AMERICAN NATIONAL STANDARD

DESIGN RESPONSE OF WEIGHTING NETWORKS FOR ACOUSTICAL MEASUREMENTS

ANSI S1.42-2001

Accredited Standards Committee S1, Acoustics

Standards Secretariat
Acoustical Society of America
35 Pinelawn Road, Suite 114E
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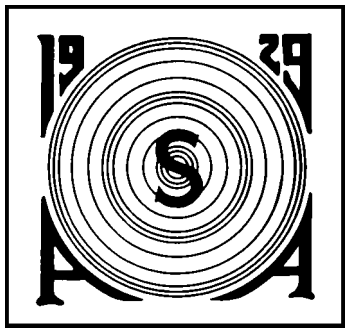

American National Standard

Design Response of Weighting Networks for Acoustical Measurements

Secretariat

Acoustical Society of America

Approved 22 October 2001

American National Standards Institute, Inc.

Abstract

This Standard provides the design criteria for both the frequency-domain response (amplitude and phase) and time-domain of the A- and C-weighting networks used in acoustically related measurements. The poles and zeros for each weighting network are given, along with equations for computing the amplitude and phase responses as functions of frequency and impulse and step responses as functions of time. Other known weighting networks that had been standardized, such as the B-, D- and E-weightings, or weightings that were published in the past, are listed in the Annexes for reference.

AMERICAN NATIONAL STANDARDS IN ACOUSTICS

The Acoustical Society of America (ASA) provides the Secretariat for Accredited Standards Committees S1 on Acoustics, S2 on Mechanical Vibration and Shock, S3 on Bioacoustics, and S12 on Noise. These committees have wide representation from the technical community (manufacturers, consumers, and general-interest representatives). The standards are published by the Acoustical Society of America through the American Institute of Physics as American National Standards after approval by their respective standards committees and the American National Standards Institute.

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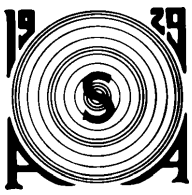

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Foreword

[This foreword is for information only and is not an integral part of ANSI S1.42-2001 *American National Standard Design Response of Weighting Networks for Acoustical Measurements*.]

Weighting networks have been widely used for many years to provide standardized means to select preferred information from acoustical signals. For example, the A- weighting has the property to enhance information over the human hearing range. Where as, the C-weighting is designed to encompass information from a wider spectrum. There is no concrete data to prove that the weighting networks are perfectly in agreement with the intent, such as the human hearing range. However, over the years, the design goals of the previously standardized weighting networks have proven to be acceptable to a majority of users, and the design goals have not been changed. Therefore it is possible to compare measured data from a vast data pool that has been accumulated over a period of more than 40 years.

For acoustical measurements, the weighting networks and the measuring instruments play important roles in arriving at correct answers. In this standard, ANSI S1.42-2001, only the design goals of the weighting networks are given. The tolerances in implementation of the weighting networks are subjected to specifications given in instrument standards. It must be pointed out that in view of the specification tolerances of weighting networks in acoustical instruments, it is possible to have instruments of the same class specification to give different measured readings for the same acoustical signal input. This is particularly true in sound level meters with relatively wide weighting network tolerances at the high and the low frequency range.

For the sake of completeness, information on other weighting less popular seldom used networks such as B-, D- and E-weightings are listed in the Annexes.

This standard was developed under the jurisdiction of Accredited Standards Committee S1, Acoustics, which has the following scope:

> *Standards, specifications, methods of measurement and test, and terminology, in the fields of physical acoustics, including architectural acoustics, electroacoustics, sonics and ultrasonics, and underwater sound, but excluding those aspects which pertain to safety, human tolerance and comfort.*

At the time this standard was submitted to Accredited Standards Committee S1, Acoustics, for final approval, the membership was as follows:

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T. J. Kuemmel, *Vice Chair*
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Individual Experts of Accredited Standards Committee S1, Acoustics, were:

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H. E. von Gierke
G.S.K. Wong
R.W. Young

Working Group S1-24, Design Response of Weighting Networks for Acoustical Measurements, which assisted Accredited Standards Committee S1, Acoustics, in the preparation of this Standard had the following membership:

G. S. K. Wong, *Chair*

D. J. Evans D. L. Johnson J. P. Seiler L. Wu

Suggestions for improvement will be welcomed. Send suggestions for improvement to Accredited Standards Committee S1, Acoustics, in care of the ASA Standards Secretariat, 35 Pinelawn Road, Suite 114 E, Melville, New York 11747-3177 USA.

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American National Standard

Design Response of Weighting Networks for Acoustical Measurements

1 Scope

The aim is to examine the design goal specifications of weighting networks for acoustical measurements. The scope is restricted to the design, or target, responses of weighting networks. Tolerances that belong in the instrument performance specifications are not included.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents listed below.

2.1 American National Standards

ANSI S1.4-1983 (R 2001) American National Standard Specification for Sound Level Meters.

ANSI S1.4A-1985 (R 2001) Amendment to ANSI S1.4-1983.

ANSI S1.6-1984 (R 2001) American National Standard Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements

ANSI S1.11-1986 (R 1998) American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.

2.2 International Standards

IEC 60651:1979 Sound level meters, Amendment No. 1 (1993)

IEC 60804:1985 Integrating-averaging sound level meters.

Amendment No. 1 (1989)

Amendment No. 2 (1993)

IEC 61012:1990 Filters for the measurement of audible sound in the presence of ultrasound

IEC 61260:1995-08 Electroacoustics-Octave-band and fractional-octave-band filters.

IEC 61261:1976 Electro-acoustical measuring equipment for aircraft noise certification

ISO 7196:1995 Acoustics-Frequency-weighting characteristics for infrasound measurements

3 Frequency-weighting characteristics

3.1 Frequency domain

3.1.1 In the frequency domain, the complex transfer function $H(jf)$ of a filter driven by a continuous sinusoidal waveform of frequency f can be expressed as

Table 1 — Poles, zeros, and normalization constants of the transfer functions for the A-, and C-weighting networks.

		A-weighting		C-weighting	
Zeros	m	q_m	$\gamma_m + j\delta_m$	q_m	$\gamma_m + j\delta_m$
	1	4	$0 + j0$	2	$0 + j0$
Poles	n	r_n	$a_n + j\beta_n$	r_n	$a_n + j\beta_n$
	1	2	$-20.598997 + j0$	2	$-20.598997 + j0$
	2	1	$-107.65265 + j0$	2	$-12\,194.217 + j0$
	3	1	$-737.86223 + j0$	- - -	- - -
	4	2	$-12\,194.217 + j0$	- - -	- - -
K			3.5041384×10^{16}		2.2428792×10^{16}