Model 105

KEF

So much of our enjoyment of art depends on reproduction.

A unique painting can be photographed and printed by the million.

A once-in-a-lifetime musical performance can be recorded and enjoyed many years later.

The more accurate the process of reproduction, the greater our enjoyment.

Today, printing techniques have brought visual reproduction to a point of startling realism.

But sound reproduction has lagged behind. So far, it has been easier to record a piece of music faithfully than to recreate it in someone's home.

Loudspeaker technology has always suffered from a lack of objective research: it has relied heavily on the subjective evaluation of the human ear.

Now KEF have combined subjective evaluation with objective standards. The result is Model 105: a loudspeaker in a class of its own, which reproduces speech and music with the highest fidelity, even at realistic concert hall levels.

Such realism is the result of years of dedication to the idea of more natural-sounding, consistent loudspeakers. KEF have continuously re-examined each of the many components which constitute a loudspeaker system, and have developed new designs and new concepts of design.

The first company to go into commercial production of drive units with diaphragms made of modern plastics, KEF were also the first to apply the techniques of digital computer analysis to the research, evaluation and quality control of loudspeakers.

KEF are proud of the results, and confident that the experience of listening to a pair of Model 105's will enrich your appreciation of stereo reproduction.

As you listen to a pair of Model 105's, you'll hear something you've probably never heard before from more conventional loudspeakers.

Music doesn't seem to be directed at you from the loudspeakers: rather, it is spread out in front of you, across a "sound stage"—an area of sound images, instruments and voices, each of which has a distinct and precise location.

The stage has depth as well as breadth: the result is a superbly natural, overall sound balance. Listen to a symphony on Model 105's and it's like having the orchestra in your room.

So good, in fact, are the dispersion characteristics of the loudspeakers, that you can walk between them and still hear excellent stereo definition.

You'll appreciate what this means if you've ever owned loudspeakers with a "forced" quality, whose sounds appear to come from two point sources. As you move your head from the central listening position, the sound image abruptly shifts with you.

The sound images from Model 105's, on the other hand, are sharply localised, and stay where they are as you move.

The ideal listening area—where the stereo is at its best—has been strictly defined, and the loudspeakers provide a visual indication to show when you're sitting in it.

The listening area has been carefully calculated with due regard to the dispersion characteristics of the loudspeakers in both the vertical and horizontal planes. Our technical specifications are verifiable within this area.

And we've related the performance of the loudspeakers not, as is often the case, to arbitrary measurements made in anechoic chambers, but to where people actually sit, because we've made the theoretical design axis of Model 105 coincide with the listening axis.

All these innovations are just part of KEF's programme of reducing loudspeaker colouration which includes any kind of distortion, acoustical, mechanical or electrical—to the minimum.

Colouration is what makes cymbals fizz rather than crash, bass drums "thumb" rather than "tump," and low organ notes rattle and buzz.

KEF have applied more engineering ability than ever before to the task of eliminating it.

These are the five major factors which we worked on.

Frequency response.

The drive units are the prime movers in a loudspeaker system.

It's essential that each one should have a consistent amplitude and phase frequency response if they are to be successfully combined.

KEF are fortunate in this respect. We manufacture all our own drive units, so we never have to accept compromises from other manufacturers.

We can tailor-make each unit for each system.

Dividing Networks.

Conventional filter designs assume that the load is a simple resistance, whereas in fact, loudspeakers present complicated loads with frequency-dependent impedance characteristics. As a result, traditional loudspeaker dividing networks rarely satisfy the conflicting requirements of smooth amplitude frequency response and desirable impedance characteristics.

An entirely new approach to dividing networks has been developed by KEF.

The new technique improves transient behaviour giving a smoother, more transparent sound quality, increased depth perspective and sharper stereo imaging.

Diffraction.

Sound waves travel in a similar way to water waves, spreading outwards in all directions, like ripples on the surface of a pond.

When they reach a discontinuity a secondary wave front is created with the discontinuity as its source.

These secondary wave fronts (caused for example by the edge of a loudspeaker enclosure), can interfere with the main wave front and may be severe enough to cause audible colouration.

Model 105 has been designed so that the enclosures present as few discontinuities as possible to the propagating sound waves, and the secondary waves are so small as to be inaudible.

The result is very smooth reproduction, uncoloured by diffraction effects, and very easy to listen to.

Time delay distortion.

Recordings, particularly those made using a simple microphone technique often preserve considerable depth perspective information which is lost in playback because of the poor time delay characteristics of the loudspeaker.

Model 105 preserves the subjectively important time relationship needed for convincing depth perspective by precise dividing network design and drive unit placement.

Delayed Resonances.

Audible colouration can be caused by delayed resonances due to enclosure walls and cone break-up.

For many years KEF have been able to control diaphragm resonances by the application of visco-elastic damping layers laminated to diaphragms made of modern plastics. These laminations dissipate unwanted energy which does not contribute to the amplitude of the units' response.

Delayed resonances in loudspeaker enclosures have been more difficult to assess other than by the unscientific "knock-test."

Techniques recently developed by KEF use short pulses of acoustical energy to excite enclosure walls. Sophisticated computer analysis provides a sensitive method of detecting any enclosure resonance and can tell us how much damping material is required and where it should be located within the enclosure.

Further on, you'll see a 3-dimensional graph drawn by the KEF computer which shows for the first time exactly what goes on inside a loudspeaker cabinet.

Reproduction or original? KEF believe they should be virtually identical.

Drive units.

Three fine drive units are used in Model 105, each matching perfectly the performance requirements of the system.

Modern plastics are used throughout for diaphragm construction, yielding many advantages over conventional materials.

These diaphragms are acoustically dead and inherently free from resonances, and are therefore ideal in producing smooth, even, frequency responses.

They form an acoustic barrier to reflections from within their enclosures. Such reflections would be heard through conventional diaphragms and cause the sound to be coloured.

They are physically predictable, varying less in performance due to temperature and humidity changes, and deteriorating less with age than paper diaphragms.

The low frequency unit is a 300 mm (12″) driver with a massive magnet and high temperature motor assembly which easily accommodates the high power for which Model 105 is designed.

The 110 mm (5″) mid range unit has an aluminium voice coil former, and a visco-elastic damped Bextrene diaphragm supported by a special PVC edge suspension.

The high frequency unit is a 52 mm (2″) radiator with a 38 mm (1½″) hemispherical Mylar plastic diaphragm and a damped roll surround.

3 enclosures.

Each drive unit in the Model 105 has its own individual enclosure.

The front edges of the mid/high frequency enclosures are smoothly curved to avoid discontinuities in the path of the wave fronts.

The resulting high quality of the Model 105's dispersion produces an undistorted sound picture over a far greater area than with other systems.

Calculated positioning of enclosures.

It's very important that the sound sources of each drive unit in a loudspeaker should be equidistant from the listening ear, otherwise time delays can become audible.

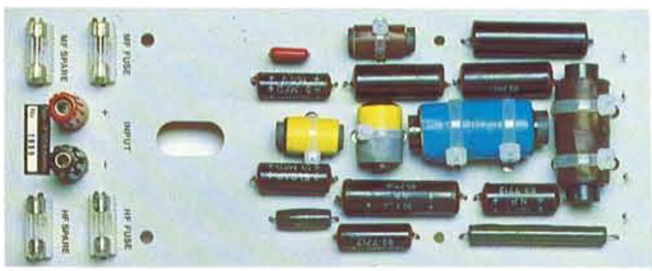
It is not enough, however, simply to put the voice coils in one vertical plane, because the coils are not, in fact, the actual acoustic centres of each unit, as now revealed by KEF's computerised impulse-testing techniques.

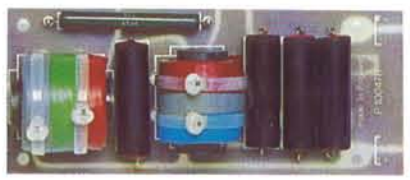
In the Model 105, it has been possible for the first time to position the three enclosures such that the true acoustic centres of the drive units are equidistant from the ear.

Dividing network.

Model 105 has a 4th order Linkwitz-Riley dividing network, one of a unique class of filters which best satisfies the complex requirements of a loudspeaker system with three non-coincident drive units.

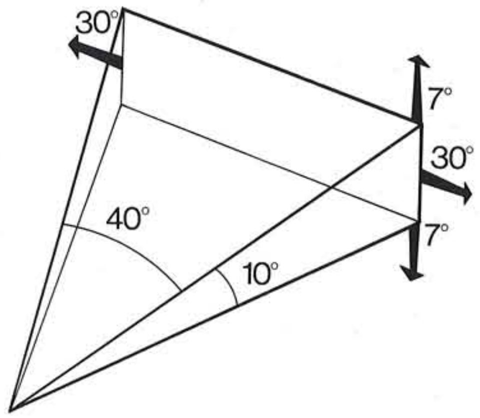
Its most significant advantage is apparent in the two crossover regions, between low and mid and mid and high frequencies. In these regions, the terminal voltages supplied to the drive units are electrically in phase, which ensures that the resultant radiation pattern does not change abruptly in the vertical plane, as a function of frequency.





Listening area.

In Model 105 the enclosures and dividing networks are designed to ensure that the frequency response is maintained substantially constant up to ±20° horizontally and ±5° vertically from the main listening axis. This ensures stable stereo imaging over an unusually large area. We refer to this area as the 'listening window.'



Listening window and indicator.

To enable the listener to identify this 'listening window.' Model 105 is fitted with a red light-emitting diode (LED), masked, so that it is only visible within the optimum listening area. If you can see the lights of both speakers simultaneously, you will then receive the best stereo definition.

The variable geometry of Model 105 takes this concept a stage further.

Listening window adjustment.

The mid/high frequency enclosure can be rotated both horizontally and vertically, independently of the bass cabinet orientation.

This gives great flexibility in placing the loudspeakers, relative to where you want to listen to them.

It is no longer necessary to live with your Model 105's in the traditional equilateral triangle arrangement. That's why Model 105's are such sociable loudspeakers: lots of people can enjoy them at the same time, not just one person in a particularly advantageous listening 'spot.'

Power Handling and fuse protection.

Model 105 can be used for normal music reproduction with amplifiers rated up to 200 watts into 8 ohms. The mid and high frequency units are protected against accidental overload by fuses.

The fuses are thermally matched to the drive units so that they allow programme peaks to pass unattenuated whilst protecting the units against fault conditions.

Peak level indicator.

Under programme conditions amplifier peak clipping can occur even when the average power into the loudspeaker (which is directly related to sound level) appears quite low, and this causes audible distortion. So that the listener may know when audible distortion is a result of amplifier overload, Model 105 is fitted with a peak level indicator. This function is provided by the same LED which is used for setting up the listening window.

The rotary switch at the rear of the MF/HF enclosure is graduated from 40 to 200 watts and should be set to the amplifier power rating. The indicator lights when the peak-to-peak voltage, which an amplifier of that rating could deliver into a load of 8 ohms, is exceeded.

Specification

Dimensions	965 x 415 x 455 mm 38 x 16.3 x 17.9 in
Weight	Net: 36 kg 80 lb
Finish	Walnut
Grille	Black cloth
Drive units (1)	300 mm low frequency driver with 50 mm high temperature voice coil and visco-elastic damped Bextrene diaphragm
(2)	110 mm mid-frequency driver with 25 mm high temperature voice coil and visco-elastic damped Bextrene diaphragm
(3)	50 mm high-frequency Mylar dome driver with damped roll surround and 38 mm dia. voice coil
Enclosures (1)	Low frequency enclosure 70 litres 4,270 cubic inches
(2)	Mid-frequency enclosure 7 litres 427 cubic inches
Dividing network	4th order Linkwitz-Riley band pass −6dB at crossover points
Dividing frequencies	400 & 2,500Hz
Nominal impedance	8 ohms
Programme rating	200 watts
Sensitivity	86dB spl for 1 watt (1 m on axis—anechoic)
Maximum continuous sinusoidal input	35Vrms 100 to 400Hz 28Vrms 400 to 2,500Hz 11Vrms 2,500 to 20,000Hz
Maximum output	107dB spl on programme peaks under typical listening conditions
Frequency response	30 to 25,000Hz ±2dB 38Hz to 22kHz at 2 m on measuring axis
Directional characteristics	Within ±1dB of axial response up to 20,000Hz (for ±5° vertical) Within ±2dB of axial response up to 13,000Hz (for ±20° horizontal)
Amplifier requirement	40 watts minimum into 8 ohms
Fuses	Fitted to mid-frequency and high-frequency sections
Peak level indicator	Switchable to indicate power levels of 40, 50, 60, 80, 100, 125, 150 and 200 watts

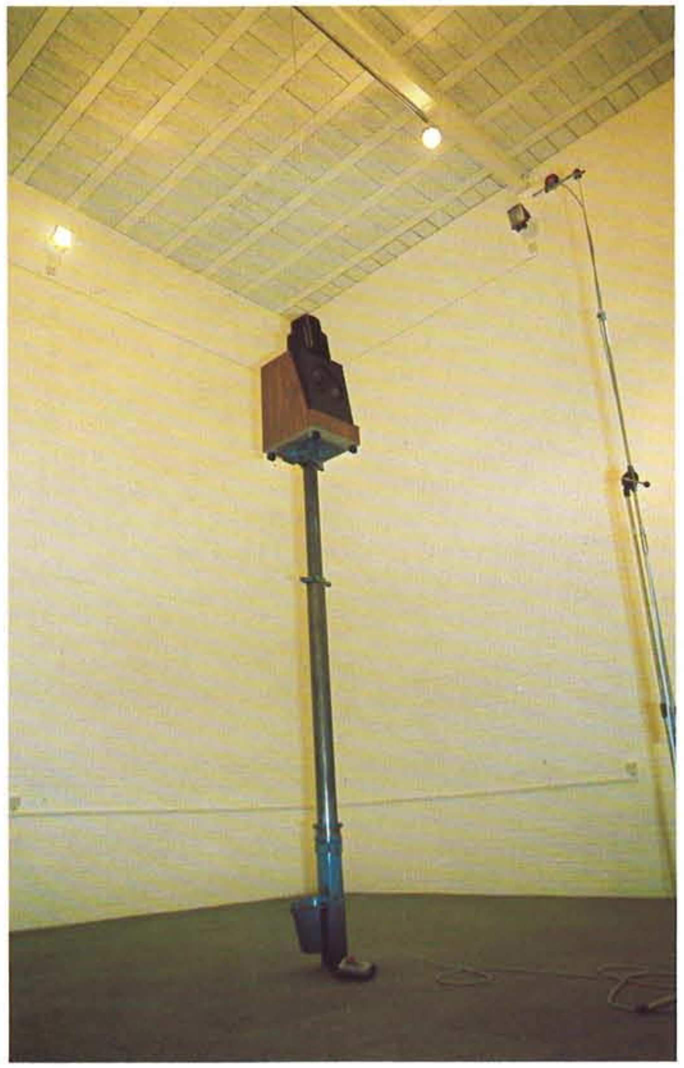
1976

KEF—the Speaker Engineers

KEF – the speaker engineers.

In 1971 we began experimenting with computer aided digital techniques for evaluating loudspeakers.

As speech and music are transient in nature, transient test signals are clearly a logical way of evaluating loudspeakers. Our research team decided to apply impulse testing, in which a short square wave burst of energy containing frequencies over the whole audio spectrum is fired at the system.



Since the signal is of very short duration, it is unnecessary for the research to be conducted under anechoic conditions, because the system reacts and settles down again long before any reflections come back to the measuring instruments.

The process is repeated many times, and the resulting impulse responses are digitised, stored and averaged by the computer.

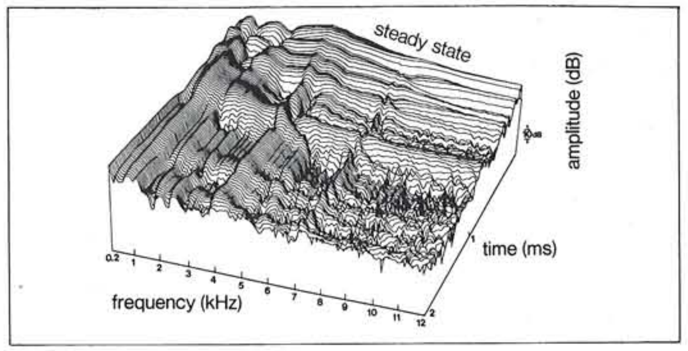
We assumed that a loudspeaker is a linear device, which may therefore be completely described either by its amplitude and phase-frequency response, or its impulse response.

Once we know the one, we can calculate the other by means of the Fast Fourier Transform.

We also established that our drive units were essentially minimum phase shift devices, and were able to relate impulse response directly to amplitude-frequency response.

From this we can calculate the amplitude-frequency response of our loudspeakers to any test signal, whether transient or steady state.

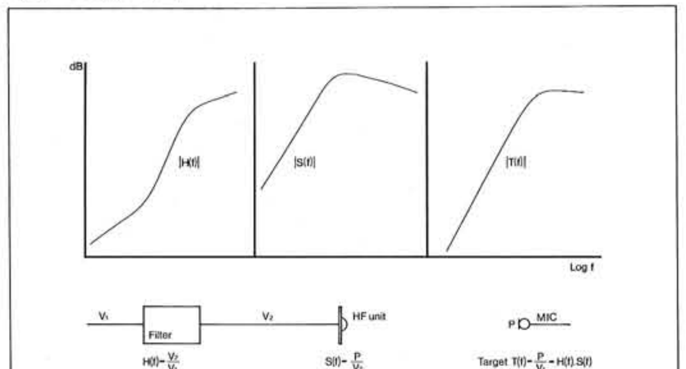
The most powerful and dramatic form of presentation of the data is the three dimensional cumulative decay spectra relating amplitude, frequency and time. This often reveals defects which are not otherwise apparent in either the impulse or the frequency responses. In the example we show of an experimental loudspeaker, the ridge running parallel with the frequency axis at about t=1 ms indicates a reflection off the rear wall of the enclosure.



Now that we were able to get a very clear picture of how our loudspeakers respond we set up the design programme which we call the "target function approach."

We define the target function as the desired amplitude and phase-frequency response of a minimum phase shift drive unit when combined with its minimum phase shift filter section.

If T(f) is the target function, H(f) the filter response and S(f) the frequency response of the drive unit, T(f)=H(f). S(f).

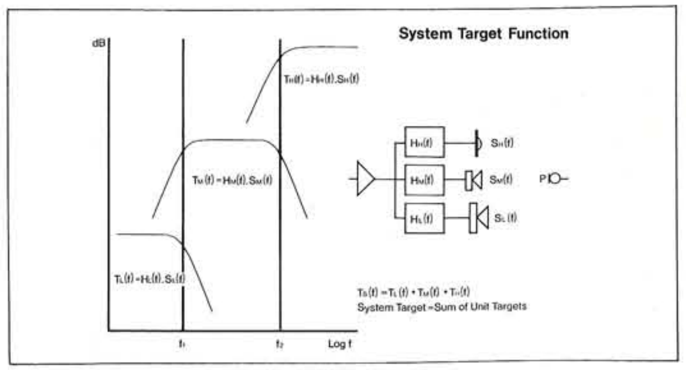


Practical realisation of Target Function for HF unit

We can measure S(f) and we have put a value on T(f) so it remains to synthesise a filter section with response H(f).

Here are three typical response curves and a schematic outline of the approach.

The target function of the whole system is simply the sum of the individual target functions.



The three filter sections $H_H(f)$, $H_M(f)$, and $H_L(f)$ are together known as the dividing network.

The design of dividing networks.

The task of any dividing network is generally to fulfil three functions, and in doing so, to provide a practical realisation of the system target function.

First, to equalise the non-flat regions of the drive units' frequency responses both within their pass bands and in their stop bands.

Second, to produce the correct roll-off characteristics at the crossover frequencies such that the output amplitudes of the drive units sum to unity and cause no peaks or troughs to appear in the overall frequency response.

Third, to offer a suitable, steady, load resistance to the power amplifier, taking into consideration the frequency dependent impedance of the drive units.

First order Butterworth filters, with 6dB/octave slopes seem to be attractive because they combine to give flat amplitude response, flat phase response and constant power response.

However, they suffer from three disadvantages.

1. Because of their low cut-off rate, it becomes necessary to control their target functions over at least three octaves outside the pass band of each drive unit, which is not practical.

2. Many drive units exhibit cut-off slopes steeper than 6dB/octave, so the filter would have to provide positive slope or boost to flatten the response even before any filter shaping.

3. The single series inductor or capacitor of a first order device is insufficient to maintain a good match between the amplifier and the changing resistive load of the speaker system.

Second order Butterworth filters cannot be considered because they do not sum to unity.

However, third order Butterworth filters are a good compromise.

Like first order, they sum to give a flat amplitude response. But unlike first order, they have a cut-off rate of 18dB/octave, giving much better attenuation in the stop band and therefore allowing a greater proportion of the working range of the drive unit to be utilised.

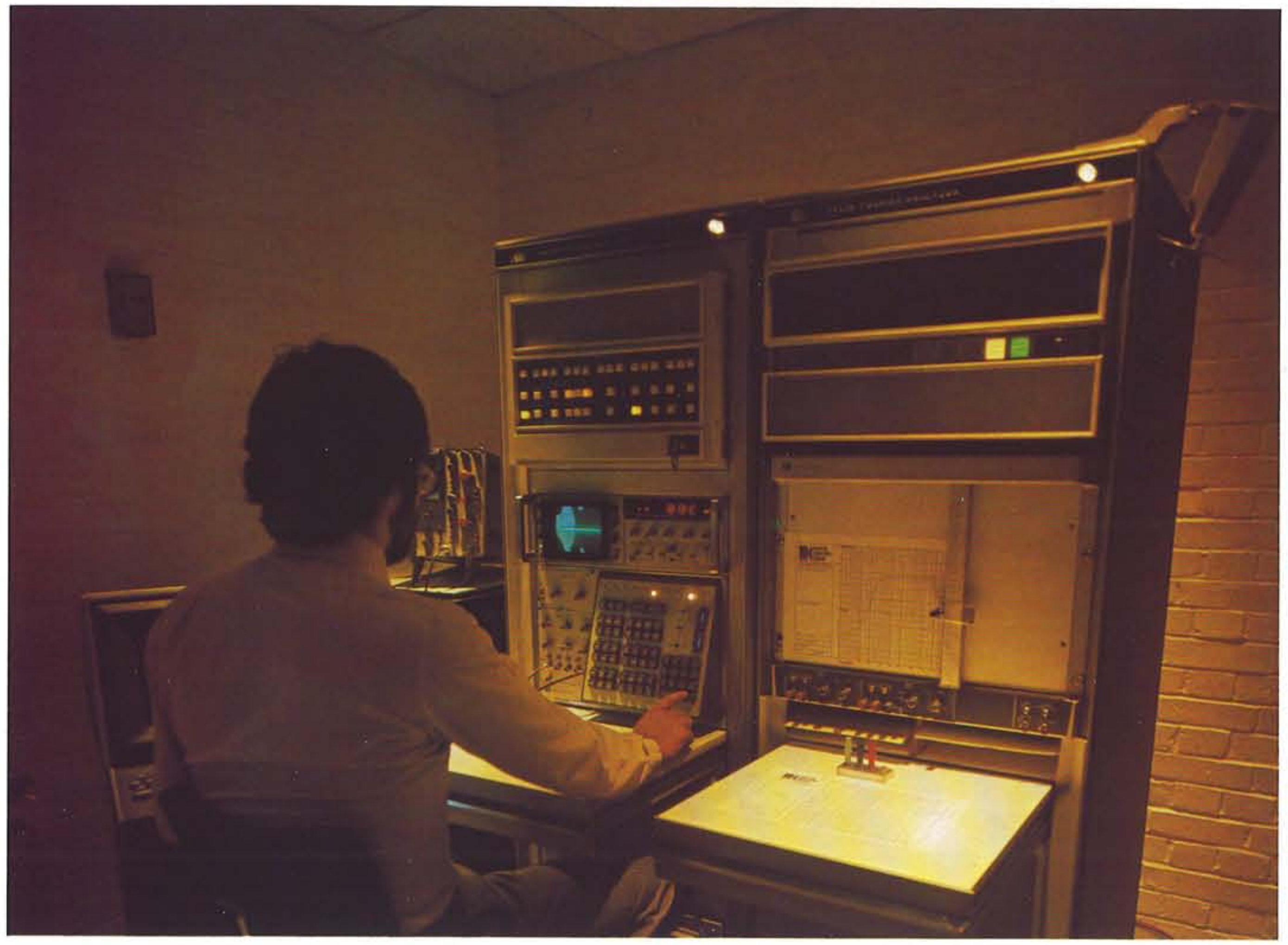
In designing the Model 105, KEF decided to synthesize an even more sophisticated filter which would satisfy still closer the system target function.

After considerable research, a fourth order Linkwitz-Riley filter was chosen.

An important feature of this filter is that the terminal voltages add in phase.

Therefore, in the crossover regions, where there is a continual shift of emphasis between one drive unit and another, the vector sum of their component outputs always lies along the target design axis. Thus the main lobe of the radiation pattern (sometimes referred to as the "polar diagram") remains symmetrical about the listening axis at all frequencies.

KEF's choice of drive units, enclosure geometry and fourth order Linkwitz-Riley filter means that the main sound-radiation lobe of the Model 105, both in the vertical and horizontal axis, is closer to the ideal shape than ever before.



Of all arts, music is the most indefinable and the most expressive, the most insubstantial and the most immediate, the most transistory and the most imperishable.

Transformed to ripples in a record groove, to a dance of electrons along a wire, its ghost lives on.

When KEF return music to its rightful habitation, your ears and mind, they aim to do so in the most natural way then can.

Without drama.

Without exaggeration.

Without artifice.

Now that we've shown how KEF do this, we ask you to compare the Model 105 with any other loudspeaker you might be interested in.

If possible, find a dealer who will demonstrate a pair of them in your home. But whether you listen to Model 105's in your sitting room or a showroom, make sure they are not too close to the walls, as these can act as diffracting surfaces. They are best placed about half a metre from the rear wall and at least one metre from each side wall, and well clear of any other equipment or furniture.

Make sure that the input equipment compliments the quality of Model 105's: we want you to hear them at their best.

And listen to records you know. Only then can you make a definitive comparison and appreciate to the full the qualities of Model 105's.

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