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## **AES Information Document for Acoustics - Plane-Wave Tubes - Design and Practice**

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# **AES Information Document for Acoustics - Plane-Wave Tubes - Design and Practice**

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## **Abstract**

The standard AES2 calls for the use of plane-wave tube measurement of high-frequency horn drivers. Because many variations and results are possible, depending on the details of construction of plane-wave tubes, this document discusses those variations for the purpose of encouraging further experimentation.

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## Foreword

This foreword is not a part of *AES information document - plane-wave tubes: design and practice*, AES 1id-1991.

An Audio Engineering Society information document is, according to the Operating Policy of the Audio Engineering Society Standards Committee, "a summary of scientific and technical information, originated by a technically competent writing group, important to the preparation and justification of a standard or to the understanding and application of such information to a specific technical subject ..." The AES Standards Committee subjects such documents to the same review as a full standard, with the understanding of all parties that the document is not a standard.

The current document is a committee report containing the text of a draft proposed standard, together with discussion materials and documentation used to draft the proposal. The material was drafted by the AESSC Working Group on Sound Reinforcement Components, under the chairmanship of Clifford A. Henricksen, as an addition to the published standard AES2-1984, "AES Recommended Practice - Specification of Loudspeaker Components used in Professional Audio and Sound Reinforcement." However, the Working Group members felt that while data obtained using the proposed method were not sufficiently repeatable and reproducible to have the full status of a standard, a standard could not be completed without further use of the proposed method in the field.

The writing group that prepared this document had the following members: Marshall Buck, Bernie Cahill, Robert T. Davis, Mark Gander, William Gelow, William Hayes, Clifford A. Henricksen (Chair), D. B. Keele, David Klepper (Secretary), Fancher M. Murray, George Owen, Daniel Queen, and Dilip Singhi.

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## Foreword to second revision, 2012

This 2012 edition is a revision of AES 1id-1991 (r2003)

Additional uses of a plane-wave tube are listed. Further tests were performed to compare a distant microphone location with a close location to test the hypothesis that non-plane-wave radiation would be more accurately measured. A termination method is described. A modern method of calibration is referenced and summarized.

Dimensions have been converted into SI units throughout, but the original US conventional units have also been retained for reference.

## Note on normative language

In AES standards documents, sentences containing the word "shall" are requirements for compliance with the document. Sentences containing the verb "should" are strong suggestions (recommendations). Sentences giving permission use the verb "may". Sentences expressing a possibility use the verb "can".

# AES Information Document for Acoustics - Plane-Wave Tubes - Design and Practice

## 1 Introduction

### 1.1 Purpose

The purpose of this document is to establish, expand, and improve the practice for the design and use of plane-wave tube measurement techniques, as recommended in AES2, "Recommended Practice - Specification of Loudspeaker Components Used in Professional Audio and Sound Reinforcement." [C.1]

### 1.2 Definition

A plane-wave tube (PWT) is a device which is intended to provide a constant acoustical impedance with a value  $\rho_0 c$  divided by the area defined by the inner diameter of the tube, where  $\rho_0 c$  is the specific impedance of air. Measurement of the standing-wave ratio (SWR) of the tube determines the consistency of this " $\rho_0 c$  termination" (see 2.3.2). Plane-wave tubes are used to provide a standard, frequency-invariant load for the testing of compression drivers, so that all drivers may be evaluated on an equal basis. In addition, when properly terminated, it is anechoic.

Uses of plane wave tubes for compression driver testing include:

- 1 Frequency response measurements
- 2 Distortion measurements
- 3 Coherence measurements
- 4 Power testing
- 5 Power compression testing
- 6 Listening tests

The use of a PWT does not replace testing a driver on a horn in an anechoic environment; it is an adjunct to it.

## 2 General

### 2.1 Usable bandwidth

#### 2.1.1 High-frequency limit

The high-frequency limit, in kHz, of a plane-wave tube is  $0,586c/d$  where  $c$  is the speed of sound in air, in m/s, and  $d$  is the tube diameter in mm. The measured response at the frequency determined by  $0,586c/d$  is characterized by a narrow, deep notch. Above this frequency, a series of Bessel-function-related notches will occur, so some data taken in this region may be considered unreliable. The following table 1 shows the first six modes: