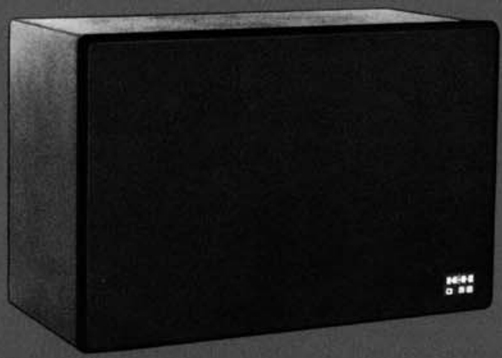
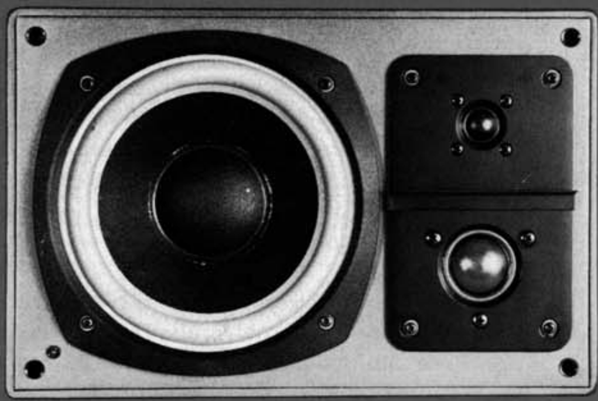
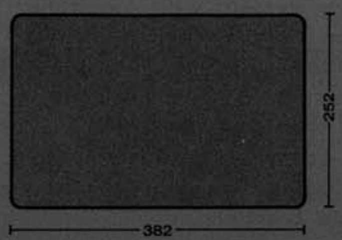
STUDIO MONITOR LOUDSPEAKER 0 98



Professional Studio Monitor Speaker System with integrated electronic crossover networks and 3-channel power amplifier system (200 W)





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THE O 98 STUDIO MONITOR LOUDSPEAKER

The large K+H model O 92 studio monitor was introduced in 1976 and has found such wide acceptance that it has become the monitor standard of the ARD and the ZDF German broadcasting organizations.

The development of the small studio monitor O 96 was concluded in 1979 and it has found applications in all of those locations where the size of the O 92 is excessive and where the requirements for extreme sound pressure levels are not as important. The acoustic quality of both loudspeakers is equivalent.

In the meantime, another equivalent quality loudspeaker of even smaller dimensions was demanded especially for applications in OB vans (remote trucks).

The experience gained from the development and operation of the two previous models was applied in this third development in the KLEIN+HUMMEL series of studio monitors and it was endowed with the newest technology and conformed to the special size requirements. One of the most important demands in the development of the O 92, just like its predecessors, was to develop a loudspeaker which was neutral with regard to sound coloration. As a result, this loudspeaker has achieved a sound quality which is comparable to the O 92 and O 96, both of which were developed along the same lines.

The compact dimensions of the O 98 allows it to be applied in all those situations where there's insufficient room for the O 96. Its power capabilities, however, are sufficient for intermediate sized control rooms and other listening environments.

Fundamental Technical Concepts

In order to obtain a unified and neutral sound within a large area in front of the loudspeaker, it was necessary to apply measures which serve to reduce the peaks in the directional characteristic, especially in the crossover range and at high frequencies. The most effective means consist of the physically close layout of the radiating surfaces of the loudspeaker systems, augmented by electronic measures and the proper dimensioning of the sound board and cabinet.

This has led to symmetrical radiation about the main axis. To allow the loudspeakers to be arranged symmetrically for stereo reproduction, the medium and high frequency speakers are mounted on a common mounting plate, whose 180^{o} rotation permits the user to set up two loudspeakers completely symmetrically about the middle of the stereo horizon.

Description

The O 98 is a 3-way loudspeaker system with electronic crossover and integrated 3-channel amplifier, which when terminated with nominal impedances of 4 ohms in the low frequency channel provides 100 watts, and when terminated with 8 ohms in the mid and high frequency channels provides 50 watts each. The loudspeaker cabinet with its dimensions of 382 mm width, 252 mm height, and 185 mm depth (15"x10"x7") and a volume of 17,5 liters is so compact, as to permit installation on normal bookshelves. To mount the speaker against the wall or in a support system, the O 98 is equipped with stable metal angle brackets.

The low frequency channel consists of a conical loudspeaker with a 210 mm (8 1/4 ") diameter, with a voice coil diameter dome. The mid and high frequency ranges are covered by a 38 mm (1.5") and 19 mm (0.7") system. As already described, the mid and high frequency loudspeaker systems are mounted on the same plate. This provides for small distances between the radiating surfaces of these two partial -

spectrum speakers, leading to a specially broad sound distribution over a wide frequency range. The acoustic crossover frequencies between the channels are at 850 Hz and at 6 kHz.

Electronic overload protection circuits in the mid and high frequency channels provide effective protection against heat overload caused by excessive input levels. These protection circuits in connection with the enormous power reserve in the amplifier channels assure the greatest output capability for signals with a high crest factor.

The entire electronic section was mounted on the inside of the loudspeaker housing back panel. All of the switches and connectors are protected mechanically by the mounting angle brackets. The connectors have been arranged in such a way so as not to interfere even if the speaker is mounted against the Wall or into a 19" rack.

The front cover is an acoustically highly transparent cloth which has been stretched on a frame, which in turn is snapped into place by means of quick-release fasteners. Although this grill influences the acoustic behavior of the loudspeaker only minimally, it may be removed for critical listening.

Technical Data

Recent years have brought a significant improvement in our ability to evaluate loudspeakers on the basis of objective physical measurements. The determining overall judgement is based on a relatively large number of individual measurements which must be evaluated in their entirety and under consideration of the numerous interactions between them. In the interests of providing a total overview, we present the individual measurement results below.

Measurement using Third Octave Pink Noise

Third octave band filtered pink noise has been found to be an effective test signal. On the one hand, it corresponds well to the frequency range and response of human hearing and on the other permits measurement in rooms with greatly differing acoustic qualities.

Free field Response

Free field measurements are carried out in a room with acoustically absorbant walls. The microphone is usually located on an axis at right angles to the loudspeaker front panel in order to obtain the distribution characteristic at different angles to this axis. The test results in free field are particularly indicative of the applicability of such a loudspeaker in a highly absorbant room and for close spacing between loudspeakers and the listener. These values are nevertheless interesting also for reverberant rooms and greater speaker-to-listener distances, because the sound reaching the listener directly, before reflections have built up, is important for things besides the localization of the sound. For this reason, free field measurements are also called direct field measurements.

The O 98 measurements over the entire frequency range using third octave partials with center frequencies between 50 Hz and 16 kHz, show a deviation of less than ±2 dB from the ideal characteristic of frequency independent transmission measurement. Since there are no one-sided broad band deviations from the ideal characteristic in any of the frequency bands, demand for coloration-free transmission is met.

Diffuse Field

For usual speaker-to-listener distances and normal listening environments, the listener is usually in that portion of the sound field in which the diffuse energy reaching the listener's ears after numerous reflections from wall surfaces predominates over the direct energy. It is therefore not enough to create a linear free field response for the direct sound portion. One rather must take care to provide a linear diffuse field response for those portions of the audio energy which reach the listener after radiation into all directions.

Measurement of the diffuse field transmission factor is done in a room with hard, non-porous walls (echoic chamber), in which the acoustic mean values of the sound level can be obtained for third octave pink noise fed to the loudspeaker. From knowledge of the frequency dependent reverberation time (T_{60}) and the cubic volume of the echoic chamber, it is possible to calculate for each third octave band the total sound power reflected from all of the room's surfaces. To provide better comparison with the free field response, one calculates from this the sound pressure level for a ficticious room with a frequency independent reverberation time.

The diffuse field transmission factor for the O 98 drops evenly by a total of 6 dB between 100 Hz and 10 kHz with a deviation from a straight line drop of only $\pm$ 1.5 dB. The positive and negative deviations from the ideal curve are evenly displaced over the entire frequency range; i.e. no specific frequency bands are either accentuated or suppressed.

Directivity Factor

The directivity factor represents a comparison between the free field and diffuse field transmission factors. It indicates to what extent the main radiating direction predominates vis-a-vis the mean value of all other directions. An even directivity factor can only then be achieved if the curves for both the free field as well as the diffuse field are in themselves even. The curves of the directivity factor provides information about the acoustic precision of the loudspeaker configuration in connection with an amplitude and phase accurate design of the electronic crossovers. A subsequent influencing of the directivity factor through application of amplitude equalization is not possible. High values of the directivity factor give one a sense of midrange boost, which when exaggerated, lead to a disagreeably sharp sound characteristic. A highly frequency dependent directivity factor provides a disagreeable listening impression and insecurity in localizing the sound.

The directivity of the O 98 rises between 100 Hz and 10 kHz evenly from 2 dB to 8 dB. The maximum deviations from the ideal curve are $\pm$ 1.5 dB and are evenly distributed over the entire test range.

Measurements using sine wave test signals

Free-field Transmission Factor

Sine wave signals are not suitable for yielding test results from which subjective impressions may be obtained, since such signals may produce interferences at the microphone location which are atypical for listening with both ears to normally broadband signals. Nevertheless one can obtain valuable information about the careful construction of loudspeakers using sine wave signal measurements. Such test results may yield design parameters down to individual edges or protrusions in the cabinet and can yield information about the optimum application of the loudspeaker.

The O 98 free field sine wave measurements made under the same conditions as for measurements with third octave band pink noise shows deviations of no more than ± 2.5 dB (typically ± 1 dB) from an ideal, frequency independent curve between 50 Hz and 16 kHz.

The suitability of a loudspeaker for stereo operation is highly dependent on an even sound pressure in a specific room volume. The ideal stereo listening arrangement in which the loudspeakers are not angled toward the listeners finds the listener at an angle of 30° to the main axis of the loudspeaker but on different sides dfor each of the two loudspeakers in a pair.

Since the mid and high frequency speakers in the O 98 hat to be arranged at right angles to the woofer - in contrast to the O 96 - it was not possible to produce complete symmetry. The measurements for vertical set-up of the loudspeakers and opposite deviations from their main axis show narrow-band differences in their frequency range above 2 kHz. For this reason, the common mounting plate for the mid and high frequency speakers may be turned by 180° after removal of only four screws, permitting any loudspeaker of an O 98 pair to be set-up as either a left or right hand speaker in a stereo pair.

When setting up the loudspeakers horizontally, these differences are predominantly in the low frequency range and far less pronounced. In this position as well, symmetry may be produced by proper arrangement and turning of the mid/high frequency mounting panel for one or both loudspeakers.

Distortion

It is well known that for low and medium sound pressure levels the nonlinear distortion leads to significant influences on the sound picture. For this reason the amplifiers and especially the low frequency loudspeaker were selected for realization of the least possible distortion.

For levels which attain a mean sound pressure level of 80 dB for the usual loudspeaker-to-listener distance of 2 meters, the 0.5 % harmonic distortion boundary above 125 Hz was clearly bettered. The increased distortion at lower frequencies is also within reason and is comparable to distortion factors of much larger loudspeakers.

Attainable Sound Pressure

If a loudspeaker is to be used for varied types of program material and in listening rooms of varying size, it must be capable of a high sound pressure level in order to be able to reproduce varying instrument groups with their original sound level and to allow for short duration loudness peaks with sufficient reserve.

A single O 98 produces in the free sound field at a distance of 2 m and full output level, a sound pressure level of 97 dB. The same level can be attained in a 600 m^3 room with a mean reverberation time of 2 seconds or a 300 m^3 room with a mean of reverberation time of 1 second. In smaller rooms, or for longer reverberation times, higher sound pressure levels are attained. When operating a stereo pair, these values are increased by 3 - 6 dB depending on the type of program signal.

The small O 98 studio monitor may be operated continuously at its full output level. It is electronically protected against overload stemming from test signals or from fast winding of tapes (the transposed frequency partials in the high frequency range).

Self-noise Level

The self-noise level of the amplifier electronics and the power transformer must be kept especially low in active loudspeaker systems using sophisticated measures. This is especially true for a loudspeaker as compact as the O 98, since this size loudspeaker is likely to be used at very close range, so that the background noise becomes particularly annoying during program pauses. It has been possible in the O 98 to suppress the self-noise level to a point where it is neither audible nor measurable at a distance of 1 m. At a distance of 5 cm (2") the equivalent sound pressure level of the self-noise level is only 26 dB(A).

Overload Protection Circuit

The voice coils of the middle and high frequency loudspeakers are electronically protected against overload. The audio signal in the mid and high frequency speakers are automatically reduced by 20 dB when a predetermined threshold has been exceeded and a predetermined delay time has run out. The return to normal operation results without delay when the audio signal has dropped 1.5 dB below the threshold point. The operation of the overload protection is indicated by blinking of the LED on the front grill.

The delayed response time of the protection circuit is designed to allow peaks in the program to be transmitted without triggering the protection circuit.

Physical Location Equalization

The transmission factor at low frequencies increases by up to 3 dB when a loudspeaker is placed against a wall as compared to a set-up in the middle of a room. If two room surfaces meet at the set-up location, the acoustic increase is up to 6 dB.

A rotary equalization switch permits these level increases to be neutralized in the O 98. Position 'O' is for a set-up in the middle of a room while position '1' is the proper position when the speaker is mounted against a wall and position '2' at the corner where two room surfaces meet.

The O 98 studio monitor speaker may be operated in any position: horizontal, vertical, standing or hanging. The horizontal mounting is to be preferred for acoustical reasons. When setting up the speaker, care must be taken to assure the symmetry to the stereo axis. To accomplish this, one can rotate the mounting plate on which the mid and high frequency speakers are mounted by 180°. If space is at a premium it is recommended that the horizontal position be selected which locates the low frequency speakers toward the center, assuring a wider functional stereo horizon.

The mounting brackets are so dimensioned as to assure air convection behind the speaker even if it mounted directly to the wall.

Electrical safety approvals

The VDE (German) requirements for studio installations are met. All metal parts that are exposed are connected to protective ground. The power transformer is equipped with a grounded shield winding connected to power ground.

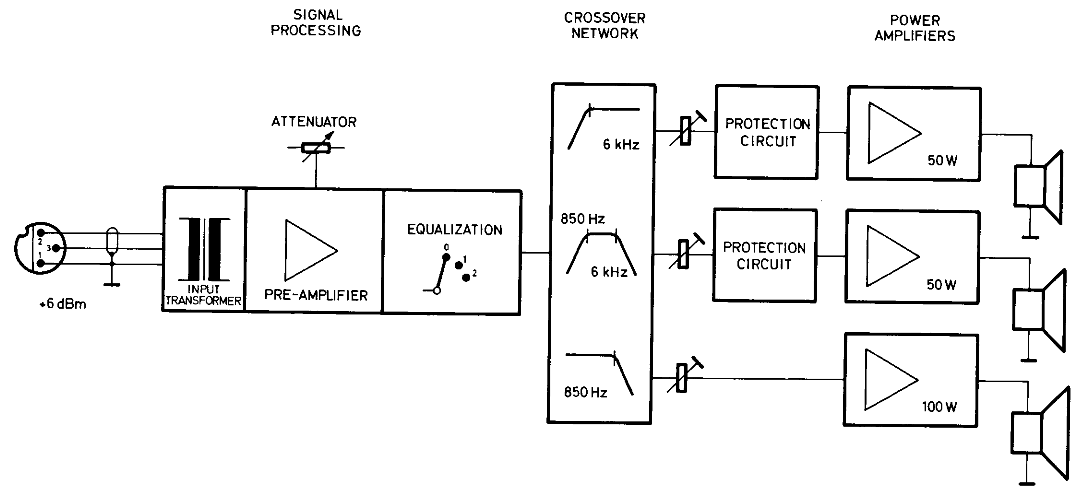

Figure 5: O 98 Block Schematic

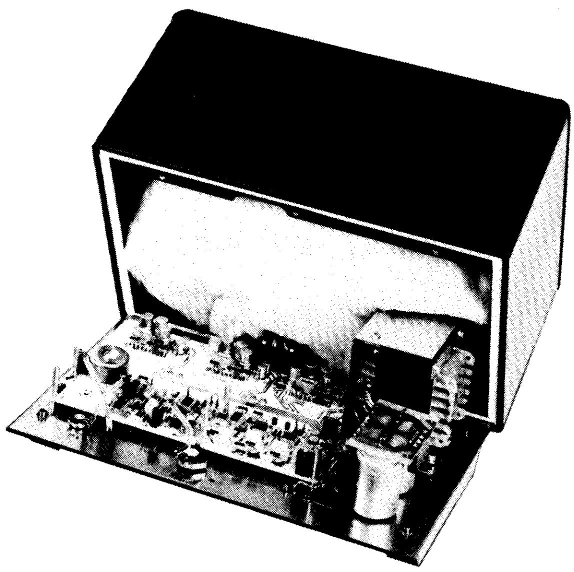

Figure 6: O 98 Electronic package
(Electronic crossovers and three channel power amplifiers)

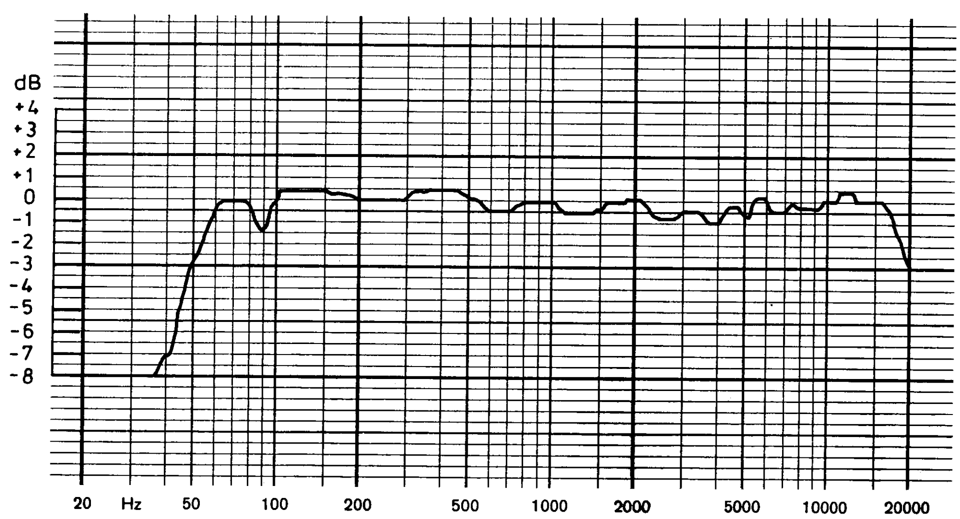

Figure 7: Free field transmission factor using sine wave test signals

TECHNICAL DATA

O 98

Sound Pressure Level

At a distance of 2 m at full output power	97 dB (rel 20 Pa)

Free-field Transmission Factor

Measured with third octave band filtered pink noise between 50 Hz and 16 kHz	frequency independent with maximum deviations ± 2 dB
Measured with sine wave signal between 50 Hz and 16 kHz	frequency independent with maximum deviations ± 2.5 dB

Diffuse field Transmission Factor

Measured with third octave band filtered pink noise between 100 Hz and 10 kHz	constant drop of a total of 6 dB with maximum deviations ± 1.5 dB

Directivity

Between 100 Hz and 10 kHz	Steadily increasing from 2 dB to 8 dB with maximum deviations ± 1.5 dB

Self-noise Level

At a distance of 5 cm (2")	26 dB(A)
At 1 m distance (3.28 feet)	neither measurable nor audible

Total Harmonic Distortion (above 125 Hz)

Measured at 80 dB at a distance of 2 m	≦ 0.5 %

Electronic complement

Low frequency channel	100 W into 4 ohm, THD 0.1 %
Mid frequency channel	50 W into 8 ohm, THD 0.1 %
High frequency channel	50 W into 8 ohm, THD 0.1 %

Electronic crossover:

transition frequencies	850 Hz and 6 kHz
attenuation	12 dB/octave

Input (balanced and floating)

Input Impedance	4 700 ohm
Nominal Input Level	+6 dBm (1.55 V)
Level Control	20 dB range, step-less
Common mode rejection	≧ 60 dB (15 kHz)

Speaker Systems

Low frequency woofer	210 mm (8 1/4 "),	Type TT 210
Mid range Speaker	38 mm (1 1/2 "),	Type MHT 40/19
High frequency Speaker	19 mm (3/4 "),	

The mid and high frequency chassis is mounted to a common panel which may be rotated 180° after removal of only 4 screws, to allow proper symmetrical radiation.

Location Equalization (Equalization switch)

Position 0	Loudspeaker free standing (middle of room)
Position 1	Mounted to a wall (1 boundary surface)
Position 2	Mounted in a corner (2 boundaries)

Power Consumption	
Idling	12 VA
Full output	130 VA
Connections	
Audio Input matching connectors:	Cannon XLR-3-32 (3-pole, male) Cannon XLR-3-IIC, Switchcraft A3F Binder 09-0256-00-03, Neutrik NC-3FC
ac power	Three pole IEC chassis connector (molded ac cable is supplied)
LED on front grill	
First Function	Power indication
Second Function	Blinks when the overload protection is in effect.
Dimensions	382 x 252 x 185 mm (15 x 10 x 7 1/4 inches, WxHxD)
Volume	17.8 liters
Net weight	12 Kg (26.4 lbs)
ac Power	110/220 V 50/60 Hz
Power fuse	3.15 / 1.6 A slo-blo
Overload protection circuit	The voice coils of the mid frequency and high frequency loudspeakers are electronically protected against overload.
Options	Second input in 0 ohm junction technology

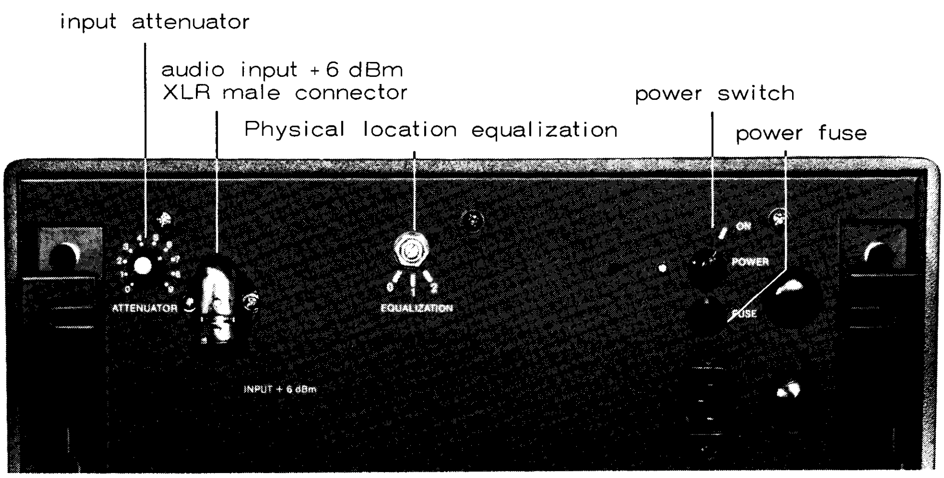

Figure 8: Back panel with connections and controls

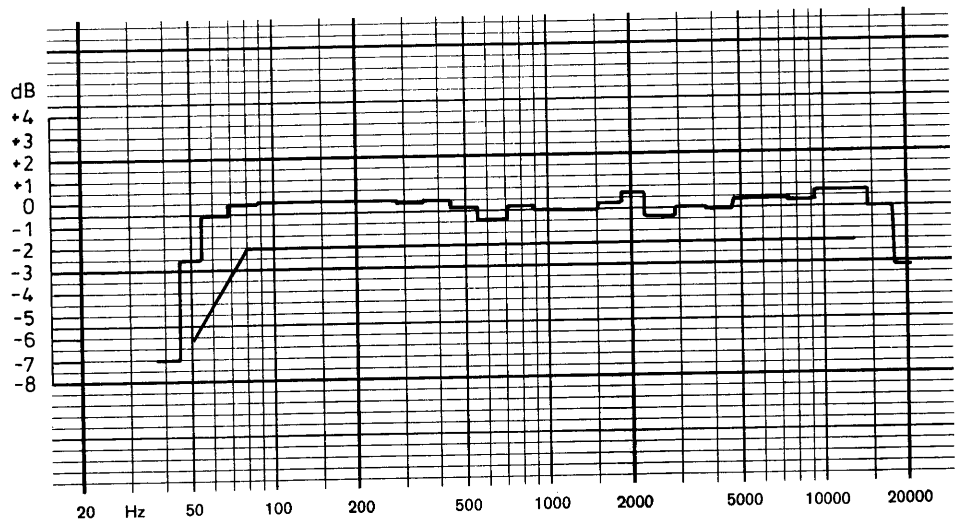

Figure 9: Free field transmission factor using third octave band filtered pink noise

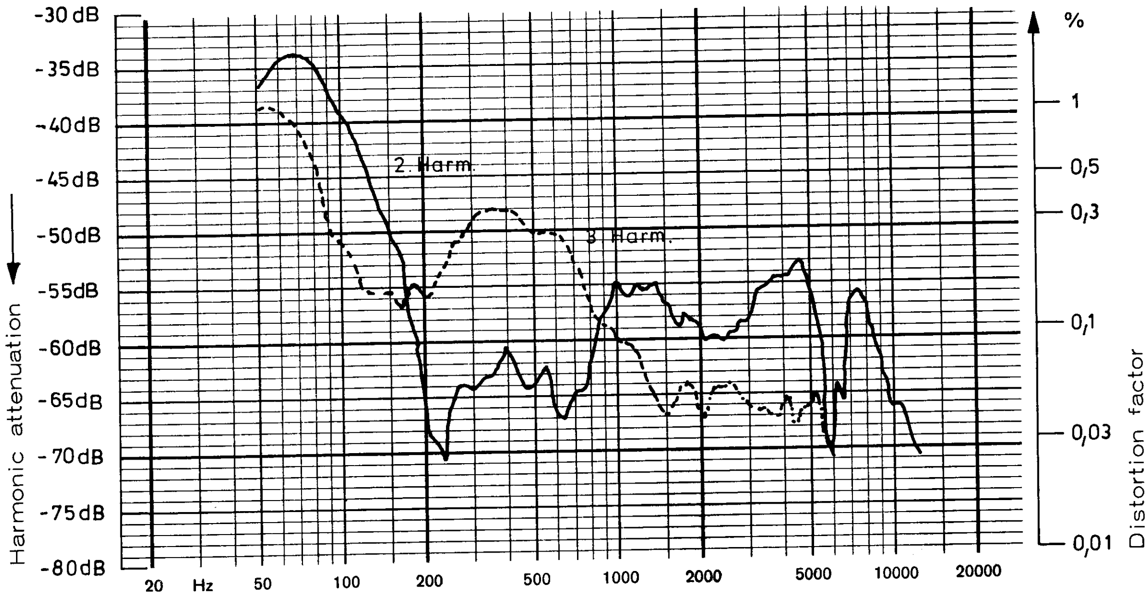

Figure 10: Harmonic distortion

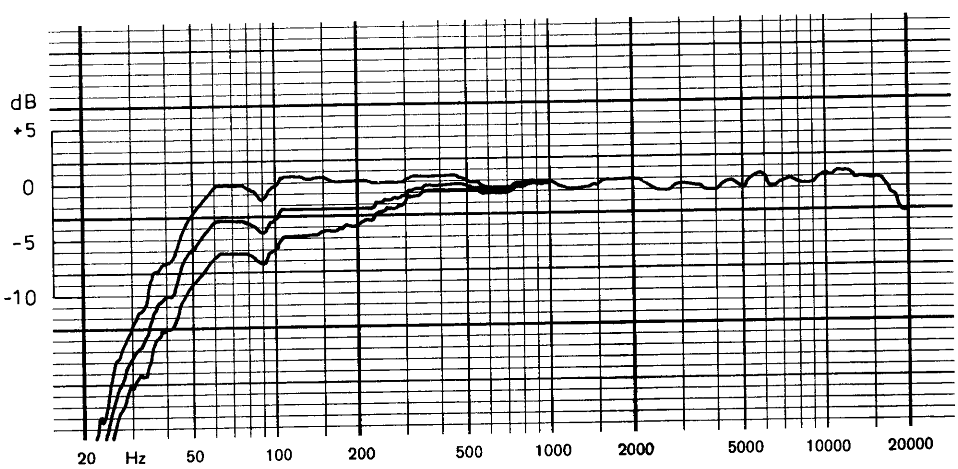

Figure 11: Free field transmission factor and the physical location equalization (measured using sine wave signal)

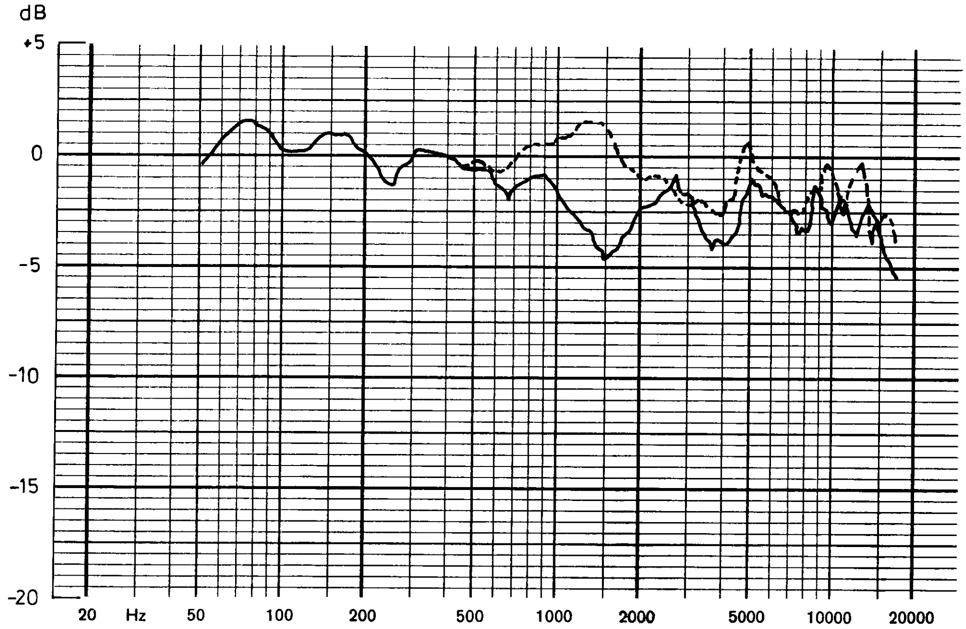

Figure 12: Free field transmission factor using sine wave test signal (comparison between 15° and 30°)

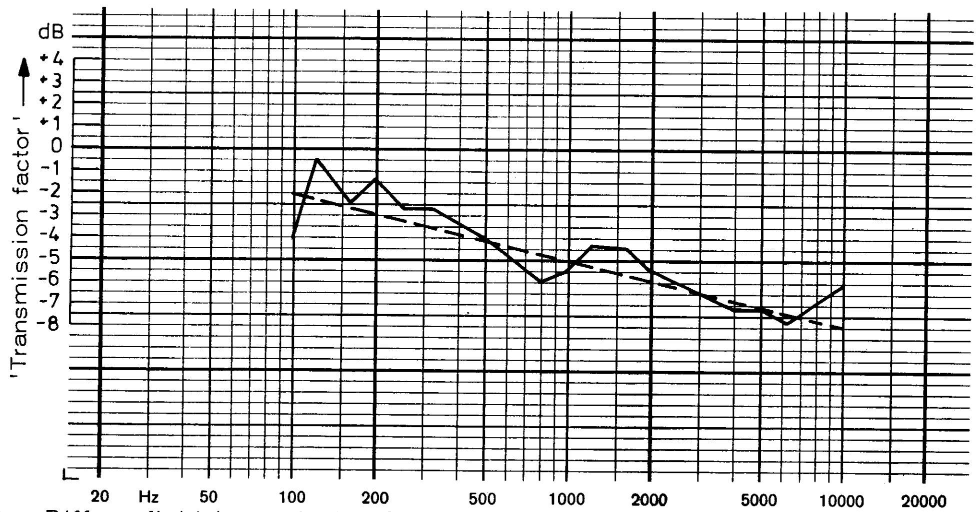

Figure 13: Diffuse field transmission factor using third octave band filtered pink noise.

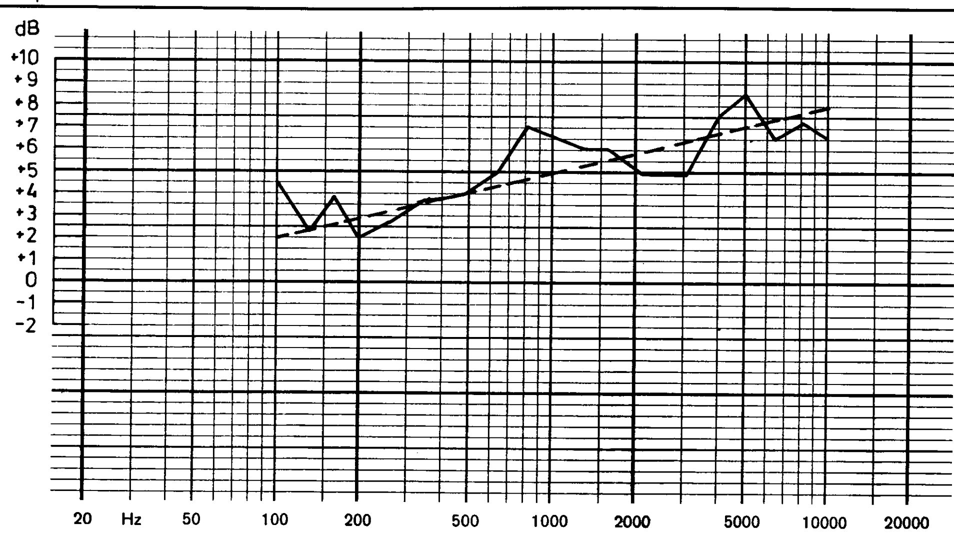

Figure 14: Directivity