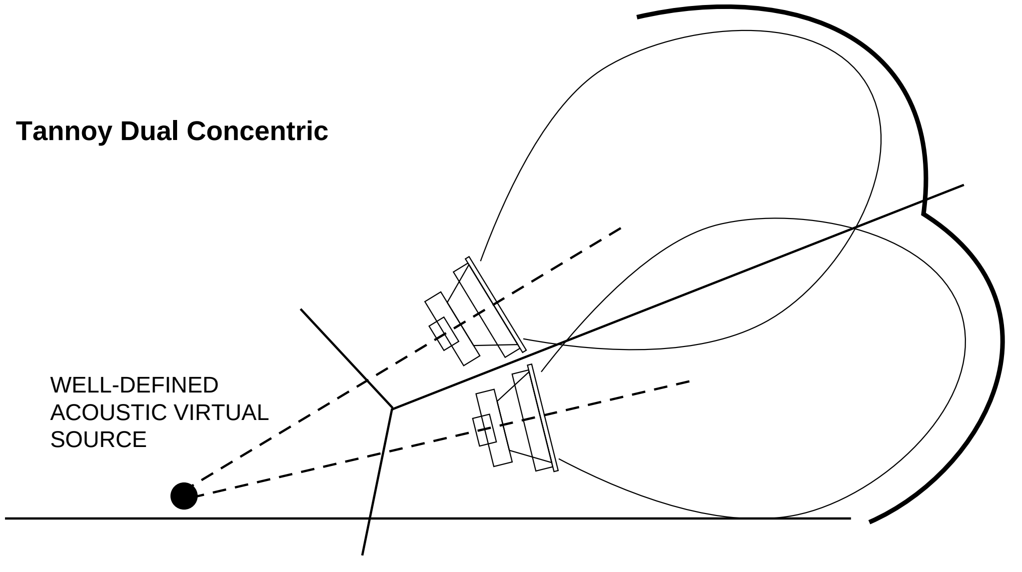
- Spherical wavefront Point Source drive units are the only way to achieve a Point Source Array.
- Arrays of Dual Concentrics are less prone to lobes leading to a more even spread of sound, less feedback and more gain.
- Dual Concentrics array equally well horizontally as vertically.

Fewer lobes – fewer problems vertically

The Tannoy Dual Concentric has a spherical dispersion, which is symmetric in both horizontal and vertical planes, they will array as well vertically as they do horizontally, which cannot be said of any horn and cone system.

Vertical Lobing Shows Significant Reduction





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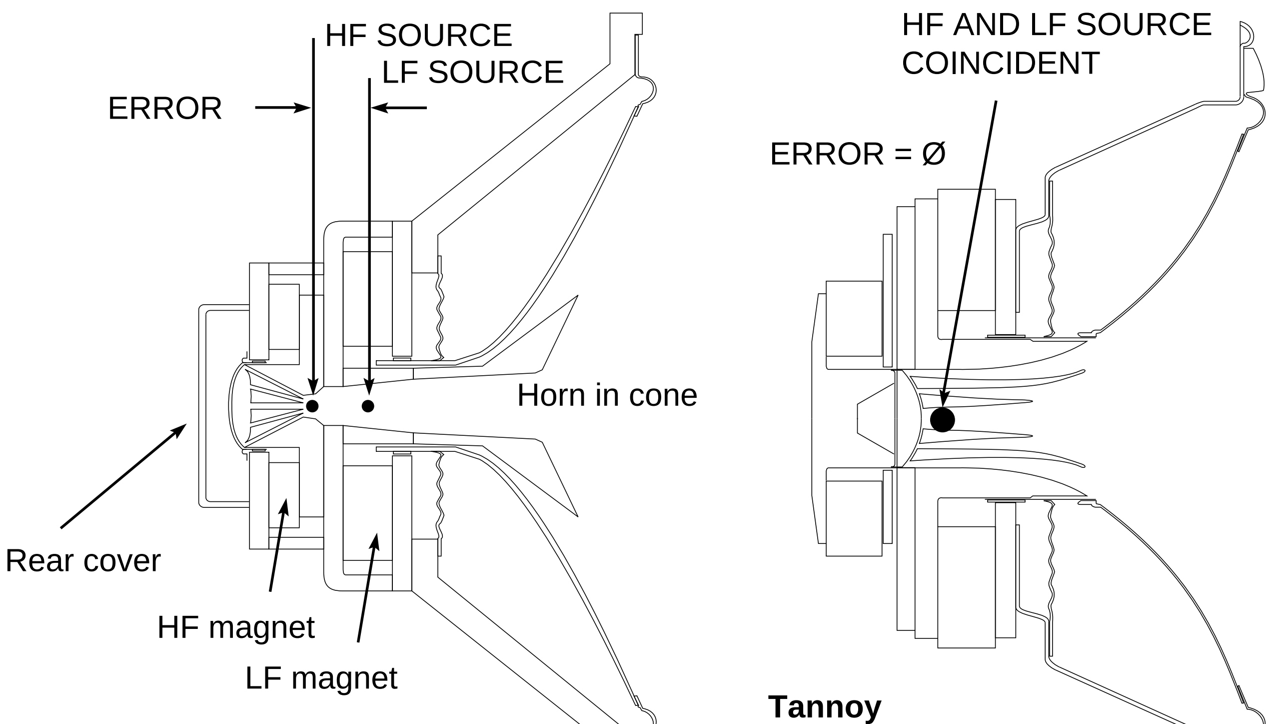
- Arrays of Dual Concentrics are less prone to lobes leading to a more even spread of sound, less feedback and more gain.
- Dual Concentrics array equally well vertically as horizontally.

A SINGLE DRIVER – AN INTEGRATED SOLUTION

An often ignored but crucial feature of the Dual Concentric is that it is designed as a fully integrated unit, with every important aspect of its performance controlled at the design stage. Tannoy engineers are continually applying the basic principles of the Dual Concentric and producing designs where every aspect – from the waveguide design to impedance control – is being addressed.

The Tannoy Dual Concentric merges high quality driver design and manufacturing with innovative and original technology.

The Tannoy Dual Concentric designed as a Point Source from First Principles



Typical Coaxial
Note error in source alignment

Tannoy
Dual Concentric
Coincident Point Source

- Coincident Point Source.
- Large throat area for high power and unrestricted dynamics.
- Lower HF compression gives lower distortion, higher power handling and SPLs.
- Precision moulded waveguide and diaphragm carrier.
- Edge wound ribbon voice coil.
- Open, cast chassis.

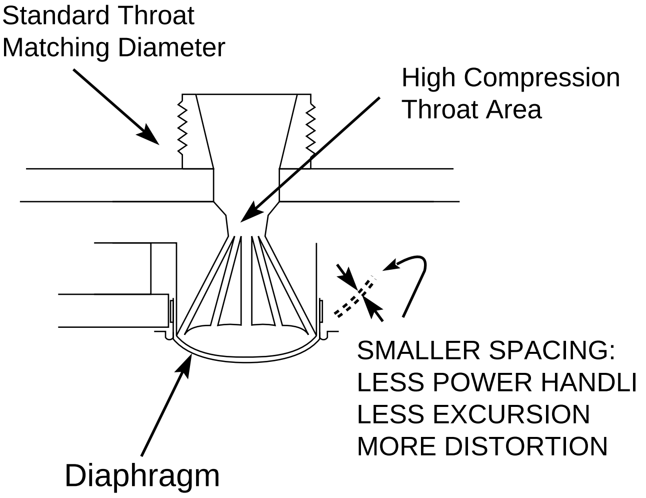
CAD waveguide – lower compression lower distortion

HF compression drive units which used a variety of separate horns always have to have one eye on physical compatibility, they have to use a standardised throat diameters (usually 1” or 2”). This is regardless of what the designer would prefer to use in the ideal world.

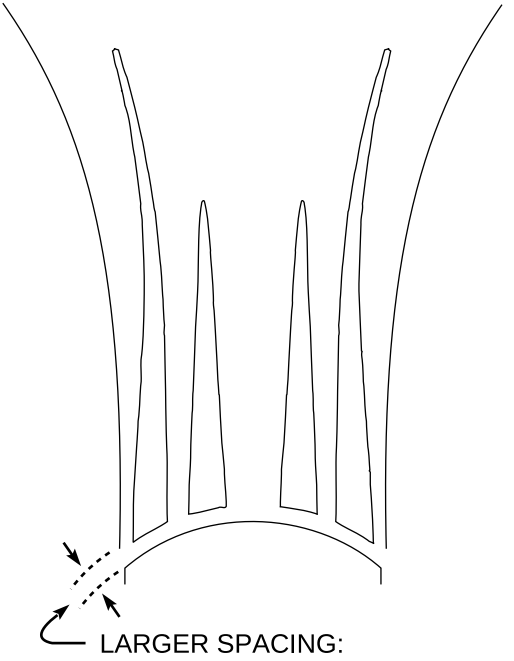
By being free of this requirement, the HF waveguide system used by the Tannoy Dual Concentric can be designed purely to meet the requirements of the whole loudspeaker’s performance.

The new wave guide developed using sophisticated computer aided design technique is a lot more open in structure, substantially decreasing the compression ratio. Lower compression means that the diaphragm can make larger excursions, with lower even order harmonic distortion.

Significantly Lower HF Compression Ratio Driver



Typical Coaxial with Slotted Phase Plug



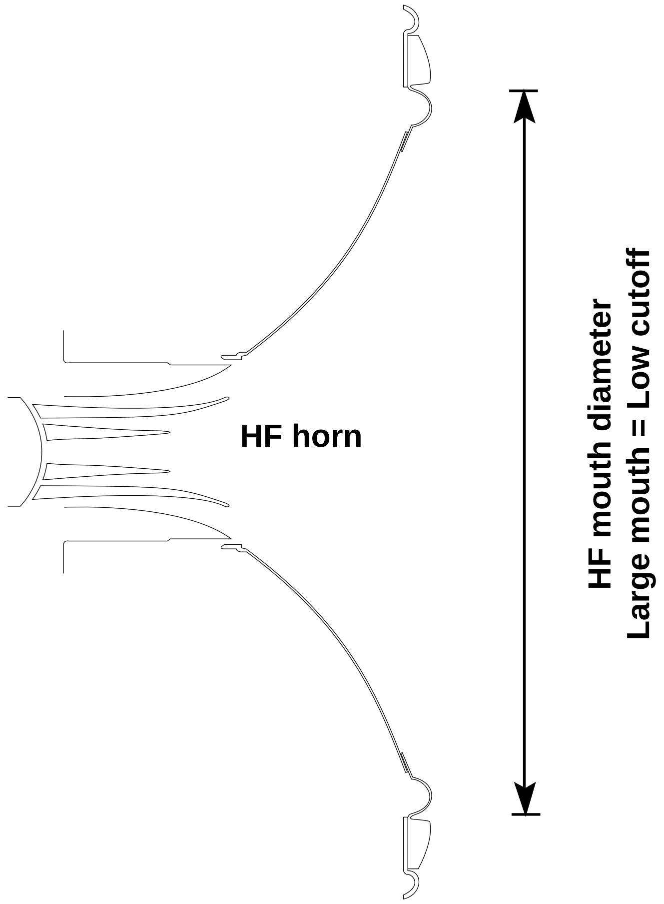
Tannoy Dual Concentric ‘Tulip’ Waveguide

- An integrated approach can concentrate on solving driver problems.
- Much lower HF compression ratios gives lower distortion, higher power handling and SPLs.

Horn and cone – a single system

The Tannoy Dual Concentric uses the cone as an extension of the HF horn. By working this way, integrating the cone and HF horn, there is no jump in acoustic impedance as the HF wavefront leaves the horn. The acoustic load impedance offered to the driver changes smoothly and gently. Smooth acoustic impedance means that there will be no large swings in electrical impedance, so making the speaker easier to drive.

LF Cone is an Extension of the HF Waveguide



- Designing the cone as an extension of the HF horn ensures a smooth acoustic impedance transition.
- Smoother acoustic impedance means smoother electrical impedance curves and more predictable powering requirements, making better use of the available amplifier power.

Smoother impedance and easier to drive

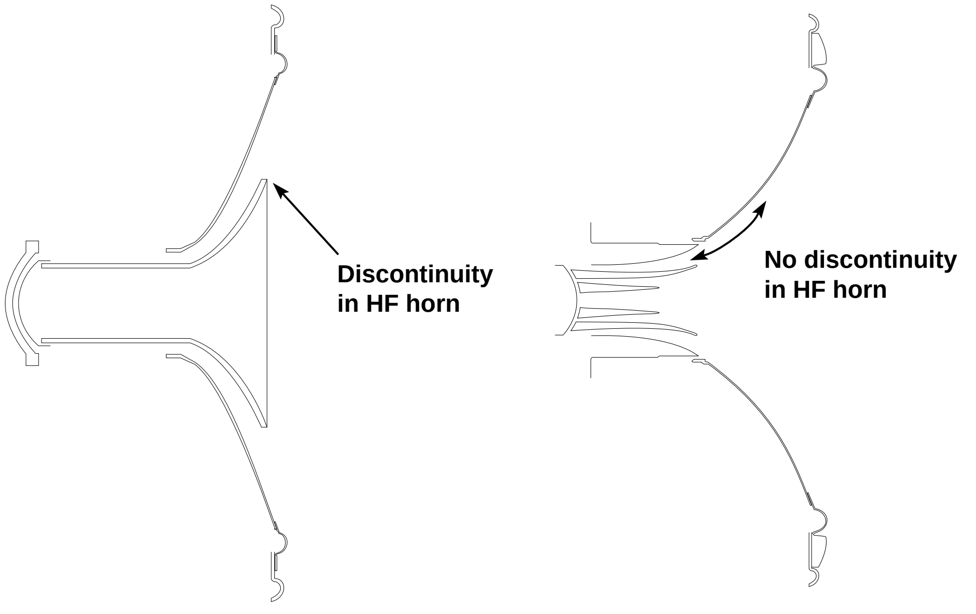
Speakers are driven by voltage swings produced by the amplifier – the greater the voltage swing, the greater the cone excursion, the louder the sound.

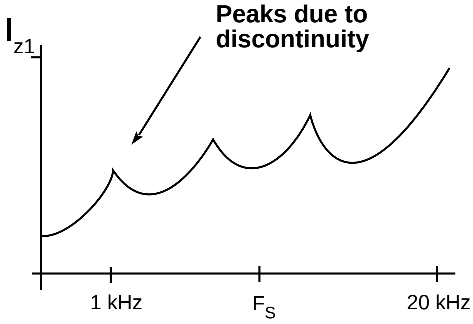
However, the current drawn from the amplifier is dependant on the speaker’s impedance. As the impedance drops then more current is drawn.

Amplifiers have a finite limit to the amount of current they can deliver and modern installation amplifiers integrate protection systems to stop the amplifier trying to deliver too much current.

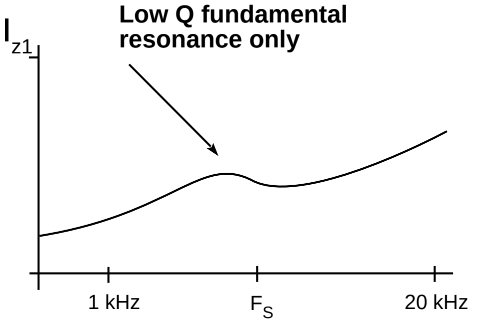
These have varying effects from restricting the dynamic range, to temporarily shutting down. So it is important that the loudspeaker presents a smooth impedance curve with no dramatic dips, that might push an already hard working amplifier into protection mode.

The Tannoy Dual Concentric Offers Smooth and Gentle Impedance Changes





Impedance of Typical Coaxial



Impedance of Dual Concentric

- Smoother impedance for less strain on the amplifiers.
- Better controlled impedance dips give less likelihood of amplifier protection circuits operating.
- Smooth impedance makes for more accurate prediction of power requirements, less incentive to over-specify amplifier powers.

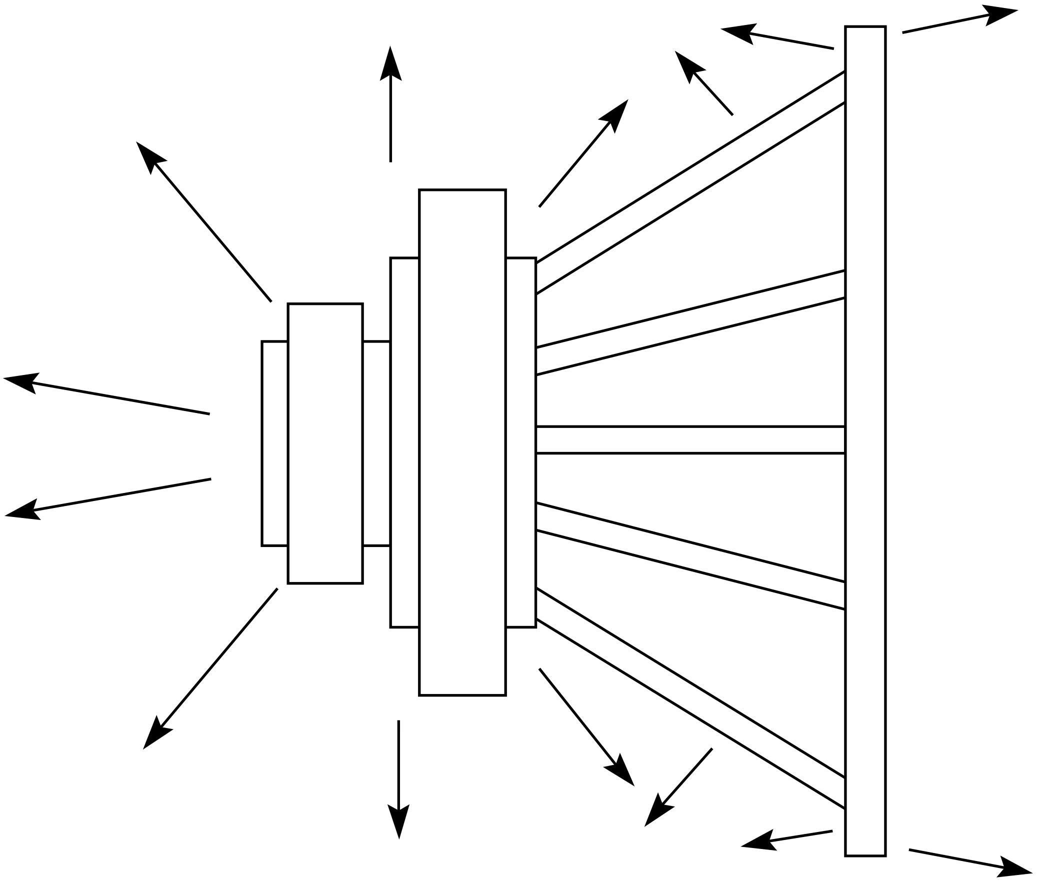
Higher heat dissipation – more accurate dynamics

Because of the large magnets and pole pieces used in the Tannoy Dual Concentric, the driver has a high thermal mass. This, linked with the use of magnetic fluid, gives better control over the coil's temperature.

If the coil temperature increases significantly then its resistance goes up, it draws less current, and the upper levels of dynamic range are compressed. For a loudspeaker designed to accurately reproduce live performance, it is critical to have accurate dynamic performance if the sound isn't going to become flat and uninteresting.

Keeping the temperature stable also helps with reliability, especially at high power levels.

High Thermal Mass and Power Dissipation



Heat dissipation from large area of LF and HF magnets and chassis

- Lower acoustic compression for better live sound.
- Better heat dissipation means better long term reliability.
- Better heat dissipation – greater tolerance of accidental overdriving.

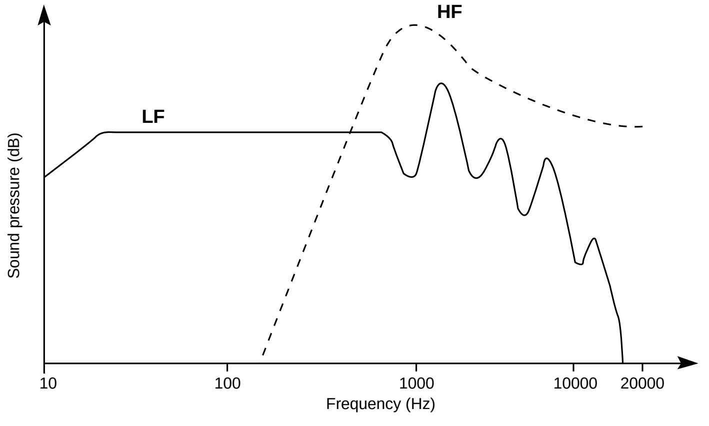
Addressing the crossover area

The crossover area is critical to the performance of a loudspeaker system, and when separate drive units are used to cover the audio spectrum, this is the one area that the design engineer has least control over.

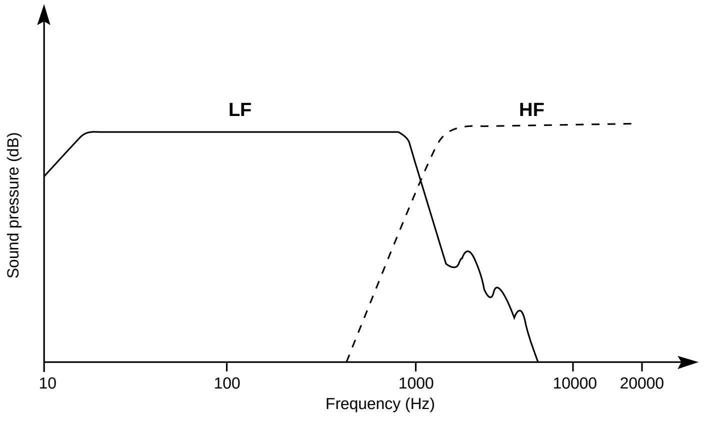
The Tannoy Dual Concentric is designed as an entire system. This means that problems, like the smooth transition of level and dispersion over the crossover area, can be resolved in the driver design.

As the two driver sections are designed to work inseparably Tannoy designers are able to modify the physical characteristics of the cone and diaphragms so that they work in a symbiotic manner, generating a perfectly even amplitude and dispersion characteristic at the crossover area.

Typical Coaxial Response Showing LF and HF Drivers Before Crossover Equalisation



Tannoy Dual Concentric Showing Before Crossover Equalisation



- An integrated driver design can address major problems at the design/manufacturing stage.
- Problems associated with the crossover area can be designed out in an integrated driver.

Better driver integration – simpler crossovers

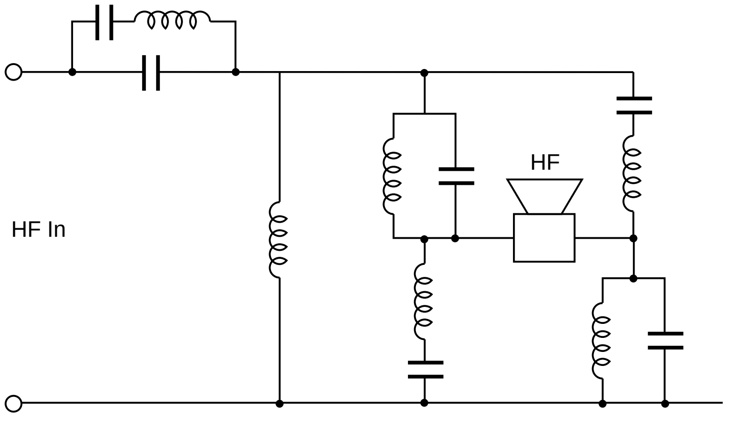
In the Dual Concentric, the integration of LF/HF drive units and horn is predetermined in the design stage. There are no unpredictable elements, such as how far the HF and LF drive units are placed away from each other and how coherent they are.

Consequently the crossover has to deal only with the smooth filtering of the signal to each section of the loudspeaker. It does not have to add components to deal with time anomalies in the crossover area and it does not need components to delay one of the signal paths. It also does not need to apply steep filtering to reduce the size of the crossover area.

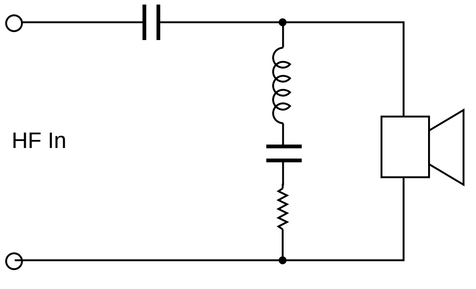
Simpler crossovers are more reliable and do less damage to the sound especially at high powers. When active crossovers are being used they result in a better response shape, and there is no requirement for additional digital delay circuits.

Since there are no 'variables' when using a Dual Concentric there is less crossover alignment work to be done on site. This will substantially reduce the time spent equalising and remove any need to introduce and then adjust HF delay line times.

Typical Coaxial Crossover Incorporating HF Time Delay



Typical Tannoy Dual Concentric Crossover



- Full control of the speaker design makes crossover design simpler.
- Simple crossovers sound better.
- Simple crossovers are less expensive.
- Simple crossovers take less time to set up on site.

DUAL CONCENTRICS – HISTORY IN THE MAKING

It is interesting to see increasing numbers of our competitors moving slowly towards the idea of a point source system. They are reducing box size, squeezing drive units closer together and using delay lines to ‘recreate’ a coincident source.

Tannoy has always believed that the obvious and natural way of solving the problems of separated drive units is not to separate them in the first place.

Throwing more and more technology at the problem can cause more difficulties than it cures.

But Tannoy’s Dual Concentric is more than a Point Source, it is a fully integrated full range loudspeaker system that maintains complete control over the system design.

The principle has been established for decades, but the technology and materials are more advanced than any of the competition.

The signal being fed to the speaker is completely homogeneous. Splitting it into different frequencies to be delivered from different positions in space, can only create problems.

The Dual Concentric is simply the right way to deliver a homogeneous signal.