KEF MODEL 104/2
REFERENCE SERIES

THE MOST THOROUGHLY ENGINEERED LOUDSPEAKER IN THE WORLD
Conjugate Load Matching
Or How to Double the Power of Your Amplifier Without Having to Buy a New One

The reproduction of a wide dynamic range at high output levels has traditionally meant using a large amplifier with large loudspeakers, making heavy demands on both.

But every good amplifier is overdesigned to cope with a wide range of loudspeaker loads, some of them notoriously 'difficult'. Thus there is 60-100% more untapped power locked inside every amplifier.

The key to unlock this extra power is 'conjugate load matching'.

Most amplifiers are rated for operation with a nominal load impedance of 8 ohms. But the load presented by a typical '8 ohm' loudspeaker is not at all like that of an 8 ohm resistor. It varies, both in magnitude and phase, with frequency.

For pure sine wave test signals, the current drawn by such a loudspeaker is seldom more than, and for some frequencies less than, that of a resistor of 8 ohms. But on complex musical signals with harmonic structure, the peak current requirement may be more than double that of an 8 ohm resistor, corresponding more closely to that of a 4 ohm resistor (Fig 1).

TABLE

<table>
<thead>
<tr>
<th>Amplifier</th>
<th>Output Voltage</th>
<th>CURRENT DRAWN BY LOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 ohm resistor</td>
<td>1 W</td>
<td>0.5 A</td>
</tr>
<tr>
<td>4 ohm resistor</td>
<td>1 W</td>
<td>1.0 A</td>
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</table>

This is why good amplifiers must have extra peak current capacity.

Advanced computer design techniques, pioneered by KEF for the past decade, have enabled the Model 104/2 to be built with a dividing network that, in addition to the usual filtering and shaping components, includes a load-matching element which makes the input impedance flat and resistive over the range 20Hz to 20kHz. Having a purely resistive characteristic enables the loudspeaker's impedance to be reduced, over the whole audio band, to 4 ohms and yet demand no more peak current from an amplifier.

The result is that sensitivity and maximum output level are effectively doubled, without any need for a more powerful amplifier.

The Integrated Midrange
Or How To Eliminate Colouration by Eliminating Its Source

The main sources of colouration in the midrange are structural resonances in the midrange chassis and the enclosure.

In the KEF 104/2, these two midrange resonant peaks are fixed directly to a separate high frequency and midrange enclosure (Fig 2). The magnetic systems being bolted to the rear of it.

Enclosure resonances are effectively suppressed by damping the entire structure with a high-density rubber foam, moulded in situ (Fig 3). This unique midrange and high frequency enclosure incorporates a centrally located high efficiency tweeter, foil-radiator cooled to ensure maximum power handling capability.

The combination of the heavily damped enclosure, the total weight of which exceeds 6.5 kg (14 lb) with no non-resonant coupled cavity bass configuration, produces a full-range system of high efficiency, capable of astonishingly high sound pressure levels. The 104/2 reproduces music with a clarity and freedom from colouration that is startling in its ability to communicate all the dynamics and fine detail of which music is composed.

Coupled Cavity Bass Loading
Or How to Get More Bass Output and Power Handling with Reduced Distortion, without Increasing the Size of the Cabinet

In conventional loudspeakers, bass output and extension is directly related to cabinet size. It is well known that a reflex system (Fig 2) will give higher output with lower distortion from any given enclosure size. This is achieved by the sound radiated by the back of the bass unit. Instead of being 'lost' in the cabinet, as in a closed box, this sound is phase inverted by the port and added to the sound radiated from the front of the unit.

Below the tuning frequency of the port, however, the two outputs are no longer in phase and cancellation ensures loss of output. The roll-off rate below this frequency is double that of a closed box resulting in poorer transient performance and susceptibility to subsonic signals as the bass unit is unloaded at very low frequencies.

The coupled cavity system of bass loading used in the Model 104/2 is the result of some nine years research by KEF engineers. By isolating the bass unit and using only the output of the reflex port (Fig 4) no output is lost through cancellation, and the tuning frequency can be placed where the musical demands are greatest. Such a system gives very low distortion with very high power handling capability. Transient performance is superior to that of a reflex system, and protection is afforded against subsonic problems. Also a lower frequency can be used for crossover to the midrange than is normal: around 150Hz instead of the more usual 250Hz-350Hz. Additionally it confers all these benefits where the mechanical demands of music reproduction are at their highest.

In the Model 104/2's two bass units are used 'balanced', creating sound images in space achieved through a combination of very high quality response and sensitivity matching between the speakers in the stereo pair, and by closely controlled on and off-axis response. To achieve this, the KEF Reference Series design and production philosophy was the reference, using computer-controlled drive unit matching within 0.5dB, and component tolerance matching in the dividing network.

Controlled Directivity
Or How To Create Lifelike Sound Pictures

The recording of lifelike, focused sound images in space is achieved through a combination of very close frequency response and sensitivity matching between the two speakers in the stereo pair, and by closely controlled on and off-axis response. To achieve this, the KEF Reference Series design and production philosophy was the reference, using computer-controlled drive unit matching within 0.5dB, and component tolerance matching in the dividing network.

To help control off-axis response the special midrange high frequency enclosure mentioned above is carefully contoured to minimize distortions in the sound distribution caused by diffraction, resulting in response being maintained well off axis.

This assembly also allows a separate reproduces around 85% of normal musical programme and the use of two identical midrange units, in addition to improved power handling, allows them to be driven over an unusually wide bandwidth (nearly a full octave lower than is usual). Widening the practical bandwidth of the midrange system means that, in conjunction with the bass loading method employed, a lower crossover point at 150Hz can be used, thus achieving a smoother distribution of energy through the important 200-400Hz region, with both midrange and colouration in the voice region, and improved imaging.

The 104/2's entire low-frequency range is radiated by a smoothly contoured duct placed below the mid-high frequency enclosure. This duct, effectively a 5" air diaphragm of very low mass, (approx. 3gm) is of similar diameter to the midrange units. Its directional characteristics match those of the midrange, ensuring an exceptionally smooth acoustical integration which further enhances the 104/2's imaging capabilities.

Electronic time delay is incorporated in the dividing network to tilt the preferred axis towards the seated listener. This helps stereo imaging without having recourse tooffset or stepped drive units.

Flexibility, Compatiblity and Pleasing Appearance
Or How To Reconcile The Irreconcilable
 Speakers perform at their highest level of performance. The 104/2 have been generally big and ugly. The relatively compact dimensions (it takes up less than 1sq ft of floor space) and elegant appearance of the 104/2 have been a part of the design brief since its inception. In addition, it is generally acknowledged that most speakers actually perform better with their grilles removed, revealing what is, to many people, unsightly drive unit arrangements. The 104/2's specifically designed to be operated with the grille on. Careful contouring and matching of the grille assembly to the midrange enclosure (Fig 7) produces an improved response with the grille in place.

The conjugate load matching technique ensures compatibility with a wide range of associated equipment by presenting the kindest possible load to the driving amplifier.

Finally, the most unpredictable and variable element in hi-fi is the listening room. The 104/2 allows greatest flexibility of positioning because it suffers less from the aberrations normally introduced when placing speakers of more conventional design.

Screw-down feet allow the speakers to be set perfectly upright to avoid the stability problems often encountered with tall, slim enclosures. This also ensures that the speaker is correctly coupled to the room.

MRHF assembly

Fig 2

Fig 3

Fig 4

Fig 5

Fig 6

Fig 7

Fig 1
The most significant advance in dynamic loudspeaker technology in a decade

The 'state of the art,' as any hi-fi enthusiast knows, moves forward by way of a constant flow of tiny improvements and innovations.

But every so often, something remarkable happens that seems to push the whole process forward by several years at a single stroke.

The KEF Reference Series 104/2 is just such a development.

Valuable experience gained in both domestic and professional surroundings with KEF's new high level, high quality monitor, the KM1, have enabled many of the KM1 design features to be adapted to this new domestic loudspeaker system.

The 104/2 employs new mechanical and electrical ideas, some bordering on the revolutionary. However, its design philosophy is still the same as that on which its distinguished predecessor, the original 104, was based 12 years ago.

The original concept was, and so remains today, simply to build the best speaker possible to meet the musical demands of the time.

Recording technology has greatly advanced over the past 12 years. The new 104/2 has been designed to meet today's challenge.

Today's digital recordings possess a wider dynamic range than ever before. Reduced background noise reveals more fine musical detail. To realise the full potential of these recordings a new breed of speaker is demanded.

What are the characteristics which this new breed of speaker should have?

A Wide Dynamic Range requires a loudspeaker of high efficiency, coupled with adequate power handling and low distortion.

Low Colouration is achieved by freedom from spectral distortion both on and off axis, and by freedom from structural resonances in the enclosure and drive units.

Stable Stereo Imaging requires exceptionally close matching between left and right hand loudspeakers, with uniform on and off axis response, under all conditions.

Pleasing appearance. Speakers are necessarily part of the furniture in the home, and must truly be 'lived with.' Industrial design, compatible with the engineering demands, should therefore ensure that the loudspeaker looks as elegant and unobtrusive as possible. It should also give of its best in all rooms irrespective of their shape and size, allow flexibility of positioning, and operate with as wide a range of associated electronics as possible, whilst extracting the best from each.
Frequency Range: 55Hz-20kHz ± 2dB at 2m on reference axis
Directional Characteristics: Within 2dB of response on reference axis
up to 15kHz for ± 10° vertically
up to 10kHz for ± 30° horizontally
up to 6kHz for ± 45° horizontally
Maximum Output: 112dB spl on programme peaks under typical listening conditions
Characteristic Sensitivity Level: 92dB spl at 1m on reference axis for pink noise input of 2.83V rms (anechoic conditions)
Distortion:
Second harmonic: less than 0.5% from 20-20,000Hz
Third harmonic: less than 0.5% from 20-20,000Hz
Measured at 1m on reference axis at mean spl of 94dB (anechoic conditions)
Enclosures:
Low frequency enclosure: 50 litres
MF/HF enclosure: 3 litres
Amplifier Requirements:
Suitable for use with amplifiers capable of providing between 25 and 200W into 4 ohms resistive load
Nominal Impedance: 4 ohms resistive from 20-20,000Hz
Weight: 32kg (70 lbs)
Dimensions: 900 (h) x 280 (w) x 415 (d) mm, 35½ (h) x 11 (w) x 16½ (d) in

KEF reserve the right to incorporate developments and amend specifications without prior notice in line with continuous research and product improvement.

The shaded band shows the limits of the listening window (in the vertical plane) within which the optimum sound reproduction is obtained.