IEC 61260-1

Edition 1.0 2014-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electroacoustics – Octave-band and fractional-octave-band filters – Part 1: Specifications

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Électroacoustique – Filtres de bande d'octave et de bande d'une fraction d'octave – Partie 1: Spécifications

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IEC 61260-1:2014-02(EN-FR)

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ELECTROACOUSTICS – OCTAVE-BAND AND FRACTIONAL-OCTAVE-BAND FILTERS –

Part 1: Specifications

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International Standard IEC 61260-1 has been prepared by IEC technical committee 29: Electroacoustics.

This first edition of IEC 61260-1, future IEC 61260-2 and future IEC 61260-3, cancel and replace the first edition of IEC 61260 published in 1995, and Amendment 1:2001. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the IEC 61260:

a) the single document in the first edition of IEC 61260:1995 is in IEC 61260 series separated into the three parts covering: specifications, pattern evaluation tests and periodic tests;

b) the IEC 61260:1995 specified three performance categories: classes 0, 1 and 2. The IEC 61260 series specifies requirements for class 1 and 2;

c) in the IEC 61260:1995, the design goals for the specification can be based on base-2 or base 10 design. In IEC 61260 series only base-10 is specified;

d) the reference environmental conditions have been changed from 20 °C / 65 % RH to 23 °C / 50 % RH;

e) IEC 61260:1995 specified tolerance limits without considering the uncertainty of measurement for verification of the specifications. IEC 61260 series specifies acceptance limits for the observed values and maximum-permitted uncertainty of measurements for laboratories testing conformance to specifications in the standard.

The text of this standard is based on the following documents:

FDIS	Report on voting
29/835/FDIS	29/839/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 61260 series, published under the general title *Electroacoustics – Octave-band and fractional-octave-band filters* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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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, 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.

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This first edition of 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.

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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.

ELECTROACOUSTICS – OCTAVE-BAND AND FRACTIONAL-OCTAVE-BAND FILTERS –

Part 1: Specifications

1 Scope

1.1 This part of the 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.

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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 analyser.

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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.

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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

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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

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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).

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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

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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

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

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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

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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

3.34
group Z band-pass filter
instrument that includes band-pass filtering facilities conforming to the requirements of this standard and requiring two or more items of equipment to be connected together by some means for the normal mode of operation, with operation either from batteries or from a public supply of electrical power

Note 1 to entry: If the items communicate by means of radio or optical methods, but are not connected by any conductive device, the items are not connected in this context.

3.35
coverage probability
probability that the set of true quantity values of a measurand is contained within a specified coverage interval

[SOURCE: ISO/IEC Guide 98-4:2012, 3.2.8]

3.36
acceptance limit
specified upper or lower bound of permissible measured quantity values

[SOURCE: ISO/IEC Guide 98-4:2012, 3.3.8]

4 Reference environmental conditions

Reference environmental conditions are as follows:

- temperature 23 °C
- static pressure 101,325 kPa
- relative humidity 50 %

5 Performance requirements

5.1 General

5.1.1 Electrical response characteristics specified in this standard for fractional-octave-band filters apply under the reference environmental conditions of Clause 4, if not otherwise stated.

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5.1.2 Any filter design realization may be utilized provided the resulting filters conform to all applicable requirements of this standard.

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5.1.3 Band-pass filters may be powered by batteries or from external power supply systems.

5.1.4 The configuration of the filter shall be as specified in the Instruction Manual for one of the normal modes of operation, including required accessories.

5.1.5 For filters enclosed in a sound level meter with detachable preamplifier, the signal input to the filter may be, as specified by the supplier, the input of the preamplifier through a suitable input device replacing the microphone, or the terminal where the signal from the preamplifier normally is connected.

5.1.6 Acceptance limits in this standard include allowances for design, manufacturing and aging.

5.1.7 In subsequent subclauses, acceptance limits are provided for allowable values of measured deviations from design goals. Annex A describes the relationship between tolerance interval, corresponding acceptance interval and the maximum-permitted uncertainty of measurement.

5.1.8 For pattern-evaluation tests and periodic tests, the laboratory shall determine that their actual expanded uncertainties, as the 95 % coverage intervals in accordance with ISO/IEC Guide 98-3 and ISO/IEC Guide 98-4, do not exceed the maximum-permitted expanded uncertainties specified in Annex B.

5.1.9 Conformance to the specifications is demonstrated when (a) the measured deviations from the design goals do not exceed the applicable acceptance limits and (b) the corresponding actual expanded uncertainties of measurements does not exceed the corresponding maximum-permitted uncertainty of measurement given in Annex B.

5.1.10 Annex C gives examples of evaluation of conformance to specifications of this standard.

5.2 Octave frequency ratio

5.2.1 For this standard, the octave frequency ratio, G, shall be given by the following expression

$$G = 10^{3/10} \tag{1}$$

5.2.2 The octave frequency ratio calculated from Formula (1) to six significant digits is 1,995 26. Filters designed according to this ratio are designated base-10 filters.

NOTE 1 Filters specified in this standard are by convention called octave-band and fractional-octave band filters.

NOTE 2 For technical reasons, some filters have been designed based on G = 2, exactly. Such filter designs are called base-2 filters. The probability that a base-2 filter conforms to the requirements of this standard decreases as the difference between the mid-band frequency and the reference frequency increases; see Annex D.

5.3 Reference frequency

For the purposes of this standard, the reference frequency, f_r, is 1 000 Hz, exactly.

5.4 Exact mid-band frequencies

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5.4.1 When the denominator of the bandwidth designator is an odd number, the exact mid-band frequencies, f_m, of any filter in a set of filters shall be determined from the following expression

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$$f_m = f_r G^{x/b} \tag{2}$$

where f_r is the reference frequency and $1/b$ is the bandwidth designator, for example 1/1 or 1/3 for octave-band or one-third-octave-band filters, respectively.

5.4.2 When the denominator of the bandwidth designator is an even number, exact mid-band frequencies of any filter in a set of filters shall be determined from the following expression

$$f_m = f_r G^{(2x+1)/(2b)} \tag{3}$$

where x in Formulas (2) and (3) is any integer, positive, negative or zero.

NOTE 1 The outputs of narrow-bandwidth fractional-octave-band filters that have exact mid-band frequencies determined from Formula (2) or Formula (3) can be combined to approximate the band level indicated by a filter of wider bandwidth with a corresponding exact mid-band frequency and corresponding band-edge frequencies.

NOTE 2 When the denominator of the bandwidth designator is an odd number, one of the filters in a complete filter set can have a mid-band frequency of 1 000 Hz. When the denominator of the bandwidth designator is an even number, the band-edge frequencies of an adjacent pair of filters in a complete filter set can be at 1 000 Hz and none of the filters will have a mid-band frequency of 1 000 Hz.

5.5 Nominal mid-band frequencies

Octave-band and fractional-octave-band filters shall be identified, or labelled, by their nominal mid-band frequencies. Annex E provides exact and nominal mid-band frequencies for octave-band and one-third-octave-band filters for the usual range of audio frequencies. Annex E also specifies a procedure for determining the nominal mid-band frequencies for fractional-octave-band filters with other bandwidth designators.