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AES information document for acoustics - Loudspeaker modeling and measurement - Frequency and angular resolution for measuring, presenting, and predicting loudspeaker polar data

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Abstract

This document provides guidelines for measuring, presenting, and predicting polar data from a single acoustic source or from an array of acoustic sources. It describes and quantifies measurement resolution, presentation resolution, prediction techniques, and measurement environments. The information presented here is based on objective measurements and does not take subjective or psychoacoustic criteria into account.

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Foreword

[This foreword is not a part of AES-5id-1997 *AES information document for room acoustics and sound reinforcement systems — Loudspeaker modeling and measurement — Frequency and angular resolution for measuring, presenting, and predicting loudspeaker polar data.]*

This document was prepared by the AESSC SC-04-03 Working Group on Loudspeaker Modeling and Measurement of the SC-04 Subcommittee on Acoustics. The group was established in 1990 under the initial leadership of T. Telesky in response to concerns for standardization in the growing field of acoustical modeling.

At its meeting in the autumn of 1993 under the chairmanship of F. Seidel, SC-04-03 recognized that although acoustical modeling programs had become useful in roughly estimating sound coverage, they are unable, yet, to sufficiently predict nulls and lobes in the direct field of loudspeaker arrays. This is in part due to the coarse measurement resolution used to characterize loudspeakers and loudspeaker arrays. Nulls as severe as 20 dB can be measured in the polar response of simple two-horn arrays that are not predicted by commonly used methods and measurement data. In addition, measured data are often presented in such a coarse resolution that these severe nulls do not appear on polar patterns.

Acoustical modeling of sound in spaces requires knowledge concerning sources, room boundaries, and psychoacoustics. To characterize sound sources and room boundaries two AES working groups, SC-04-03 and SC-04-02, were formed. The required measurement resolution to model the total sound field for a given direct to reverberant sound ratio is not known at this time. The resolution required is likely to be a function of this ratio.

This information document evolved out of the effort of working group SC-04-03 to establish, for the direct field, the relationship between the resolution, of measurement and of data presentation, and the accuracy of presented and predicted polar patterns and frequency responses of loudspeakers, individually and in arrays.

A round robin set of measurements, designated AES-X07 experiment 1.1, was designed and executed to study, among other issues, the relationship between resolution and accuracy. AES project AES-X07 is described in detail in AESSC News in *JAES,* vol. 42, no. 9, p. 707. The results of these measurements were presented and discussed at the 97th AES Convention in San Francisco and reported in AESSC News in *JAES* vol. 43, no. 6, p. 519. This work, supplemented by subsequent analysis and further measurements by Felicity Seidel and Henrik Staffeldt, using facilities provided by Meyer Sound Laboratories, Inc., and by the Department of Acoustics Technology at the Technical University of Denmark, and reported in *JAES,* vol. 44, no. 7/8, has led to the writing of AES-5id-1997.

The application of these data in modeling the total sound field for a given direct to reverberant sound ratio has yet to be investigated and is in the scope of the working group SC-04-01.

A writing group headed by Seidel and Staffeldt prepared this document based on the instructions of the working group.

Mendel Kleiner
Chair, AESSC SC-04 Subcommittee on Acoustics
1996-04-16

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1 Scope

This document provides guidelines for measuring, presenting, and predicting polar data from a single acoustic source or from an array of acoustic sources. It describes and quantifies possible errors, defined as differences in numeric values, associated with measurement resolution, presentation resolution, prediction techniques and measurement environments.

> NOTE The term “error” is used in its mathematical sense and does not imply incorrect procedures, but only that the results of procedures are always associated with finite accuracies.

The information presented here is based on objective measurements and does not take subjective or psychoacoustic criteria into account. The supporting experiments were conducted in the 1-kHz to 10-kHz frequency range on small devices having commensurate ratios between the critical device or array dimensions and the measurement wavelength. Nevertheless, the results are valid from 100 Hz to 10 kHz because these ratios can also be commensurate below 1 kHz for larger devices and arrays.

Additionally, the supporting experiments were conducted on single devices and two-device arrays. Nevertheless, the results are valid for a single acoustic source and for an array of acoustic sources because the peaks and nulls appearing in the off-axis frequency responses and polar patterns of the single devices and two-device arrays used in these experiments can also be commensurate with those appearing in the frequency responses and polar patterns of arrays consisting of more than two devices. Annex D, citation 3, contains additional information.

These guidelines are not intended to be restrictive but to illuminate possible errors associated with some common practices in loudspeaker modeling and measurement. They are intended to build a common foundation from which reliable data on sound sources can be gathered and compared. The application of these data in modeling the total sound field for a given direct to reverberant sound ratio has yet to be investigated and is not in the scope of this document.

2 Normative references

The following standard contains provisions that, through reference in this text, constitute provisions of this document. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent edition of the indicated standard.

ISO 266, *Acoustics — Preferred frequencies for measurement*. Geneva, Switzerland : International Organization for Standardization, 1975.