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ENGINEERING WHITE PAPER

The JBL Model L212 Loudspeaker System

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I. Design Parameters

The main design goal in the L212 program was to optimize loudspeaker/ listening room performance throughout the frequency range of 28 Hz to 20 kHz. High frequencies tend to radiate into the listening space while low frequencies tend to couple into the space, and the typical full range loudspeaker system is at a disadvantage in attempting to fulfil both requirements. Thus, the decision was made early in the program to treat the low frequency problem separately by dividing the spectrum at a suitable crossover frequency and feeding the signal into loudspeakers and enclosures specifically tailored to their respective roles.

The advantages in the approach are obvious, and we list them below:

A. Bass Reproduction

1. With a suitably low crossover frequency (judged on the basis of listening tests to be approximately 70 Hz), a bass reproducer can be located almost anywhere in the listening room without affecting stereophonic localization.

2. Restricted to the range below 70 Hz, a sub-woofer/amplifier system ca be designed and tailored for its specific function. In the L212, we chose to use a

single 12-inch LF transducer, driven by a left-plus-right signal below 70 Hz, powered by its own integral amplifier. The transducer is capable of a total linear excursion of 3/4 inch, and its cone is mass-loaded to maintain a system resonance of 33 Hz in an enclosure only 19 1/8 x 18 1/2 x 18 1/2 inches deep.

3. Driving power can be determined by the specific peak and average demands existing at low frequencies. In the case of the L212 bass driver/enclosure combination, 50 W continuous sine wave power is sufficient to drive the LF transducer to its limits of linearity at 28 Hz.

B. Reproduction Above 70 Hz

1. Freed from the requirement of generating substantial low bass energy, the transducers in the side modules can be made smaller; in the case of the L212 the 8-inch, 5-inch and 1-inch transducers fit into a small vertical array only 13 1/2 inches high. This "tight" array produces highly coherent radiation, even at fairly close distances, and symmetry about the vertical axis produces a horizontally symmetrical polar radiation pattern.

2. Components can be chosen to be the optimum size for the job at hand. In the L212 side modules, an 8-inch cone transducer reproduces the spectrum from 70 Hz to 800 Hz, a 5-inch cone transducer carries the spectrum up to 3 kHz, and a 1-inch dome transducer handles the range above that point. The diameter/wavelength relationships for the 8-inch and 5-inch units are such that these transducers are operating well within their piston range -- thus ensuring fairly constant radiation, with respect to angle, over their frequency ranges. The 1-inch dome transducer, carrying the range upward to 20 kHz, is allowed to narrow the

effective radiation angle somewhat.

The maintenance of constant dispersion over the bulk of the frequency range means that the reverberant sound energy in the listening room will be as smooth as that of the direct on-axis response of the system. This is an essential ingredient for realistic sound reproduction.

3. The side modules can be scaled to reasonable physical dimensions for ease and flexibility of location in the listening room. The L212 side modules are 38 5/8 inches high, 17 inches wide and only 5 inches deep (flaring out at the pedestal to be 13 inches deep).

II. System Performance

A. Free-field Measurements

On-axis frequency response measurements at JBL are made on a large square flat baffle, 30 feet on a side, essentially into half-space. Figure 1 shows the overall on-axis response of the L212 system at 6 feet, 1.25 W nominal power input.

Figure 2-a shows the response of the bass unit alone, and Figure 2-b shows the response of the side module.

Figure 3 shows the impedance of the side module.

Figures 4-a through 4-r are horizontal polar plots of the response of the side module.

Another view of the horizontal polar characteristics is shown in Figure 5. Here we have plotted the effective horizontal radiation angle (the angular space between the 6-dB-down points) with respect to frequency. Note that throughout the large part of the frequency range, the horizontal response is constant within 180° and 135°.

Figures 6-a through 6-r are vertical polar plots for the side module. The vertical polar response is not symmetrical since the frequency selective components are arrayed vertically. Note that the vertical response is quite smooth within an angle of 45° about the axis.

B. Bass Response in Typical Environments

The response of the LF system depends upon its location in a given room, the nature of low frequency sound absorption in the room, and the spacing of normal room modes (those "preferred" frequencies the room tends to emphasize). Figure 7 shows typical 1/3-octave response of the LF system in a room 17 feet wide, 36 feet long and 12 feet high.

C. Characteristics of the Dividing Networks

Figure 8-a shows the voltage drive characteristic of the LF system, and Figure 8-b shows the voltage drive to the three elements of the side modules. In Figure 8-b the voltage levels are characteristic of the system level controls set for flat acoustical response.

D. Low Frequency Distortion Measurements

Figure 9 shows second and third harmonic distortion characteristics of the LF transducer. For these measurements, the unit was placed in a 2.3-cubic foot enclosure, and the drive level was a nominal 10 W (without equalization). Measurement was made at a distance of 10 feet in the free field. Note that above

50 Hz the distortion products are more than 40 dB down. In the range of 30-50 Hz, the second harmonic component is still 25 dB down, or better, and the third harmonic component is 20 dB down.

E. Overall System Sensitivity and Power Handling Characteristics

The nominal sensitivity of the L212 system is 89 dB SPL (1 W referred to a distance of 1 m). In a free field, an input of 10 W will produce a level of about 90 dB SPL at 10 feet (about 3-4 dB higher in a typical indoor environment). Normal music levels, even for pop or rock, are in the 90-100 dB SPL range, so it is clear that the 75-W nominal power rating (per channel) of the system can more than meet these demands. Typically, 75 W per channel will produce sound pressure levels in the 104-105 dB SPL range in living rooms of average size.

F. Time Domain Relationships

In the design of the L212, considerable attention has been paid to time domain relationships between the components, and the result is exemplary transient accuracy. Typical impulse signal response is shown in Figure 10.

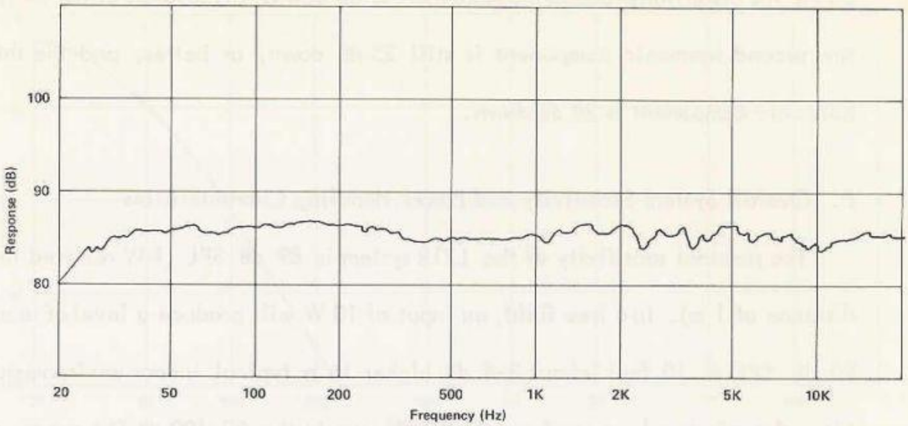


Figure 1

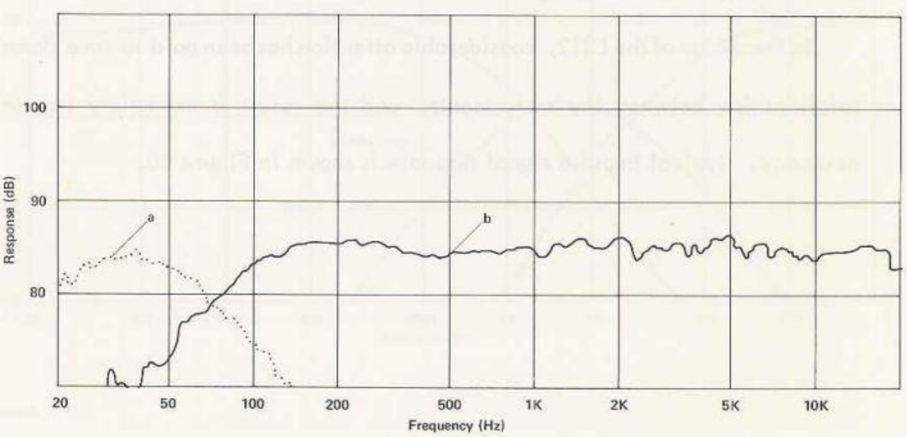


Figure 2

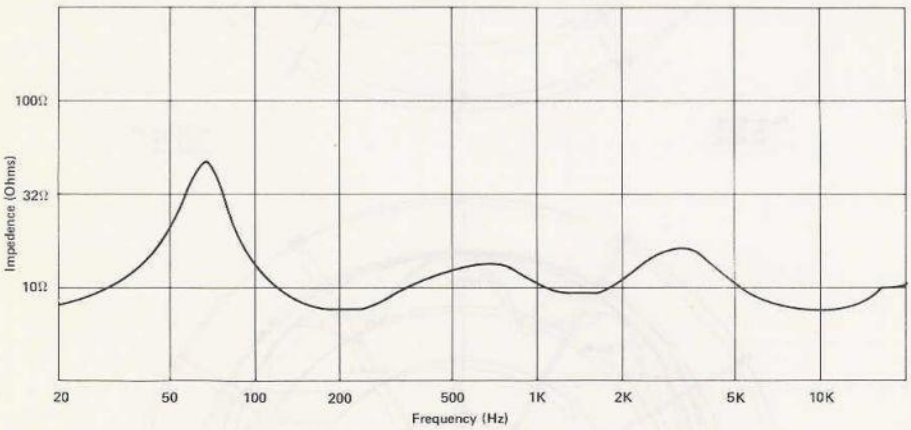

100Ω
32Ω
10Ω
Impedence (Ohms)
20
50
100
200
500
1K
2K
5K
10K
Frequency (Hz)

Figure 3

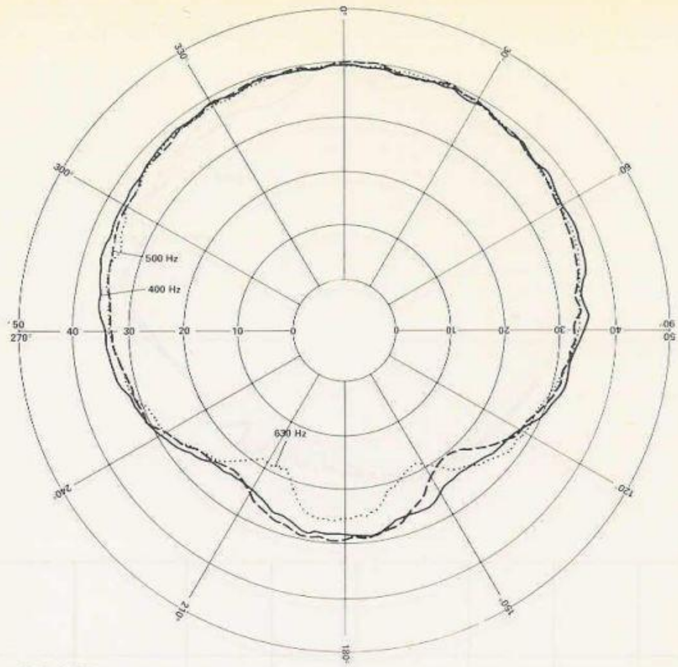


Fig. 4a - 400 Hz
4b - 500 Hz
4c - 630 Hz

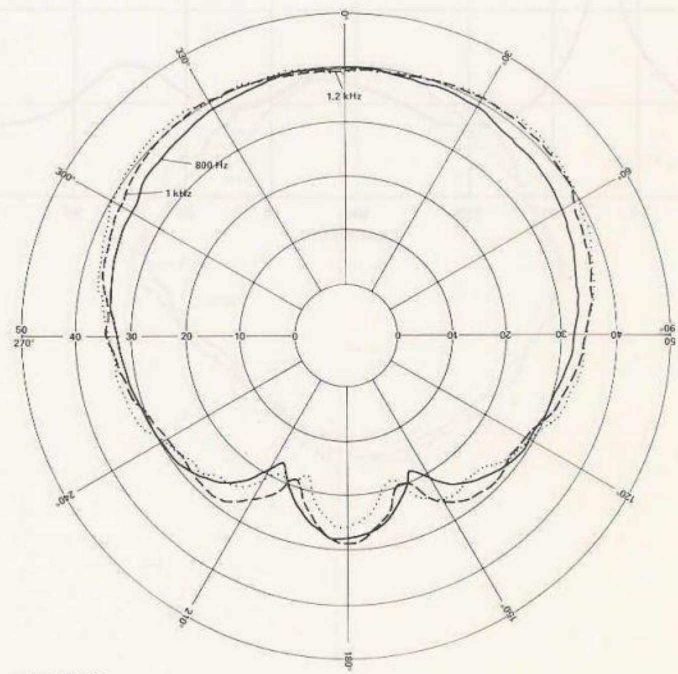


Fig. 4-d 800 Hz
4-e 1 kHz
4-f 1.2 kHz

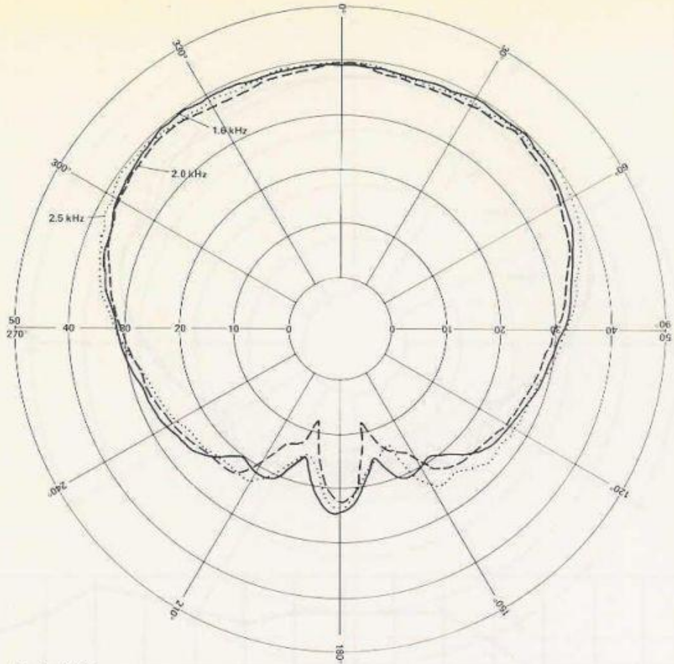


Fig. 4-g 1.6 kHz
4-h 2 kHz
4-i 2.5 kHz

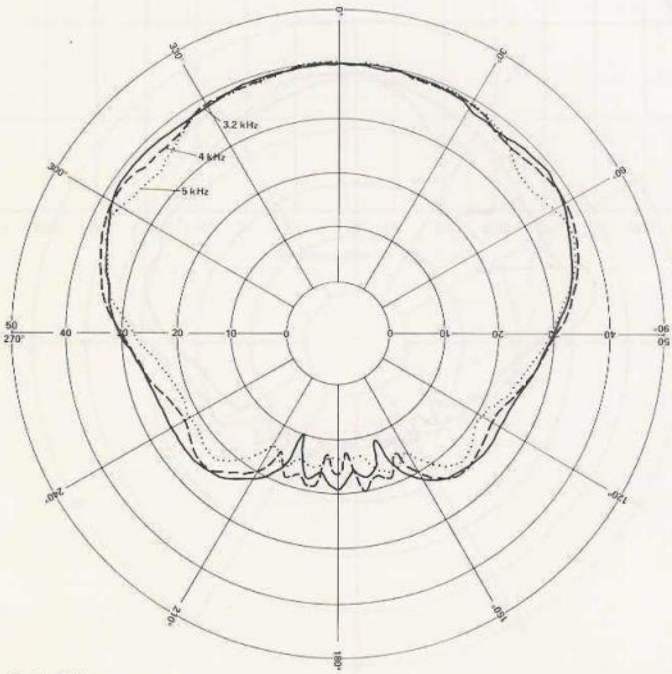


Fig. 4-j 3.1 kHz
4-k 4 kHz
4-l 5 kHz

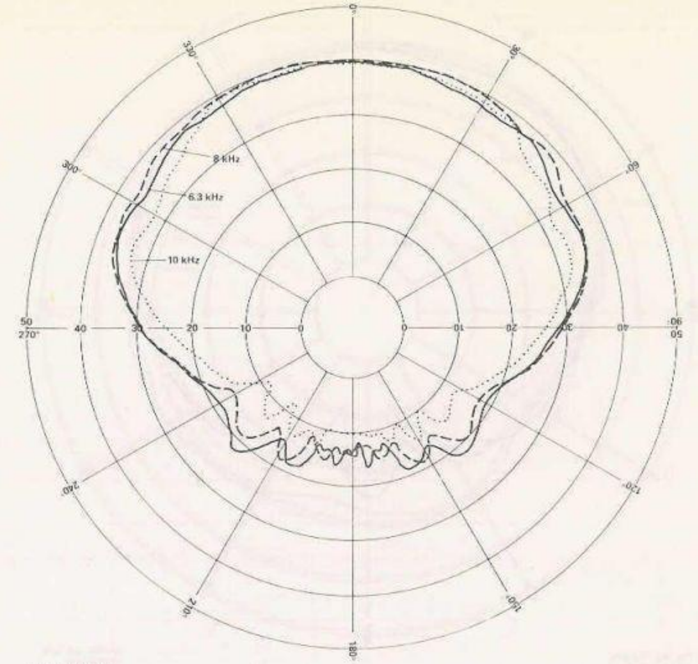


Fig. 4-m 6.3 kHz
4-n 8 kHz
4-o 10 kHz

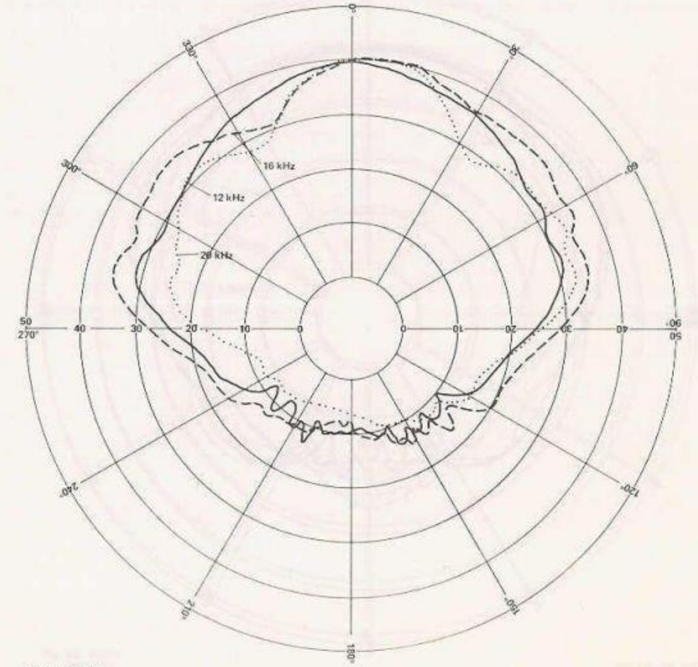


Fig. 4-p 12 kHz
4-q 16 kHz
4-r 20 kHz

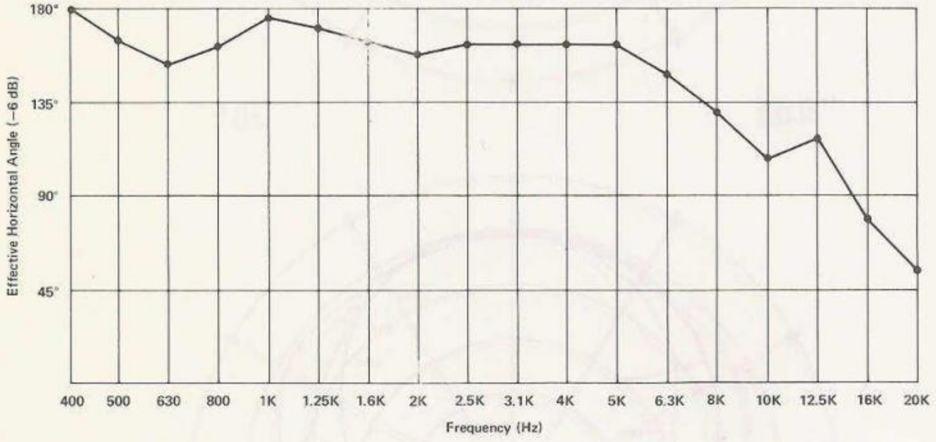

180°
135°
90°
45°
Effective Horizontal Angle (−6 dB)
400
500
630
800
1K
1.25K
1.6K
2K
2.5K
3.1K
4K
5K
6.3K
8K
10K
12.5K
16K
20K
Frequency (Hz)

Figure 5

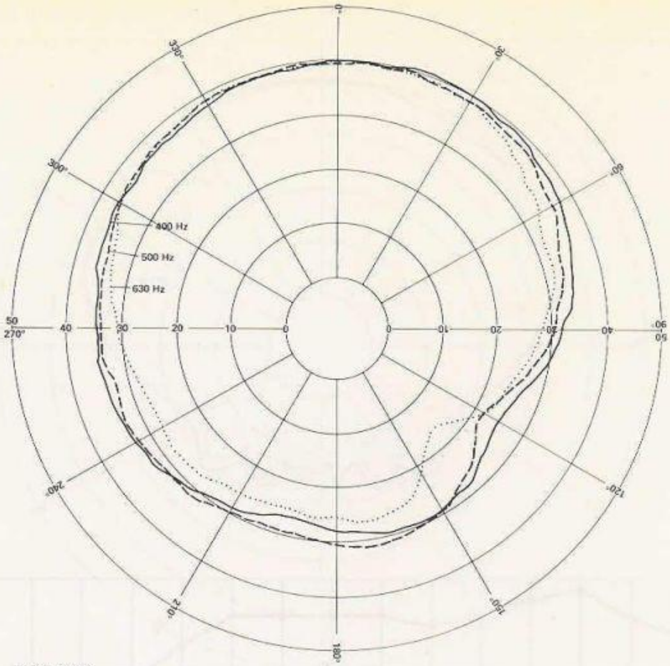


Fig. 6-a 400 Hz
6-b 500 Hz
6-c 630 Hz

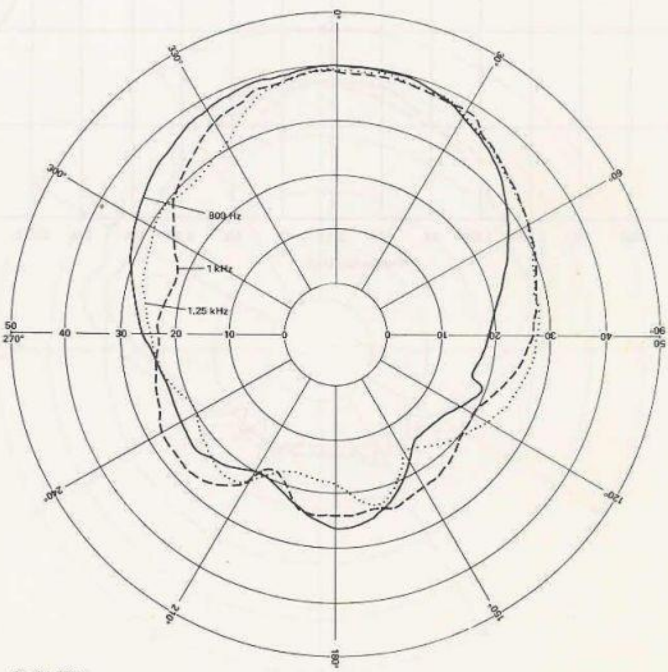


Fig. 6-d 800 Hz
6-e 1 kHz
6-f 1.25 kHz

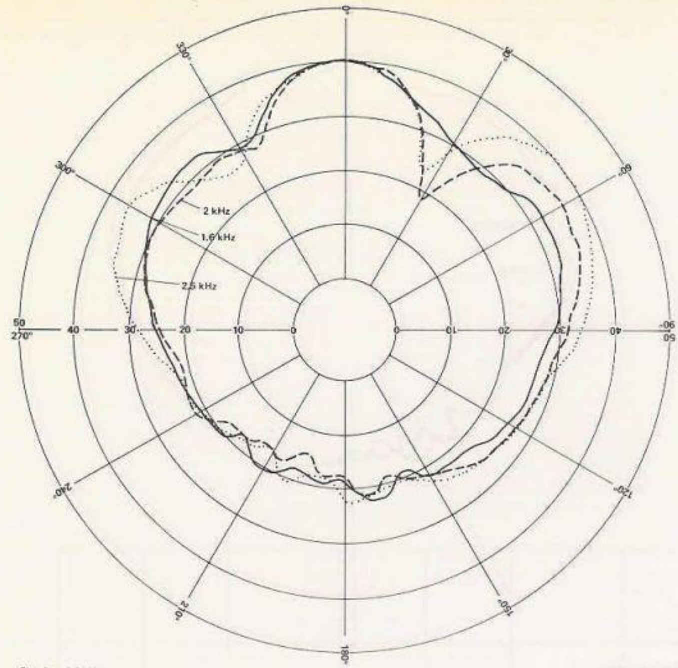


Fig. 6-g 1.6 kHz
6-h 2 kHz
6-i 2.5 kHz

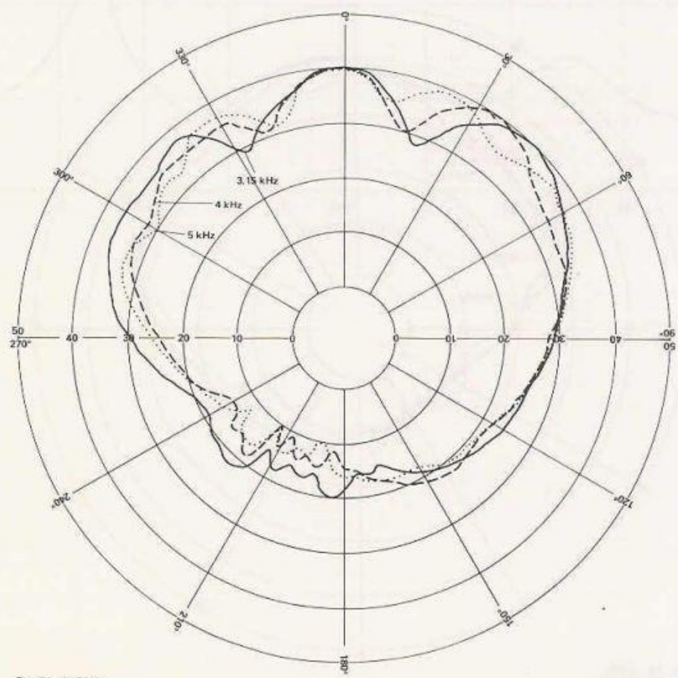


Fig. 6-j 3.15 kHz
6-k 4 kHz
6-l 5 kHz

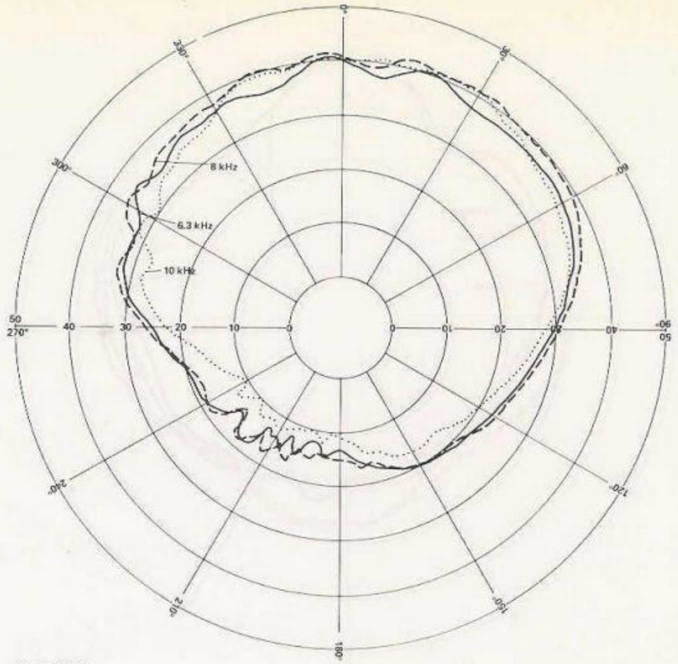


Fig. 6-m 6.3 kHz
6-n 8 kHz
6-o 10 kHz

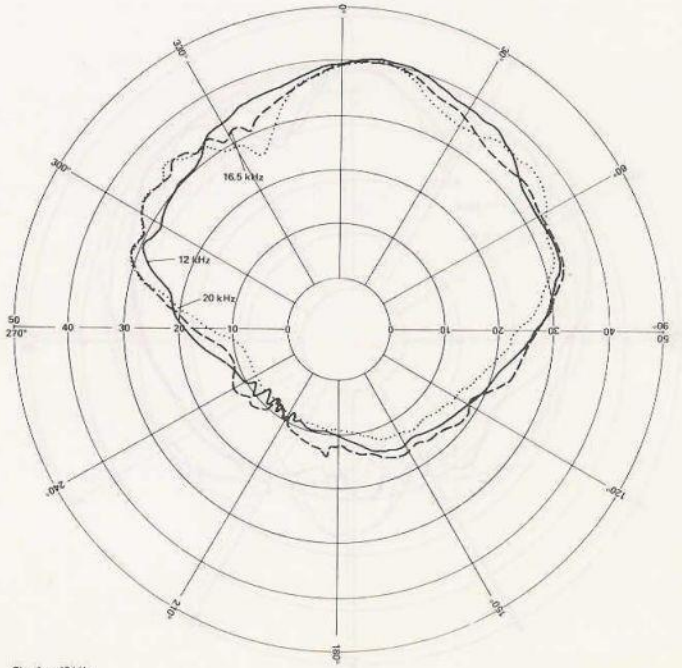


Fig. 6-p 12 kHz
6-q 16.5 kHz
6-r 20 kHz

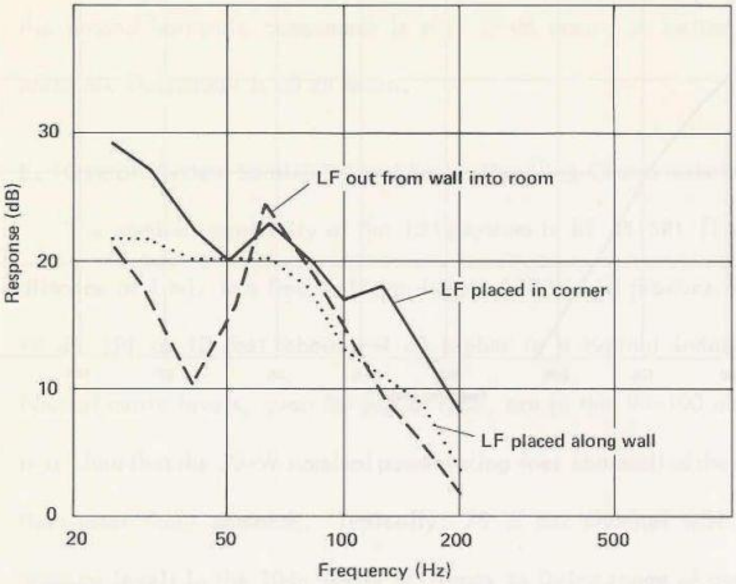


Figure 7

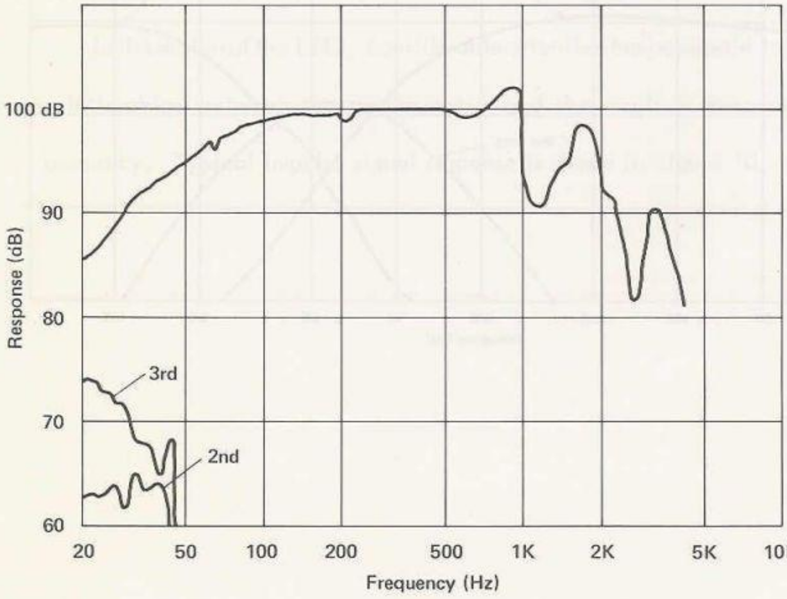


Figure 9

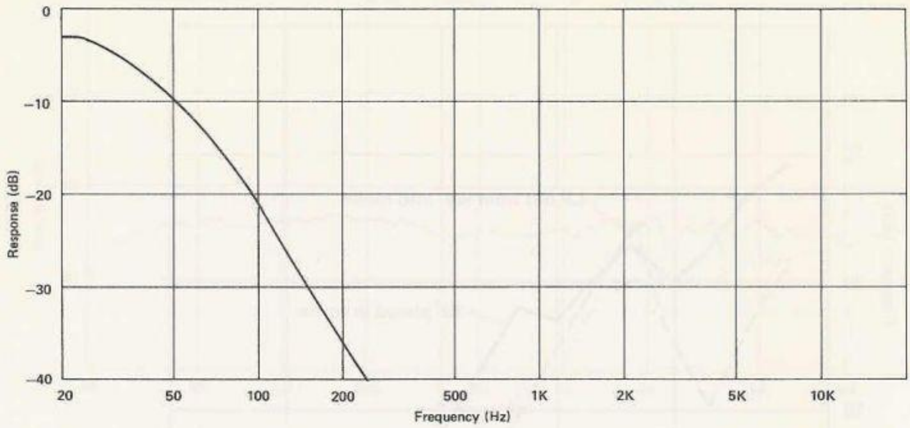


Figure 8-a

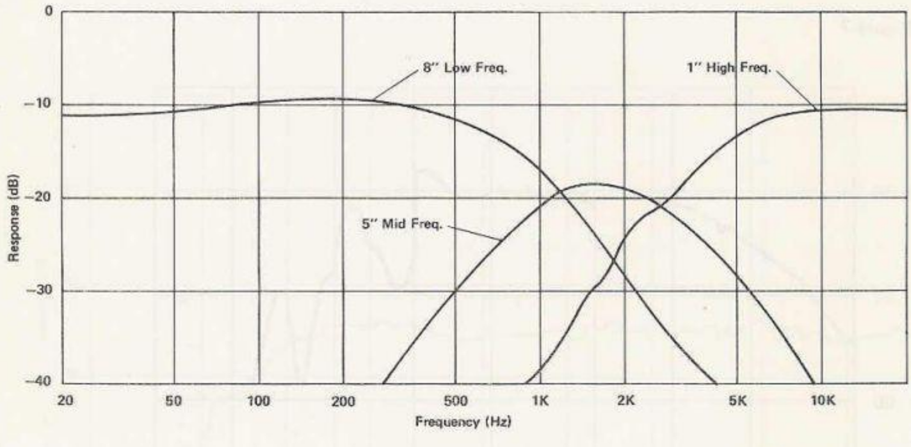
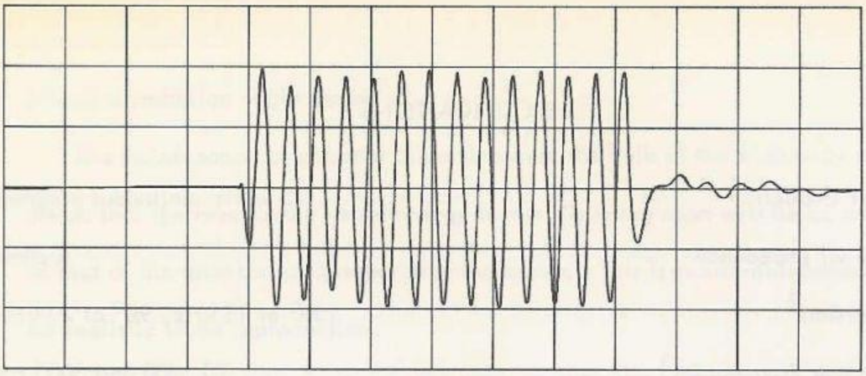
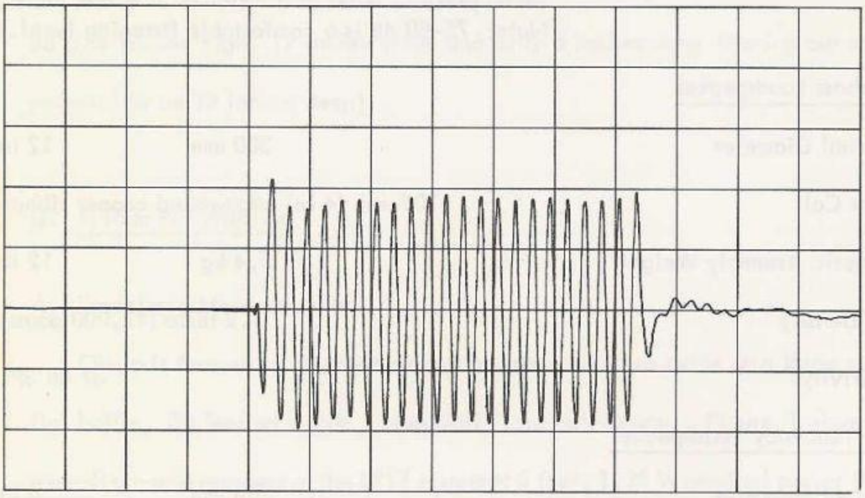


Figure 8-b



600 Hz Tone Burst



1 kHz Tone Burst

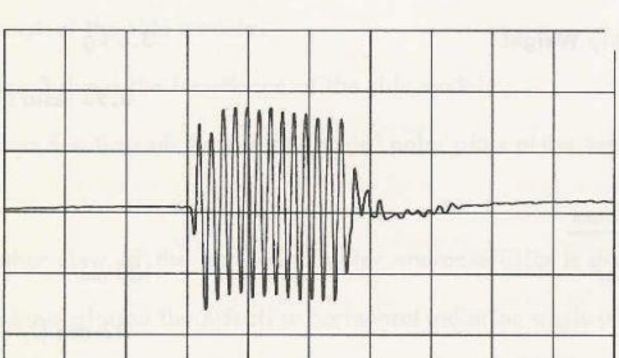


Figure 10

7 kHz Tone Burst

SPECIFICATIONS

Power Capacity[1]	75 watts continuous program	
Nominal Impedance	8 ohms	
Dispersion[2]	150° at 15 kHz, 90° at 20 kHz	
Crossover Frequencies[3]	70, 800 and 3000 Hz	
System Sensitivity[4]	1 watt input produces 77 dB sound pressure level at a distance of 4.6 m (15 ft) (Note: 75-80 dB is a comfortable listening level.)	

<u>Ultrabass Loudspeaker</u>

Nominal Diameter	300 mm	12 in
Voice Coil	102-mm (4 in) edgewound copper ribbon	
Magnetic Assembly Weight	5.4 kg	12 lb
Flux Density	1.2 tesla (12,000 gauss)	
Sensitivity[5]	37 dB SPL	

<u>Low Frequency Loudspeaker</u>

Nominal Diameter	200 mm	8 in
Voice Coil	76-mm (3 in) edgewound copper ribbon	
Magnetic Assembly Weight	3.5 kg	7 3/4 lb
Flux Density	0.93 tesla (9300 gauss)	
Sensitivity[5]	42 dB SPL	

<u>Midrange Transducer</u>

Nominal Diameter	130 mm	5 in
Voice Coil	22-mm (7/8 in) copper	
Magnetic Assembly Weight	0.74 kg	1 5/8 lb

Flux Density	1.4 tesla (14,000 gauss)
Sensitivity[6]	45 dB SPL

High Frequency Hemispherical Radiator

Hemisphere Diameter	25 mm	1 in
Voice Coil	25-mm (1 in) aluminum	
Magnetic Assembly Weight	0.68 kg	1 1/2 lb
Flux Density	1.4 tesla (14,000 gauss)	
Sensitivity[7]	41 dB SPL	

Bass Energizer

Primary Operating Range	20 to 100 Hz, equalized
Signal-To-Noise Ratio	Better than 85 dB at full output
Damping Factor	Greater than 80
Power Requirement[8]	120 volts AC, 50/60 Hz
Power Consumption	
Quiescent	15 watts
1/3 Power Output	60 watts, continuous signal
Full Power Output	120 watts, continuous signal

General

Finish	Oiled Walnut
Grilles	Black fabric
Ultrabass Top Surface	6-mm (1/4 in) gray plate glass with ground and seamed edges; black foam cushioning 430 mm x 430 mm, ±1.5 mm 16 15/16 in x 16 15/16 in, ±1/16 in
Dimensions	
Ultrabass	486 mm x 470 mm x 470 mm deep 19 1/8 in x 18 1/2 in x 18 1/2 in deep

3-Way Loudspeaker Systems		981 mm x 432 mm x 330 mm deep, 38 5/8 in x 17 in x 13 in deep	
Shipping Weight		102 kg	225 lb

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1. Based on a laboratory test signal. See Power Capacity section for amplifier power recommendation.

2. The angle through which system output is diminished by no more than 6 dB relative to system output measured directly on-axis.

3. The 70-Hz transition, between the Ultrabass and the 3-way loudspeaker systems, is controlled by the Bass Energizer and by the acoustic characteristics of the 8-inch low frequency loudspeaker. The 800-Hz and 3000-Hz transitions are controlled by the frequency dividing networks contained in each 3-way system.

4. System sensitivity can also be expressed as 90 dB SPL at 1 metre (3.3 ft).

5. Since the major portion of the energy reproduced by the Ultrabass and low frequency loudspeakers lies below 800 Hz, this specification represents the sensitivity, within 1 dB, at 30 feet (9.1 m) using a 1-milliwatt test signal swept from 100 to 500 Hz, rather than the 1-kHz sine wave test signal on which the conventional EIA sensitivity rating is based.

6. Averaged from 1 to 3 kHz, within 1 dB, measured at 30 feet (9.1 m) with a 1-milliwatt input.

7. Averaged from 5 to 20 kHz, within 1 dB, measured at 30 feet (9.1 m) with a 1-milliwatt input.

8. Can be converted for 240-volt AC, 50/60-Hz operation by qualified service personnel.