ASA/ANSI S1.18-2018

AMERICAN NATIONAL STANDARD

Method for Determining the Acoustic Impedance of Ground Surfaces

Secretariat:

Acoustical Society of America

Approved on October 31, 2018:

American National Standards Institute, Inc.

Abstract

This Standard describes procedures for obtaining the real and imaginary parts of the normalized acoustic impedance ratio of ground surfaces from in-situ measurements of the sound pressure levels at two vertically separated microphones using specified geometries and the averaged values of the difference between the simultaneous, instantaneous sound-pressure signals at the two microphones. It enables the user to either deduce parameters for a ground impedance model by fitting spectral data to templates or obtain values of the normalized specific acoustic impedance ratio of the ground entirely from measurements and independently of any model for the acoustic impedance of the ground surface except as a check on the validity of the resulting values.

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Method for Determining the Acoustic Impedance of Ground Surfaces

ANSI/ASA S1.18-2018

Accredited Standards Committee S1, Acoustics

Standards Secretariat
Acoustical Society of America
1305 Walt Whitman Road, Suite 300
Melville, NY 11747

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ANSI/ASA S1.18-2018
(Revision of ANSI S1.18-2010)

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Contents

Tables

Figures

Foreword

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This Standard comprises a part of a group of definitions, standards, and specifications for use in acoustics. It was developed and approved by Accredited Standards Committee S1 - Acoustics under its approved operating procedures. Those procedures have been accredited by the American National Standards Institute (ANSI). The Scope of Accredited Standards Committee S1 is as follows:

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This Standard is a revision of ANSI/ASA S1.18-2010, which has been modified and corrected. A template method is augmented by a procedure to utilize measurements of the magnitude and relative phase of the averaged ratio of the difference between instantaneous sound-pressure signals at two specific locations relative to the location of a sound source and thereby deduce the real and imaginary parts of the complex normalized specific acoustic impedance ratio.

This Standard is not comparable to any existing ISO Standard.

This Standard includes five Annexes, all of which are informative and are not considered part of this Standard.

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Working Group S1/WG 20, Measurement of Ground Impedance and Attenuation of Sound due to the Ground, which assisted Accredited Standards Committee S1, Acoustics, in the development of this Standard, had the following membership.

K. Attenborough, Chair
K.M. Li, Vice-Chair

W.C.K. Alberts, II
C. Hansen
J. Sabatier
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M. Stinson
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Suggestions for improvements to this Standard will be welcomed. They should be sent to Accredited Standards Committee S1 - Acoustics in care of the Standards Secretariat of the Acoustical Society of America, 1305 Walt Whitman Road, Suite 300, Melville, New York 11747. Telephone: 631-390-0215; FAX: 631-923-2875; E-mail: asastds@acousticalsociety.org.

Introduction

Experimental techniques to measure impedance include the use of an impedance tube, techniques that measure the sound pressure levels above a surface, and direct measurements of sound pressure and volume velocity.

This Standard does not consider the direct measurement of sound pressure and volume velocity.

The impedance tube is in common use to measure the acoustic impedance of porous materials. It has the advantage of a straightforward theoretical framework that allows direct determination of both the real and imaginary parts of the impedance. However, its application in the field to obtain ground impedance suffers from two major disadvantages. First, it requires an accurate measurement of the distance from the first interference minimum to an ill-defined test surface, and, secondly, it is invasive. This Standard does not recommend the use of an impedance tube for the measurement of the acoustic impedance of a ground surface.

Techniques that use measurements of sound pressure levels above a surface include several variations based on the type of excitation, angle of incidence, number of microphones, and fitting methods. All enjoy the advantage that the measurement is performed on the ground in its natural condition. However, because of the spherical wavefront, the theoretical framework is mathematically intricate. Annexes C and D detail the expressions and special functions used in the calculations in Clause 4.

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American National Standard

Method for Determining the Acoustic Impedance of Ground Surfaces

1 Scope

Outdoor sound close to the ground is influenced by the acoustical properties of the ground. This Standard describes recommended procedures to characterize, and the instruments to measure quantities that may be used to deduce, the acoustical properties of ground surfaces. Although this Standard is intended primarily for outdoor measurements, indoor measurement of undisturbed portions of a ground surface, such as sod, is within its scope also.

The Standard yields the real and imaginary parts of the normalized specific acoustic impedance ratio of ground surfaces in the frequency range between 250 and 4000 Hz for outdoor sound propagation predictions. The Standard uses measurements of the interference between direct and ground-reflected sound to deduce both normalized specific acoustic impedance ratio and impedance model parameters. The impedance-ratio model parameters of effective flow resistivity and a porosity factor, determined from best fits to the templates of calculated level differences, may be used to estimate the normalized specific acoustic impedance ratio at frequencies outside the specified range.

The basic purpose of this Standard is to establish uniform procedures for obtaining the real and imaginary parts of the normalized specific acoustic impedance ratio of ground surfaces outdoors.

The method is applicable to all nominally flat, commonly occurring surfaces including grassland or snow-covered ground.

The method is not applicable to rough grounds where the variation in height is greater than half of the shortest wavelength of interest. For the specified upper frequency of 4 kHz this limits the variation in height to about 5 cm. See also Clause 4.4.

2 Normative references

The following referenced documents are indispensable for the application of this Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI/ASA S1.1, American National Standard Acoustical Terminology

ANSI/ASA S1.4/Part 1/IEC 61672-1, American National Standard Electroacoustics – Sound level meters – Part 1: Specifications (a nationally adopted international standard)

ANSI/ASA S1.11/Part 1/IEC 61260-1, American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters (a nationally adopted international standard)

ANSI/ASA S1.40, American National Standard Specifications and Verification Procedures for Sound Calibrators,

IEC 61094-4 Ed.1.0 1995 Measurement microphones - Part 4: Specifications for working standard microphones