Building a Plane-Wave Tube: Experimental and Theoretical Aspects*

ROBERTO MAGALOTTI, *AES Member*, AND CARLO ZUCCATTI, *AES Member***

Generalmusic S.p.A., 47842 S. Giovanni, Marignano (RN), Italy,

AND

PAOLO PASINI

Technogym s.r.l., 47035 Gambettola (FO), Italy

The design, building, and testing of a plane-wave tube for measurements of compression drivers are described. Testing the device, the acoustical properties of open and closed ducts, and the capability of MLS-based measurement systems to retain the anechoic part only of the impulse response were exploited. The influence of higher modes of vibration in setting the upper limit of usable bandwidth is investigated.

0 INTRODUCTION

Compression drivers are never used in direct radiation. Their operation is strictly dependent on the acoustic load provided by the loudspeaker horn to which they are coupled. Therefore the measurement techniques usually employed for direct-radiation devices are not suitable for compression drivers. On the other hand, every loudspeaker horn has its own features, and the same driver gives markedly different results with different horns. This situation calls for a standard device for measurement purposes that has to be easy to reproduce and can offer a hornlike acoustic load.

The plane-wave tube is such a device. It is a rigid, cylindrical duct that can be mounted on the exit area of a compression driver just like a loudspeaker horn. It is partially filled with sound-absorbing material in order to cancel reflections from the far end without modifying the load on the driver. Near the driver, a hole in the tube allows the insertion of a measurement microphone to record the progressive wave coming from the driver without perturbing system conditions.

This simple device loads the driver with a real frequency-constant acoustic impedance [1], equal to the high-frequency limit of any diverging horn having the same throat diameter.

The main purpose of this paper is to describe the building and testing of a plane-wave tube in the audio laboratory of Generalmusic [2]. The first experimental results have led us to investigate some theoretical questions also.

1 BUILDING THE TUBE

1.1 Suggested Configuration

The AES information document AES-1ID-1991 [3] gives indications and suggestions on the design, building, and measurement of a plane-wave tube. According to that document, the absorbing material should be cut to a wedge shape, completely filling the far end of the tube and gradually tapering toward the driver throat [Fig. 1(a)]. The microphone should be inserted in the short section between the wedge tip and the driver, with the diaphragm placed radially in the inner wall so as to minimize perturbation on the system.

The main section of the Generalmusic plane-wave tube is made of rigid, transparent plastic material with an inner diameter of 25.4 mm (1 in) and a length of 1.25 m. This tube is connected to a metallic section that includes the microphone probe hole. Three different metallic fittings, with circular openings of 25.4-, 38.1-, and 50.8-mm (1-, 1.5-, and 2-in) diameter, can be in-

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