

Artificial HEAD

Equalization

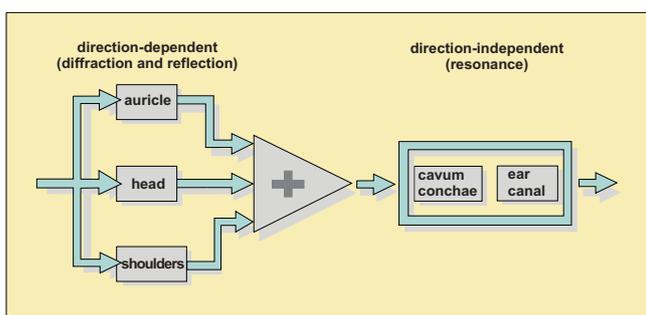
Why is an artificial head ...

... recording equalized
before playback?

Thanks to artificial head technology sound events can be recorded exactly like a human being would hear them. An artificial head recording contains not only the original timbre and volume, but also the original directional information of the sounds. When a sound scenario is recorded with an artificial head, the recording preserves the possibility for the human ear to select and identify different sound sources within the soundscape during playback.



Unlike any other microphone arrangement, an artificial head modifies a sound field in a way that is very similar to a human due to its geometry designed according to the human anatomy. Regarding these intended modifications, it is necessary to distinguish between direction-dependent and direction-independent changes. The direction-independent changes are caused by the sound waves passing the auricle cavity (cavum conchae) and the ear canal on their way to the eardrum. The outer body parts, i.e. shoulders, head and outer ear influence sound fields in a direction-dependent way, because a part of the sound waves does not reach the auditory canal directly, but is reflected by the shoulders, the head and parts of the outer ear before entering the cavum conchae and the ear canal. These reflections modify the timbre and volume of the sounds. Depending on the direction of incidence of the sound waves, the brain identifies the direction from which a specific sound is coming. In an environment with several different sound sources, for example road traffic or at a party, the direction-dependent sound transfer functions help to selectively hear individual sounds, i.e. to concentrate on them.



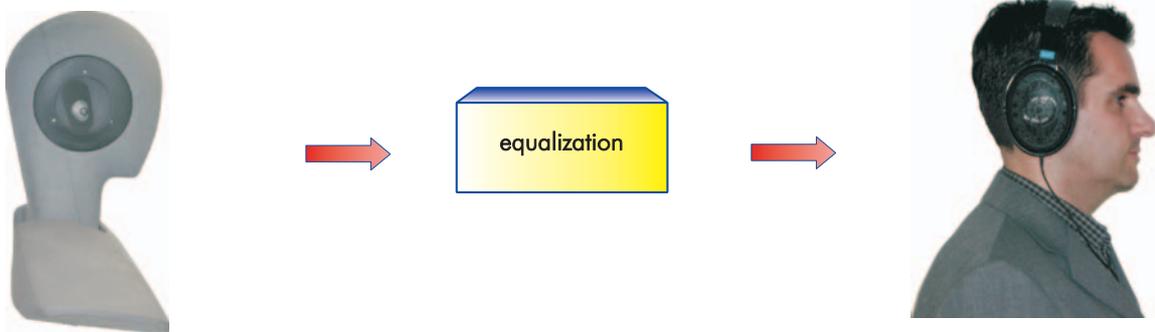
Model for the description of direction-dependent (shoulders, head, auricle) and direction-independent (cavum conchae, ear canal) components of the transfer function.

Why is there ...

... an equalization interface?

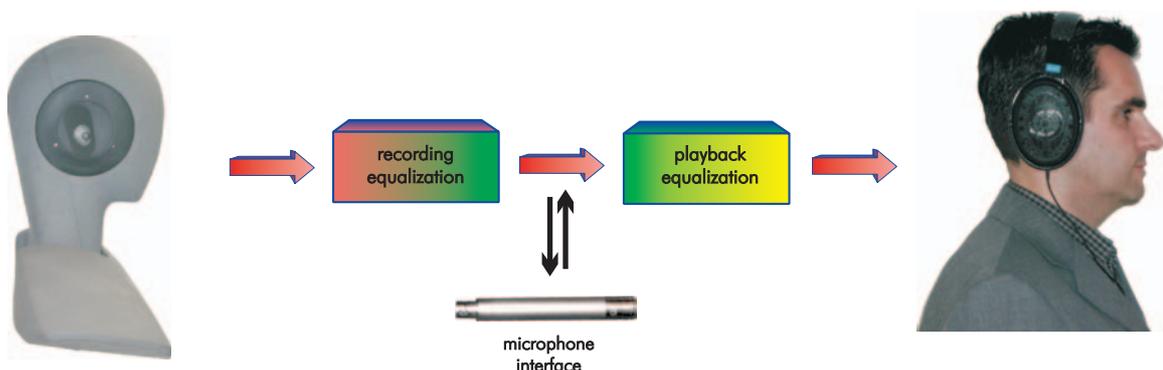
When listening to an artificial head recording without a playback equalization various influences would significantly change the hearing experience.

Among these influences are, in particular, certain distortions caused by the fact that the headphone membranes are not located directly in front of the eardrums of the listening persons. The sound waves must still cross the auricle cavity (cavum conchae) and the ear canal. The transfer characteristics of the headphone itself are also considered. These distortions can be removed by performing certain calculations i.e. Equalizations for the playback, so that the artificial head recording is aurally compensated and exactly reproduced.



The equalization interface makes artificial head recordings and conventional microphone recordings compatible with each other. In such a way they can be compared and analysed in a meaningful way. Without equalization a compatibility cannot be achieved since there are significant differences between both measurement systems.

In order to achieve a compatibility between artificial head recordings and conventional recordings nevertheless, the equalization interface is used under certain, predefined conditions depending on the type of sound field to remove the direction-dependent and/or the direction-independent changes from the artificial head recording.

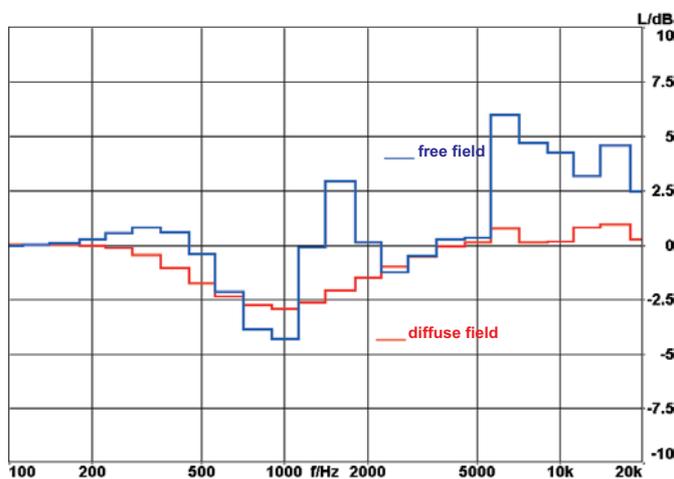


Why are there ...

... different equalization options?

The different equalization options account for the fact that, depending on the type of sound field, different direction-dependent changes (distortions) occur. A sound event recorded head-on generates a different spectrum than a sound source that is located to the side of, above, or behind the artificial head. The environment in which the recording takes place influences the sound field as well. Recordings in a diffuse sound field are different from similar measurements in a free field. In order to achieve an optimal equalization and thus a compatibility with measurement microphones, three different options are available:

The free field equalization (FF) equalizes artificial head recordings when a sound source is recorded head-on in a free field. This option requires recordings to be made in a low-reflective environment, where the artificial head is positioned in front of the sound source at a distance of 3 meters (10 ft). These conditions can be reproduced, however, they are not always true in practice.

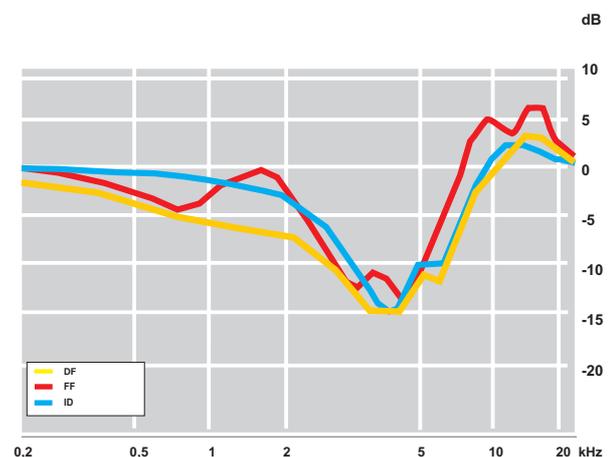


Free field and diffuse field equalization related to the ID equalization (0 dB line)

The diffuse field equalization (DF) is selected for measurements in diffuse sound fields. The equalization considers the direction-dependent factors caused by diffraction and reflection, averaged over all directions of sound incidence. The FF and DF equalizers correct the direction-dependent factors (FF for head-on sound incidence, DF averaged over all directions) as well as the direction-independent factors.

A third equalization option, called "independent-of-direction equalization" (ID), is an interface independent of the sound field, which equalizes only the direction-independent resonance of the artificial head. The ID equalization can be used in almost any type of sound field.

Influences caused by resonance in the cavum conchae and in the ear canal are characteristic for all three equalizations.



Which equalization ...

The selection of the most suitable equalization depends on the type of sound field. If the conditions cannot be exactly assigned to a specific sound field type, the equalization most closely matching the actual conditions should be chosen.

The advantage of the FF equalization is the exact reproducibility of its defined preconditions. This is the primary reason why many regulations prescribe FF equalization. In most cases, free field conditions can only be realized with high effort, since the measurements must be carried out in a low-reflective environment. For the simultaneous measurement of several sound sources or in reflective environments, the free field equalization should not be chosen. Another restriction applies to the measurement of moving objects. In a pass-by measurement, for example, the equalization would only be correct at that moment when the moving car is exactly in front of the artificial head.

The conditions for a diffuse field (DF) are laid down bindingly as well. However, pure diffuse fields almost never occur in practice and are hard to reproduce. In earlier days, the DF interface was preferably chosen in the studio area, and before the ID equalization was established, it was also used for the equalization of measurements inside a vehicle.

Until the 1980s, there was no alternative for the FF and DF equalizations. Only when it became possible to separate direction-independent and direction-dependent factors through calculations the direction-independent ID interface finally was developed. The ID equalization considers only the direction-independent components and is therefore, applications have proven, suitable for all measurements that are not carried out under largely pure free field or diffuse field conditions.

... is suitable for which measurement?



An artificial head records aurally accurate sound events. This means that, with a correct playback, a human being hears the sound events through the head-phone in exactly the same way as if he had been in the place of the artificial head. In order to make the listening experience match the original sound event, several different factors must be considered and equalized.

While the purpose of playback equalization is the accurate reproduction of artificial head recordings, an equalization interface can also be used to achieve technical compatibility between artificial head recordings and conventional microphone recordings. Three different equalization options are available: free field (FF), diffuse field (DF) and independent-of-direction (ID) equalization.

The selection of the correct equalization depends on the type of sound field. Free field and diffuse field conditions are exactly defined and guarantee a high reproduction accuracy. In practice, however, free fields or diffuse fields are rarely found. In these cases, the ID equalization should be chosen for measurements. As practical applications have shown, it is suitable for almost any kind of sound field.



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