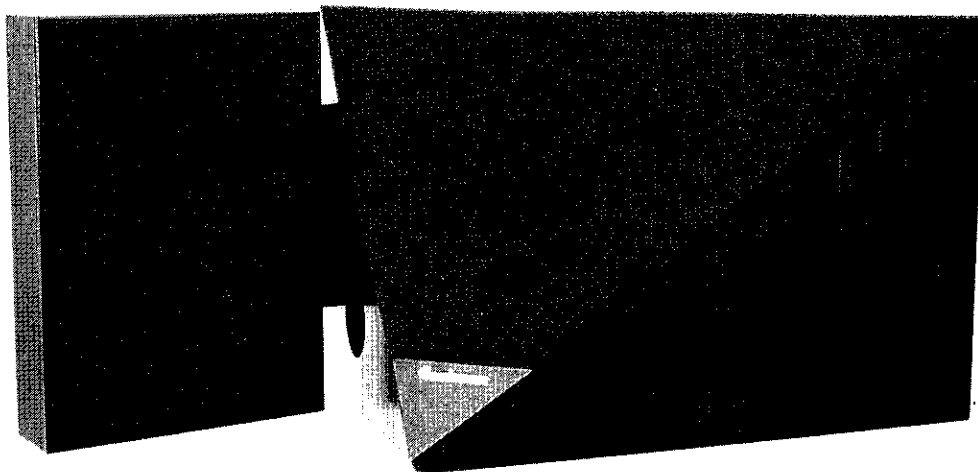


Carlsson

OA-51 Ortho-Acoustic Loudspeaker System



The Loudspeaker and the Listening Room

The correct specification of fundamental performance characteristics presents greater difficulties in loudspeakers than in any other type of sound recording and reproducing equipment. The loudspeaker is also usually the component in the sound reproduction chain which accounts for the largest deviations from a flat frequency response. The loudspeaker is, therefore, often subject to wishful claims of performance.

The Ambiguity of Loudspeaker Frequency Response Curves

The other components in the sound reproduction chain have output terminals which are clearly defined and the transfer characteristics are, therefore, easy to measure. Measuring the transfer characteristics of a loudspeaker—the sound pressure as a function of frequency at a constant input level—is complicated by the fact that the sound pressure not only varies with the direction from the loudspeaker, but also is influenced by interaction with reflecting boundaries in the listening environment. It is, in fact, possible to measure an infinite number of different frequency response curves. Which then, if any, is the true representation of the loudspeaker?

Different measuring methods are practised:—measurement with the loudspeaker in a free sound field, measurement with the front of the loudspeaker flush mounted into a wall in an otherwise free sound field, or measurement with the loudspeaker placed in a reverberant chamber. Two fundamentally different measuring signals are used:— either a sine wave, which is a pure tone, or some form of smoothing signal such as noise with a suitable bandwidth. The most commonly published type of frequency response curve is measured straight in front of the speaker in a free sound field such as an anechoic chamber without reflecting surfaces. Such measurements are well defined and easy to repeat in other acoustic laboratories but say very little about the actual frequency response performance of the loudspeaker when used in the normal listening environment of, for instance, a domestic living room.

The Loudspeaker in the Listening Room

In the normal listening environment the direct sound accounts for only a comparatively small part of the total sound transferred from the loudspeaker to the listener. This is true of all types of direct radiator loudspeakers, that is loudspeakers radiating without the interposition of a horn. During the first hundredth of a second after the arrival of the direct sound, the listener receives sound which has been reflected from the floor and the ceiling, from the wall behind the loudspeaker, from the side-wall nearest to the loudspeaker and from the wall behind the listener. Sound reflected from the opposite side-wall may or may not arrive within this time frame. Another hundredth of a second later, in a normal size living room, the listener will have received reflections from about sixty different directions. If the loudspeaker faces the listener, the direct sound may have a frequency response which closely corresponds to the response measured in a free sound field. Most of the reflected sound, however, originates from directions in which conventional loudspeakers have an inferior frequency response, with a darker timbral balance.

Frequency response curves that vary with direction make early room reflections cause tonal distortion

The build-up of sound in the listening room, by direct and reflected sound, has the effect that the frequency response of the loudspeaker changes from the frequency response of the direct sound into that of what may simply be called the total sound of the loudspeaker. The character of this change in spectral balance depends on how the directional response pattern of the loudspeaker as well as how the reflective properties of the room vary with frequency. The difference in frequency response between the direct sound and the total sound of conventional loudspeakers is often sufficient to make the rapid changes in spectral balance from direct to reflected sound exert a considerable influence on the character of the reproduction. In live music similar changes in spectral balance occur at various rates of speed, appearing as integral parts of the generation of tones by the musicians and instruments and also as a result of the way the sound reflected by the environment is influenced by the frequency dependence of the directional radiation patterns of the musical instruments. Such timbral changes are important components of the characteristic tone quality of each type of musical instrument. When caused by the loudspeakers, however, they are a kind of tonal distortion.

OA-51

The OA-51 has a front panel which slopes inwardly and upwardly so that the drive units incline upwards into the listening room. This patented mounting of the drive units makes the frequency response of the direct sound less dependent on the position of the listener within the listening area. At the same time, it almost eliminates the difference in frequency response between direct and reflected sound and minimises tonal distortion resulting from rapid changes in spectral balance from direct to reflected sound. This design is essential in maintaining the integrity and natural timbre of the musical sounds. The high frequency content of the reflected sound also influences the listener's perception of acoustic space.

Nearby room boundaries cause distortion of the frequency and time response of loudspeakers

Among the reflected sound waves, the two or three that are first to arrive after the direct sound strongly influence the reproduction of the bass range and also affect the reproduction of the midrange. At least those reflected sound waves which arrive from virtually the same direction as the direct sound are likely to be indistinguishable from the direct sound. This usually applies to the sound reflected from the wall behind the loudspeaker.

The presence of a reflected sound wave has the effect of increasing the level of the direct sound at very low frequencies (lower than $1/4$ or $1/3$ of the inverted value of the difference in arrival time between the direct sound and the reflected sound wave). The lower the frequency the more completely the sound pressure of the reflected sound wave adds to the sound pressure of the direct sound, thereby increasing the efficiency of the loudspeaker and increasing the ratio of direct to reflected sound. At higher frequencies, however, the reflected sound interferes with the direct sound, causing the frequency response of the sum of direct and reflected sound to vary between maxima and minima (minima when the frequencies are equal to $1/2$ and $3/2$ and $5/2$ etc., of the inverted value of the difference in arrival time between the direct sound and the reflected sound wave).

To minimise these room boundary effects, it is often suggested that loudspeakers are positioned well away from walls, floor and ceiling. This increases the difference in arrival time and level between the direct sound and the reflected sound wave in question, but also extends the frequency region where interference occurs towards lower frequencies.

OA-51

The OA-51 provides a solution to minimize room boundary effects from the wall behind the loudspeaker which greatly improves the performance whilst simultaneously preventing the loudspeakers from intruding into the living area of the listening room. When the OA-51 is positioned with its back close to a wall, the proximity of the bass/midrange unit to the wall allows the reflected sound from the wall to reinforce the direct sound of the loudspeaker throughout the bass range, right up to about 300 Hz. Attached to the side of the cabinet, an absorbent panel (patent applied for) reduces the level of midrange sound reflected from the wall. By utilising the reflected sound from the wall in the bass range and by damping the reflected sound from the wall in the midrange, the interferences from the wall behind the loudspeaker are to a large extent eliminated and the ratio between direct and reflected sound is increased. This considerably enhances bass and midrange definition.

Approaching a Flat Frequency Response Curve in Loudspeakers

By solving these two problems the OA-51 has created a new situation, and only thereby is the concept of the frequency response curve of a loudspeaker of any meaning. To date, the design of most loudspeakers has been based on the idea that the frequency response of the loudspeaker is represented by the frequency response curve of the direct radiation from the loudspeaker, the frequency response of the total radiation from the loudspeaker not being taken into account. Conversely, the design of some other types of loudspeakers has been based on the concept that the frequency response to be considered is actually that of the total radiation from the loudspeaker, relegating the frequency response curve of the direct radiation from the loudspeaker to only secondary importance. Most likely, however, both of these frequency response curves are important performance characteristics of a loudspeaker. In the case of the OA-51, the frequency response curves of the direct radiation and of the total radiation are almost identical, and the influence of the nearest of the room boundaries—the wall behind the loudspeaker—is well defined and correctly compensated for. The uncertainty as to which frequency response curve represents the frequency response of the loudspeaker is thereby eliminated.

In order to achieve perfect reproduction the frequency response curve of the entire recording and reproduction system, from the original sound to the listener, must be flat. The OA-51 is designed to have a frequency response curve which deviates as little as possible from a flat response curve. Therefore, the OA-51 will provide accurate reproduction when a flat frequency response curve is maintained from the sound pressure recorded to the input terminals of the loudspeakers. However, when microphones with a rising treble response and/or falling bass response have been used, or when similar deviations from a flat response have been introduced by electronic means, the frequency response curve of the recording needs to be compensated by a tone control circuit providing the correct amounts of treble attenuation and/or bass amplification.

Recordings that have such deviations from a flat frequency response curve are still common, the intention being to suit the recording to a majority of loudspeakers with a boomy bass and/or weak treble. The deviations from a flat frequency response curve vary from one recording company to another, and also from one production to another within the same company. The usual types of bass and treble controls in preamplifiers very often cannot compensate for the frequency response deviations that are prevalent in recordings. Therefore, a suitable tone control unit to be connected via the tape monitor function of an existing preamplifier will be marketed as an accessory to the Carlsson loudspeaker systems.

Suitable Amounts of Reflected Sound in the Listening Room Benefit Tonal and Spatial Perceptions

The reflected sound in the listening room, whilst being a cause of imperfections in the reproduction, also, when applied in suitable proportions, has valuable, if not indispensable, aural effects. In live music the acoustics of the environment play an important part in the aural experience. That is, the ratio of direct to reflected sound and the ratio of the early arriving parts of the reflected sound to the subsequent reverberant sound, as well as the directions of incidence of the reflected sound, have a determining influence on the tonal and spatial qualities of live performances of music.

An important consideration is that perception of tonal quality in music appears to be closely related to perceptions of acoustic space. The early reflected sound which reaches the listener from various directions within the first few hundredths of a second after the arrival of the direct sound is known to enrich the tonal quality without being perceived as reverberation. Thus adequate reproduction of the natural changes in the timbral quality of musical instruments and of the early reflected sound in the recording environment is often more important than a correct reproduction of the actual positions of the musical instruments.

In stereophonic reproduction, reflected sound in the listening room has almost a formative influence on the listener's perceptions of acoustic space. This is because, in order to enable acoustic space to be perceived, the directions of incidence of the direct sound from the loudspeakers may have to be complemented by sound from other directions of incidence. Reflections off the boundary surfaces of the listening room can provide these other directions of incidence. It is primarily the high frequency content of the reflected sound that helps to activate the ambient information of those recordings which include early reflected sound from the recording environment.

Directional hearing utilises binaural as well as monaural directional mechanisms. The binaural mechanism compares the arrival times and the sound intensities at the two ears to determine the horizontal direction to the sound source. The monaural mechanism is based on a kind of coding of high frequency sounds which is dependent on the direction of incidence in relation to the pinna (the external ear). This monaural directional mechanism is responsible for the localisation of sound sources outside the head, and for the perception of acoustic space.

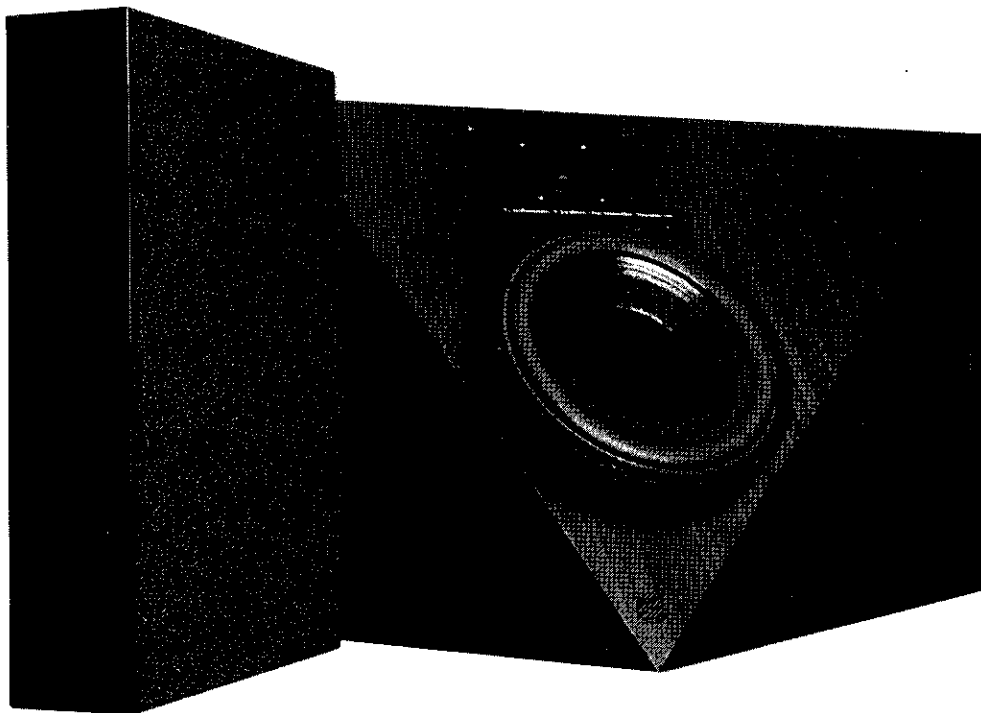
The observation that high frequency sounds reflected off the walls and ceiling of the listening room may serve as a kind of catalyst for the ambient information contained in the recording, indicates that the monaural directional mechanism is more dependent on the presence of various directions of incidence than on the precise direction and arrival time of the incident sound.

The loudspeakers may use the listening room to help the hearing decipher the ambience of the recording

In stereophonic sound reproduction the direct sound from the two loudspeakers provides the aural clues from which the direction and, when the recording includes reflected sound from the recording environment, the distance to the individual sound sources are determined. Since the direct sound from the two loudspeakers only provides two directions of incidence, it cannot produce the impression of a performance in an enclosed space even if the recording includes reflected sound from the recording environment, until it is complemented by additional directions of incidence in the listening room.

The balance between the direct sound from the loudspeakers and the reflected sound from the listening room is important. A too high ratio of reflected to direct sound results in a lack of definition, or the masking of subtle details, in the stereophonic information which the direct sound of the loudspeakers conveys. The ratio of direct to reflected sound in the listening room can be increased by introducing more sound absorbing objects, such as soft upholstered furniture and deep pile carpets. It can also be increased by shortening the listening distance from the loudspeakers.

When the two loudspeakers and a suitable amount of reflected sound from the listening room combine to produce a sufficient number of directions of incidence for the high frequencies, the reproduction of a stereophonic recording which includes reflected sound from the recording environment can evoke impressions of ambience which emanates from the recording environment and not from the listening room, as well as impressions of height which are dependent on the recording and are not restricted by the height of the loudspeakers themselves. The OA-51 offers such quality in stereophonic reproduction.



Construction Characteristics of the OA-51

The Drive Units

For the bass and midrange a 7" drive unit with unique performance characteristics has been developed and is manufactured exclusively for the OA-51. The chassis is cast in a low-resonance magnesium alloy. A long copper cylinder around the centre pole of the magnet (as per Ragnar Lian's patent) renders the electrodynamic motor virtually free from distortion. The length of the high-power handling aluminium voice coil has been made three times the height of the magnetic air gap to keep the distortion low even at large cone excursions. The back and part of the front of the diaphragm has a combination of selected coatings resulting in a smooth frequency response and low distortion.

The tweeter has a 1" dome made of specially processed synthetic textile fabric. It has high efficiency and a wide directional response pattern, even above 12 kHz, and has been designed to provide a total sound with a flat frequency response.

The Cabinet

The acoustic design concept demands that the cabinet has a front panel which positions the drive units close to the back of the cabinet and at the same time at an angle which makes the axes through the drive units of the two speakers intersect above the listening area. The result is a cabinet of unique shape and expensive manufacture.

The cabinet is a rigid construction employing internal bracing by battens and a stay wall which joins all walls except the side walls. The walls are made of special high quality 16 mm birch chipboard. All outer walls are veneered on both sides with natural wood veneer.

The shape of the cabinet is designed to avoid interferences due to diffraction at the edges of the front panel and standing waves inside the cabinet. The internal volume is largely filled with glass wool. The ducted port in the smaller of the two side walls increases the efficiency of the cone movement in the frequency range 30–100 Hz, and helps to keep distortion low, even during strong bass tones.

The smaller side wall accommodates the screw mounted absorbent panel. The back wall incorporates flush-mounted wall hanging brackets. The removable front cover is made of reticulated foam of high acoustic transparency.

The Crossover Network

The drive units are connected in-phase and co-operate between 2 and 4 kHz in the direct sound of the loudspeaker. The bass/midrange unit is connected in series with an inductor. The tweeter is shunted by an inductor and connected in series with a capacitor and a resistor. The components are of high quality: the inductors are of air-core type and the capacitor is of metallised polypropylene which has particularly low dielectric absorption and it is designed to have high impulse handling capacity.

The Input Terminals

The OA-51 is equipped with special input sockets for insulated banana plugs. Normal 4mm banana plugs and double banana plugs with 19mm pitch can also be used. The sockets, which are gold-plated, are rated for 35A and are located at the lower back corner of the outward facing side walls.

OA-51 Specifications

Frequency Range:

—3 dB at 42 Hz and 18 kHz when positioned with back against a wall (32 Hz—20 kHz according to DIN).

Frequency Response:

The direct frequency response is measured using a sine tone and in a free sound field with the measuring microphone placed in the median plane of the drive units and at a height of 0.2 m above the plane extending from the bottom of the loudspeaker and at a minimum distance of 1 m from the loudspeaker, and is flat within ± 2 dB from 300 Hz to 17 kHz. The response below 300 Hz is attenuated to counterbalance the increase in efficiency caused by a reflecting wall directly behind the loudspeaker.

Distortion:

At a nominal input of 5 W, corresponding to a sound level of 94 dB at 1 m from the loudspeaker in a free sound field, the total harmonic distortion between 300 and 7,000 Hz is less than 0.4 %, with the exception of occasional peaks at 2 to 3 Hz approaching 0.8 %.

Sensitivity:

87 dB (1 W, 1 m).

Impedance:

8 Ω nominal (not less than 8 Ω from 5 Hz upwards) with phase angle not exceeding $\pm 28^\circ$.

Power Handling Capacity:

100 W undistorted music programme.

Dimensions:

Width: 430 mm (720 mm incl. absorbent panel and connecting plug).

Height: 296 mm (302 mm incl. front cover).

Depth: 248 mm (276 mm incl. front cover).

Weight:

11 kg each.

Finishes:

Walnut, rosewood and black ash veneer as well as white lacquer are standard finishes. Other finishes are available on request.

Units of Delivery:

The OA-51 system is supplied in mirror image pairs of matched veneer.

Carlsson Ortho-Acoustic Systems

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