



ASA/ANSI S1.11-2014/Part 1 / IEC
61260-1:2014

Reaffirmed by ANSI December 11, 2023

AMERICAN NATIONAL STANDARD

**Electroacoustics – Octave-band and Fractional-
octave-band Filters –
Part 1: Specifications
(a nationally adopted international standard)**

Secretariat:

Acoustical Society of America

Approved on July 2, 2014:

American National Standards Institute, Inc.

Abstract

This standard provides performance requirements for analog, sampled-data, and digital implementations of band-pass filters that comprise a filter set or spectrum analyzer for acoustical measurements. It supersedes ANSI/ASA S1.11-2004 (R2009) American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters, and is an identical national adoption of IEC 61260:2014 Electroacoustics – Octave-band and fractional-octave-band filters, Part 1: Specifications. Significant changes from previous versions is that IEC 61260 has been adopted in full: (1) the original test methods of IEC 61260 clause 5 that was moved to an informative annex was replaced as normative, (2) the term “band number,” was replaced, and (3) some references were removed.

ANSI/ASA S1.11-2014/Part 1 / IEC 61260-1:2014

Reaffirmed by ANSI August 9, 2019

AMERICAN NATIONAL STANDARD

**Electroacoustics – Octave-band and
Fractional-octave-band Filters –
Part 1: Specifications
(a nationally adopted international standard)**

ANSI/ASA S1.11-2014/Part 1 /
IEC 61260-1:2014

Accredited Standards Committee S1, Acoustics

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

The American National Standards Institute, Inc. (ANSI) is the national coordinator of voluntary standards development and the clearinghouse in the U.S.A. for information on national and international standards.

The Acoustical Society of America (ASA) is an organization of scientists and engineers formed in 1929 to increase and diffuse the knowledge of acoustics and to promote its practical applications.



AMERICAN NATIONAL STANDARD

Electroacoustics – Octave-band and Fractional-octave-band Filters – Part 1: Specifications
(a nationally adopted international standard)

Secretariat:

Acoustical Society of America

Approved on July 2, 2014 by:

American National Standards Institute, Inc.

Abstract

This standard provides performance requirements for analog, sampled-data, and digital implementations of band-pass filters that comprise a filter set or spectrum analyzer for acoustical measurements. It supersedes ANSI/ASA S1.11-2004 (R2009) *American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters*, and is an identical national adoption of IEC 61260:2014 *Electroacoustics – Octave-band and fractional-octave-band filters, Part 1: Specifications*. Significant changes from previous versions is that IEC 61260 has been adopted in full: (1) the original test methods of IEC 61260 clause 5 that was moved to an informative annex was replaced as normative, (2) the term “band number,” was replaced, and (3) some references were removed.

AMERICAN NATIONAL STANDARDS ON 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, S3/SC 1 on Animal Bioacoustics, and S12 on Noise. These committees have wide representation from the technical community (manufacturers, consumers, trade associations, organizations with a general interest, and government representatives). The standards are published by the Acoustical Society of America as American National Standards after approval by their respective Standards Committees and the American National Standards Institute (ANSI).

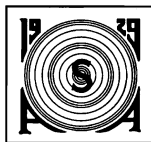
These standards are developed and published as a public service to provide standards useful to the public, industry, and consumers, and to Federal, State, and local governments.

Each of the Accredited Standards Committees (operating in accordance with procedures approved by ANSI) is responsible for developing, voting upon, and maintaining or revising its own Standards. The ASA Standards Secretariat administers Committee organization and activity and provides liaison between the Accredited Standards Committees and ANSI. After the Standards have been produced and adopted by the Accredited Standards Committees, and approved as American National Standards by ANSI, the ASA Standards Secretariat arranges for their publication and distribution.

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered and that a concerted effort be made towards their resolution.

The use of an American National Standard is completely voluntary. Their existence does not in any respect preclude anyone, whether he or she has approved the Standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the Standards.

NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this Standard.



Acoustical Society of America
ASA Secretariat
1305 Walt Whitman Road, Suite 300
Melville, New York 11747
Telephone: 1 (631) 390-0215
Fax: 1 (631) 923-2875
E-mail: asastds@acousticalsociety.org

© 2014 by Acoustical Society of America. This standard may not be reproduced in whole or in part in any form for sale, promotion, or any commercial purpose, or any purpose not falling within the provisions of the U.S. Copyright Act of 1976, without prior written permission of the publisher. For permission, address a request to the Standards Secretariat of the Acoustical Society of America.

These materials are subject to copyright claims of IEC and ASA. No part of this publication may be reproduced in any form, including an electronic retrieval system, without the prior written permission of the Acoustical Society of America (ASA). All requests pertaining to this standard should be submitted to ASA.

Contents

1	Scope	1
2	Normative references	1
3	Terms and definitions	2
4	Reference environmental conditions	6
5	Performance requirements	6
5.1	General.....	6
5.2	Octave frequency ratio	7
5.3	Reference frequency	7
5.4	Exact mid-band frequencies.....	7
5.5	Nominal mid-band frequencies	8
5.6	Band-edge frequencies	8
5.7	Time-averaged signal levels	8
5.8	Filter attenuation.....	9
5.9	Reference attenuation	9
5.10	Relative attenuation	9
5.11	Normalized effective bandwidth	11
5.12	Effective bandwidth deviation.....	13
5.13	Linear operating range	13
5.14	Time-invariant operation	14
5.15	Anti-alias filters	15
5.16	Summation of output signals.....	15
5.17	Overload indicator	15
5.18	Filter decay time	16
5.19	Maximum input signal	16
5.20	Output terminals and terminating impedances	16
5.21	Power supply check	16
5.22	Sensitivity to various environments.....	17
5.23	Electrostatic-discharge and electromagnetic-compatibility requirements	17
6	Instrument marking	20
7	Instruction manual	20
7.1	General.....	20
7.2	Operation.....	21
7.3	Testing.....	22
Annex A (informative) Relationship between tolerance interval, corresponding acceptance interval and the maximum-permitted uncertainty of measurement		23
Annex B (normative) Maximum-permitted expanded uncertainties of measurement		24
Annex C (informative) Examples of conformance assessment to specifications of this standard		25
C.1	General.....	25
C.2	Conformance criteria	25
C.3	Example test results	26

Annex D (informative) Base 2 filters	28
Annex E (normative) Nominal mid-band frequencies	29
E.1 Mid-band frequencies for octave-band and one-third-octave-band filters	29
E.2 Mid-band frequencies for one-half-octave-band filters	29
E.3 Mid-band frequencies for other bandwidths	29
Annex F (informative) Normalized frequencies at breakpoints of acceptance limits on minimum and maximum relative attenuation for one-third-octave-band filters.....	31
Annex G (informative) Filter response to exponentially swept sinusoidal signals	33
G.1 Exponential frequency sweep.....	33
G.2 Response of set of band-pass filters to a sweep.....	33
Annex H (informative) Measurement of filter decay time	36
H.1 General	36
H.2 Measurement of filter decay time.....	36
Bibliography	38

Tables

Table 1 – Acceptance limits on relative attenuation for octave-band filters.....	10
Table 2 – Limits for radiated disturbance of class B Information Technology Equipment (ITE) at a distance of 10 m.....	20
Table 3 – Limits for conducted disturbance to the voltage of a public supply of electric power	20
Table B.1 – Maximum-permitted expanded uncertainties of measurement	24
Table C.1 – Examples of conformance assessment	26
Table E.1 – Mid-band frequencies for octave-band and one-third-octave-band filters in the audio range.....	30
Table F.1 – Acceptance limits on relative attenuation for one-third-octave-band filters	32

Figures

Figure 1 – Minimum and maximum limits on relative attenuation as a function of f/f_m for class 1 and class 2 octave-band filters	12
Figure A.1 – Relationship between tolerance interval, corresponding acceptance interval and the maximum-permitted uncertainty of measurement	23
Figure C.1 – Examples of conformance assessment	27
Figure G.1 – Relation between the logarithmic frequency scale and the linear time scale due to the exponential sweep	35

Foreword

[This Foreword is for information only, and is not a part of the American National Standard ANSI/ASA S1.11-2014/Part 1 / IEC 61260-1:2014 American National Standard Electroacoustics – Octave-band and Fractional-octave-band Filters – Part 1: Specifications. As such, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard.]

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:

Standards, specifications, methods of measurement and test, and terminology in the field of physical acoustics, including architectural acoustics, electroacoustics, sonics and ultrasonics, and underwater sound, but excluding those aspects which pertain to biological safety, tolerances, and comfort.

This standard revises and replaces ANSI/ASA S1.11-2004 (R2009) *American National Standard Specification for Octave-band and Fractional-octave-band Analog and Digital Filters*.

This standard is an identical national adoption of IEC 61260-1 Ed 1.0 2014-02 *Electroacoustics – Octave-band and fractional-octave-band filters – Part 1: Specifications*, which was prepared by IEC/TC 29. However, in conformance with ANSI and IEC rules, the words “this part of ANSI/ASA S1.11 / IEC 61260” replace the words “this part of IEC 61260” where they appear in the IEC document, decimal points were substituted in place of the decimal commas used in IEC documents, and American English spelling is used in place of British English spelling.

This standard includes eight Annexes. Annexes B and E are normative and are considered to be a part of this standard. Annexes A, C, D, F, G, and H are informative and are not considered part of this standard.

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

R.J. Peppin, *Chair*
A. Scharine, *Vice-Chair*

S.B. Blaeser, *Secretary*

3M Personal Safety Division, Detection Solutions	P.J. Battenberg
.....	M. Wurm (Alt.)
Acoustical Society of America	R.J. Peppin
.....	R.D. Hellweg (Alt.)
Air-Conditioning, Heating and Refrigeration Institute	S.J. Lind
.....	D. Abbate (Alt.)
American Industrial Hygiene Association	D. Driscoll
.....	D. Sandfort (Alt.)
Campanella Associates	A.J. Campanella

Casella USA	R. Brauch
ETS-Lindgren Acoustic Systems	D. Winker
.....	M. Black (Alt.)
G.R.A.S. Sound & Vibration	B. Schustriach
.....	J. Soendergaard (Alt.)
Information Technology Industry Council	W.M. Beltman
.....	J. Rosenberg (Alt.)
National Council of Acoustical Consultants	E. Logsdon
.....	G.E. Winzer (Alt.)
National Institute of Standards & Technology (NIST)	R.P. Wagner
.....	S. Fick (Alt.)
PCB Group	K. Cox
.....	L. Harbaugh (Alt.)
Scantek, Inc.	S. Marshall
.....	M. Golden (Alt.)
U.S. Air Force (USAF)	R.L. McKinley
.....	F. Mobley (Alt.)
U.S. Army Construction Engineering Research Laboratory	M. Swearingen
.....	M.J. White (Alt.)
U.S. Army Research Laboratory, Human Research and Engineering Directorate	A. Scharine
.....	M.A. Ericson (Alt.)
U.S. Department of Labor – Mine Safety and Health Administration	J. Homer

Individual Experts of Accredited Standards Committee S1, Acoustics, were:

V. Buzduga
P. Hanes

V. Nedzelitsky
P.D. Schomer

C. Walber
L. Wu

Working Group S1/WG 5, Band Filter Sets, which assisted Accredited Standards Committee S1, Acoustics, in the development of this standard, had the following membership.

R.J. Peppin, Chair

O-H. Bjor

M. Buzduga

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

IEC 61260:1995 and its Amendment 1:2001 are now separated into the following three parts of IEC 61260 series:

- Part 1: Specifications
- Part 2: Pattern evaluation tests (under consideration)
- Part 3: Periodic tests (under consideration)

For assessments of conformance to performance specifications, ANSI/ASA S1.11/Part 1 / IEC 61260-1 uses different criteria than were used for the IEC 61260:1995 edition.

IEC 61260:1995 did not provide any requirements or recommendations to account for the uncertainty of measurement in assessments of conformance to specifications. This absence of requirements or recommendations to account for uncertainty of measurement created ambiguity in determinations of conformance to specifications for situations where a measured deviation from a design goal was close to a limit of the allowed deviation. If conformance was determined based on whether a measured deviation did or did not exceed the limits, the end-user of the octave-band and fractional-octave-band filters incurred the risk that the true deviation from a design goal exceeded the limits.

To remove this ambiguity, IEC Technical Committee 29, at its meeting in 1996, adopted a policy to account for measurement uncertainty in assessments of conformance in International Standards that it prepares.

ANSI/ASA S1.11/Part 1 / IEC 61260-1 uses an amended criterion for assessing conformance to a specification. Conformance is demonstrated when (a) measured deviations from design goals do not exceed the applicable *acceptance limits* and (b) the uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty. Acceptance limits are analogous to the tolerance limits allowances for design and manufacturing implied in the IEC 61260:1995.

Actual and maximum-permitted uncertainties of measurement are determined for a coverage probability of 95 %. Unless more-specific information is available, the evaluation of the contribution of a specific filter or filter set to a total measurement uncertainty can be based on the acceptance limits and maximum-permitted uncertainties specified in this standard.

American National Standard

Electroacoustics – Octave-band and Fractional-octave-band Filters – Part 1: Specifications (a nationally adopted international standard)

1 Scope

1.1 This part of the ANSI/ASA S1.11 / IEC 61260 series specifies performance requirements for analogue, sampled-data, and digital implementations of band-pass filters. The extent of the pass-band region of a filter's relative attenuation characteristic is a constant percentage of the exact mid-band frequency for all filters of a given bandwidth. An instrument conforming to the requirements of this standard may contain any number of contiguous band-pass filters covering any desired frequency range.

1.2 Performance requirements are provided for two filter classes: class 1 and class 2. In general, specifications for class 1 and class 2 filters have the same design goals and differ mainly in the acceptance limits and the range of operational temperature. Acceptance limits for class 2 are greater than, or equal to, those for class 1. Maximum-permitted expanded uncertainties of measurement are also specified.

1.3 Performance requirements are given for designs where the octave frequency ratio and the mid-band frequencies are powers of ten.

1.4 Band-pass filters conforming to the performance requirements of this standard may be part of various measurement systems or may be an integral component of a specific instrument such as a spectrum analyzer.

1.5 This standard specifies the ranges of environmental conditions for operation of the filters. The required range depends on whether the instrument containing the filters is designed to be operated in a controlled environment or more generally in the field.

1.6 Band-pass filters conforming to the requirements of this standard are capable of providing frequency-band-filtered spectral information for a wide variety of signals, for example, time-varying, intermittent or steady; broadband or discrete frequency; and long or short durations.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-6-1:2005, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-2:2005, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61000-6-3:2006, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments* Amendment 1:2010

IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*

CISPR 22:2008, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM: 1995)*

ISO/IEC Guide 98-4:2012, *Uncertainty of measurement – Part 4: Role of measurement uncertainty in conformity assessment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61000-4-2, IEC 61000-4-3, IEC 61000-6-1, IEC 61000-6-2, and IEC 61000-6-3, as well as the following apply.

3.1

band-pass filter

filter with a single transmission band (or pass-band with small relative attenuation) extending from a lower band-edge frequency greater than zero to a finite upper band-edge frequency

3.2

octave frequency ratio

frequency ratio nominally equal to an octave or a frequency ratio of 2:1

Note 1 to entry: 5.2.1 gives the expression of the octave frequency ratio for this standard.

3.3

bandwidth designator

reciprocal of a positive integer, including 1, to designate the fraction of an octave band

Note 1 to entry: The bandwidth designator is used to designate the nominal bandwidth of the filters in a set of filters, for example, for $1/b = 1/12$, the filters are designated as one-twelfth-octave-band filters.

3.4

reference frequency

single frequency selected to normalize the attenuation response for all band-pass filters in a filter set

Note 1 to entry: The reference frequency is expressed in hertz (Hz).

3.5

exact mid-band frequency

frequency that has a specified relationship to the reference frequency such that the ratio of the exact mid-band frequencies of any two contiguous band-pass filters is the same for all filters in a filter set of a specified bandwidth

Note 1 to entry: Exact mid-band frequency is expressed in hertz (Hz).

3.6**nominal mid-band frequency**

rounded mid-band frequency for the designation of band-pass filters

Note 1 to entry: Nominal mid-band frequency is expressed in hertz (Hz).

3.7**normalized frequency**

for a band-pass filter, ratio of a frequency to the corresponding exact mid-band frequency

3.8**band-edge frequencies**

frequencies at the lower and upper edges of the pass-band of a band-pass filter such that the exact mid-band frequency is the geometric mean of the lower and upper band-edge frequencies

Note 1 to entry: Band-edge frequencies are expressed in hertz (Hz).

3.9**normalized bandwidth of a filter**

relative bandwidth for a given filter, the ratio of the upper band-edge frequency minus the corresponding lower band-edge frequency to the exact mid-band frequency

3.10**octave-band filter**

band-pass filter for which the ratio of upper band-edge frequency to lower band-edge frequency is the octave frequency ratio

3.11**fractional-octave-band filter**

band-pass filter for which the ratio of upper band-edge frequency to lower band-edge frequency is the octave frequency ratio raised to an exponent equal to the applicable bandwidth designator

Note 1 to entry: An octave-band filter is also a fractional-octave-band filter ($1/b = 1/1$).

3.12**signal level****time-average signal level**

at any frequency, ten times the logarithm to the base ten of the ratio of a specified time-mean-square signal to the square of a specified reference value

Note 1 to entry: Time-averaged signal level is expressed in decibels (dB).

3.13**filter attenuation**

at any frequency, for a band-pass filter, the input signal level minus the corresponding output signal level

Note 1 to entry: Filter attenuation is expressed in decibels (dB).

3.14**reference attenuation**

for all band-pass filters in an instrument, nominal filter attenuation in the pass-band for determining relative attenuation

Note 1 to entry: Reference attenuation is expressed in decibels (dB).

3.15

relative attenuation

filter attenuation minus the reference attenuation

Note 1 to entry: Relative attenuation is expressed in decibels (dB).

3.16

normalized response

at any normalized frequency, the anti-logarithm to the base ten of minus one-tenth of the corresponding relative attenuation

3.17

normalized effective bandwidth

integral over normalized frequency of the normalized response of a band-pass filter to constant-amplitude sinusoidal input signals, the normalized response being weighted with the inverse of the normalized frequency

3.18

normalized reference effective bandwidth

normalized effective bandwidth for a band-pass filter having zero relative attenuation in the passband and infinite relative attenuation at other frequencies

3.19

effective bandwidth deviation

ten times the logarithm to the base ten of the ratio of the normalized effective bandwidth of a filter to the normalized reference effective bandwidth

Note 1 to entry: Effective bandwidth deviation is expressed in decibels (dB).

3.20

reference level range

one of the available level ranges specified for testing the electrical performance characteristics of the band-pass filters in a filter set

3.21

reference input signal level

specified reference level of the input signal on the reference level range

Note 1 to entry: The reference input signal level is expressed in decibels (dB).

3.22

level linearity deviation

on any level range at the exact mid-band frequency, if not otherwise specified, an indicated output signal level minus the anticipated output signal level

Note 1 to entry: Level linearity deviation is expressed in decibels (dB).

3.23

linear operating range

for a stated filter and a stated level range, the extent of steady sinusoidal input signal levels over which level linearity deviations do not exceed the applicable limits of this standard

Note 1 to entry: Linear operating range is expressed in decibels (dB).

3.24**level range control**

device for adjusting the sensitivity of a band-pass filter in response to changes in the level of the input signal in order to maintain the overall operation of the filter within the linear operating range

3.25**measurement range**

for any exact mid-band frequency, the range from the lower boundary of the input signal level for the linear operating range on the most-sensitive level range to the upper boundary of the input signal level for the linear operating range on the least-sensitive level range

Note 1 to entry: A measurement range is expressed in decibels (dB).

3.26**analogue filter**

filter that operates continuously on an input signal to produce a filtered output

3.27**sampled-data filter**

computational process that operates on samples of an input signal to produce a filtered output

3.28**digital filter**

subset of sampled-data filters that operates on digitized samples of input data

3.29**time-invariant operation**

operational mode or capability of a system of band-pass filters such that the response to a signal is independent of the time when the signal was applied

3.30**filter decay time**

at a stated frequency, elapsed time required for the output signal level to decrease by 60 dB after sudden cessation of the signal from the input to the filter

Note 1 to entry: Filter decay time is expressed in seconds (s).

3.31**reference orientation**

orientation of a band-pass filter with respect to the principal direction of an emitter or receiver of radio-frequency fields

3.32**group X band-pass filter**

self-contained instrument that includes band-pass filtering facilities conforming to the requirements of this standard and which specifies internal battery power for the normal mode of operation and requiring no external connection to other apparatus to operate the instrument

3.33**group Y band-pass filter**

self-contained instrument that includes band-pass filtering facilities conforming to the requirements of this standard and which specifies connection to a public supply of electrical power for the normal mode of operation and also requiring no external connection to other apparatus to operate the instrument