BS EN 61260-3:2016

BSI Standards Publication

Electroacoustics — Octave-band and fractional-octave-band filters

Part 3: Periodic tests

National foreword

This British Standard is the UK implementation of EN 61260-3:2016. It is identical to IEC 61260-3:2016. Together with BS EN 61260-1:2014 and BS EN 61260-2:2016, it supersedes BS EN 61260:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/29, Electroacoustics.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Electroacoustics - Octave-band and fractional-octave-band filters - Part 3: Periodic tests (IEC 61260-3:2016)

Electroacoustique - Filtres de bande d'octave et de bande d'une fraction d'octave - Partie 3: Essais périodiques (IEC 61260-3:2016)

Elektroakustik - Bandfilter für Oktaven und Bruchteile von Oktaven - Teil 3: Periodische Einzelprüfung (IEC 61260-3:2016)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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European foreword

The text of document 29/846/CDV, future edition 1 of IEC 61260-3, prepared by IEC TC 29, Electroacoustics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61260-3:2016.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2017-01-27
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2019-04-27

This document supersedes EN 61260:1995.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61260-3:2016 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)
Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 61260-1	2014	Electroacoustics - Octave-band and fractional-octave-band filters -- Part 1: Specifications	EN 61260-1	2014
IEC 61260-2	2016	Electroacoustics - Octave-band and fractional-octave-band filters - Part 2: Pattern-evaluation tests	EN 61260-2	2016
IEC 61672-1	-	Electroacoustics - Sound level meters -- Part 1: Specifications	EN 61672-1	-
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	-	Uncertainty of measurement -- Part 4: Role of measurement uncertainty in conformity assessment	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 3: Periodic tests

FOREWORD

International Standard IEC 61260-3 has been prepared by IEC technical committee 29: Electroacoustics.

This first edition of IEC 61260-3 (together with IEC 61260-1:2014 and IEC 61260-2:2016), cancels and replaces the first edition of IEC 61260 published in 1995 and its Amendment 1 published in 2001. This edition constitutes a technical revision.

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

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

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

c) In IEC 61260:1995, the design goals for the specification can be based on base-2 or base-10 design. In the 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 while the 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:

CDV	Report on voting
29/846/CDV	29/882A/RVC

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 of 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 website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

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

- Part 1: Specifications
- Part 2: Pattern evaluation tests
- Part 3: Periodic tests

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 the 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.

This edition of IEC 61260-3 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.

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

Part 3: Periodic tests

1 Scope

1.1 This part of IEC 61260 describes procedures for periodic testing of octave-band and fractional-octave-band filters that were designed to conform to the class 1 or class 2 specifications given in IEC 61260-1:2014. The aim of this standard is to ensure that periodic testing is performed in a consistent manner by all laboratories.

1.2 The purpose of periodic testing is to assure the user that the performance of an octave-band and fractional-octave-band filter conforms to the applicable specifications of IEC 61260-1 for a limited set of key tests and for the environmental conditions under which the tests were performed.

1.3 The extent of the tests in this standard is deliberately restricted to the minimum considered necessary for periodic tests.

1.4 Periodic tests described in this standard apply to filters for which the manufacturer claims conformance to the specifications in IEC 61260-1:2014. Periodic tests in this standard apply to filters for which the model has been, or has not been, pattern approved by an independent testing organization responsible for pattern approvals in accordance with the test procedures of IEC 61260-2.

1.5 Because of the limited extent of the periodic tests, if evidence of pattern approval is not publicly available, no general conclusion about conformance to the specifications of IEC 61260-1 can be made, even if the results of the periodic tests conform to all applicable requirements of this standard.

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 61260-1:2014, *Electroacoustics – Octave-band and fractional-octave-band filters – Part 1: Specifications*

IEC 61260-2:2016, *Electroacoustics – Octave-band and fractional-octave-band filters – Part 2: Pattern-evaluation tests*

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

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, *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 61260-1, ISO/IEC Guide 98-3 and ISO/IEC Guide 98-4 apply.

4 Submission for testing

4.1 An instruction manual applicable to the model and version of the filter shall be available in order to perform periodic tests of a filter. If an applicable instruction manual is not submitted along with the filter, nor available at the calibration laboratory, nor publicly accessible from the Internet web site of the manufacturer or supplier of the filter, then no periodic tests shall be performed.

4.2 The source for the instruction manual shall be described in the documentation for the periodic tests.

4.3 All items or accessories for the filter that are necessary for periodic testing shall accompany the filter when it is submitted for testing.

4.4 Periodic tests as described in this standard shall not be performed unless the markings on the filter are as required by IEC 61260-1 or there is evidence that the filter was originally so marked. At least the serial number and the model designation shall be visible on the filter or instrument containing the filter.

4.5 Data required to perform the periodic tests shall be available, and the source of the data shall be recorded and reported by the laboratory. The data shall include all relevant information required by IEC 61260-1.

5 Conformance

5.1 Conformance to a performance specification is demonstrated when the following criteria are both satisfied:

a) a measured deviation from a design goal does not exceed the applicable acceptance limit and;
b) the corresponding uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty of measurement given in IEC 61260-1 for the same coverage probability of 95 %.

IEC 61260-1:2014 gives example assessments of conformance using these criteria.

5.2 Laboratories performing periodic tests shall calculate all uncertainties of measurements in accordance with the guidelines of ISO/IEC Guide 98-3. Actual measurement uncertainties shall be calculated for a coverage probability of 95 %. Calculation of the actual measurement uncertainty for a particular test should consider at least the following components, as applicable:

- the uncertainty attributed to calibration of the individual instruments and equipment used to perform the test;
- the uncertainty resulting from environmental effects or adjustments;
- the uncertainty resulting from errors that may be present in the applied signals;
- the uncertainty attributed to effects associated with the repeatability of the results of the measurements. When a laboratory is only required to perform a single measurement, it is necessary for the laboratory to make an estimate of the contribution of random effects to the total uncertainty. The estimate should be determined from an evaluation of several measurement results previously obtained for a similar filter and parameter;

- the uncertainty associated with the resolution of the applied display device. For digital display devices that indicate signal levels with a resolution of 0,1 dB, the uncertainty component should be taken as a rectangular distribution with semi-range of 0,05 dB; and
- the uncertainty associated with each correction applied to the measurement data.

5.3 If an actual uncertainty of measurement for a test performed by the laboratory exceeds the corresponding maximum-permitted uncertainty, the result of the test shall not be used to evaluate conformance to this standard for periodic testing.

6 Preliminary inspection

Prior to any measurements, the filter and all accessories shall be visually inspected to ensure that the filter is in normal working order. All relevant controls shall be operated to ensure that they are in working order. If the controls or other essential elements are not in proper working order, no periodic tests shall be performed.

7 Power supply

For all tests, the filter shall be powered from its preferred supply or a suitable alternative. Before and after conducting the set of tests, the power supply for the filter shall be checked by the method stated in the instruction manual to ensure that it is within the specified operating limits. If the voltage or the equivalent indication of the status of the power supply is not within the operating limits and the reason cannot be attributed to partially discharged batteries or an incorrect selection of the voltage of the public power supply, then no periodic tests shall be performed as a malfunction is indicated.

8 Environmental conditions

8.1 Periodic tests shall be performed within the following ranges of environmental conditions: 20 °C to 26 °C for air temperature, and 25 % to 70 % for relative humidity.

8.2 As a minimum, the air temperature and the relative humidity shall be measured and recorded at the start and end of periodic testing. The recorded values expanded with the actual expanded uncertainty of measurement shall not exceed the limits in 8.1.

9 Mandatory facilities and general requirements

9.1 General

9.1.1 No test specified in this standard shall be omitted unless the bandpass filter does not possess the feature described for the test.

9.1.2 If the filter does not possess the mandatory features listed in IEC 61260-1, including an overload indicator and means to check that the power supply is adequate for battery powered instruments which contain the filter, the filter does not conform to the specifications of IEC 61260-1, and no periodic tests shall be performed.

9.1.3 If, for an instrument containing filters with more than one bandwidth, the supplier claims conformance to IEC 61260-1, each bandwidth for which the supplier claims conformance shall demonstrate conformance to the specifications in this standard, otherwise the instrument does not conform to the requirement in this standard.

9.1.4 For all periodic tests, the configuration of the filter shall be as specified in the instruction manual for one of the normal modes of operation, including required accessories. The input and output terminals shall be terminated with the impedances specified by the supplier, if appropriate.

9.1.5 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.

9.1.6 For filters with digital readout devices, or with an output that is available in a manufacturer-specified digital format (for example over a digital interface connection), the level of the output should be determined from the numeric readout or via the digital output to a suitable display or recording device.

9.1.7 If the filter is enclosed in an instrument containing a level detector and a display device for displaying the level of the filtered signal with a resolution of at least 0,1 dB, the displayed value from this display device shall be used for testing. If an electrical output is provided corresponding to the displayed value and the testing laboratory intends to utilize the electrical output instead of the display device, the laboratory shall verify that changes in the levels of applied electrical input signals produce corresponding changes in the signal levels indicated on the display device and at the electrical output that are in accordance with the specifications of IEC 61260-1. Where multiple outputs are present, if an output is specified in the instruction manual for testing, this output should be used for the periodic tests.

9.1.8 For filters that are designed to operate with measuring devices that comply with the requirements for sound level meters as specified in IEC 61672-1, the display indicator of this device shall be used to measure the level of the output signal from the filter.

9.1.9 If the instruction manual specifies a procedure for adjusting the filter, e.g. sensitivity adjustment, this procedure shall be followed before any measurements are performed.

9.1.10 The filter shall be allowed to reach equilibrium with the prevailing environmental conditions before switching on the power to perform a test.

9.1.11 As appropriate, the laboratory shall utilize the recommendations given in the instruction manual for performing the periodic tests.

9.1.12 If the filter has more than one signal-processing channel, periodic tests shall be performed for each channel that utilizes unique signal processing techniques. For multi-channel systems with the same functional equivalence in all channels, the number of channels to be tested may be less than the total number of channels, at the discretion of the testing laboratory.

9.1.13 The number of channels tested may also be limited by the customer. In this case, the test report, and possibly any calibration marks on the instrument, shall clearly indicate that the reported results are only valid for the channels tested.

9.1.14 During periodic tests, as described in this standard, extensive tests are only performed on a limited number of filters in a set of filters. Should any test not meet the requirements of this standard, the set of filters does not conform to the specifications of IEC 61260-1.

9.1.15 If, during testing, the test laboratory uncovers evidence that the set of filters do not comply with the requirements of IEC 61260-1 in general, even if all tests carried out as specified in this standard do meet the requirements of IEC 61260-1, the filter set shall be reported as having passed all tests specified in this standard, but with a note detailing where the filter set does not conform to IEC 61260-1 and making it clear the filter set overall does not comply with IEC 61260-1.

9.2 Test instruments

9.2.1 The laboratory shall use instruments that have been calibrated for the appropriate quantities at appropriate intervals. As required, the calibrations shall be traceable to national measurement standards.

9.2.2 Most of the required tests utilize steady sinusoidal signals of various frequencies and signal levels. Sinusoidal signals for testing filter attenuation shall have a total distortion including noise of not more than 0,01 % for class 1 filters and not more than 0,03 % for class 2 filters. The total distortion for other sinusoidal signals shall not exceed 0,3 %.

9.2.3 Measurement of the effective bandwidth deviation may use a constant amplitude sinusoidal signal the frequency of which is varied, or swept, at an exponential rate. The uncertainty of the measured deviation due to the uncertainty in the amplitude and sweep-rate shall be calculated. The expanded uncertainty shall not exceed the limits given in IEC 61260-1 for test of time invariant operation.

NOTE See Annex B for an example of measuring effective bandwidth using an exponential swept sine. See Annex A for information regarding the computation of uncertainty due to using a swept sine as input.

9.2.4 Instruments for measuring the environmental conditions during the tests shall have an uncertainty appropriate to ensure that the requirements in 8.1 are maintained.

10 Test of relative attenuation at midband frequency or effective bandwidth deviation

10.1 General

10.1.1 The purpose of the tests in Clause 10 is to demonstrate that every filter in a set of filters is in working order since more extensive tests are only performed on a limited number of filters in a set of filters.

10.1.2 The test may either be performed as the measurement of the relative attenuation at the midband frequency of every filter in a set, or alternatively, by measurement of the response to an exponential, sinusoidal sweep covering all filters in a set. For time invariant filters, the response to an exponential sweep corresponds to a measurement of the effective bandwidth deviation. The tests are described in 10.2 and 10.3 respectively. For time invariant filters, testing may be made using either the tests in 10.2 or 10.3, at the choice of the testing laboratory. For filters not being time invariant, only tests in 10.2 apply.

10.2 Tests of relative attenuation at midband frequency

10.2.1 The relative attenuation at the exact midband frequency shall be measured for every filter in a set of filters. The relative attenuation $\Delta A(\Omega)$ at any midband frequency is determined from Formula (8) given in IEC 61260-1:2014. The reference level range shall be selected for the test. The level of the test signal shall be equal to the reference input signal level.

10.2.2 The measured relative attenuation shall not exceed the acceptance limits ± 0,4 dB for Class 1 filters or ± 0,6 dB for class 2 filters as specified in 5.10 in IEC 61260-1:2014.

10.3 Test of effective bandwidth deviation

10.3.1 The effective bandwidth deviation of each filter in a set of filters shall be measured by a swept-frequency test as described in 5.14 in IEC 61260-1:2014 for the test for time-invariant operation. The test shall be conducted on the reference level range. The level of the input signals shall be (3 ± 0,1) dB less than the upper boundary of the linear operating range on the reference level range.

10.3.2 The sweep shall start at the frequency, f_{start}, being lower than the lowest bandedge frequency for the filter with the lowest midband frequency in the filter set and where the relative attenuation for this filter is at least 55 dB. The sweep shall end at a frequency, f_{end}, higher than the highest bandedge frequency for the filter with the highest midband frequency in the filter set, and where the relative attenuation is at least 55 dB.

10.3.3 The sweep shall have constant amplitude, and the frequency of the signal shall be increased at a constant exponential rate as described in Annex G of IEC 61260-1:2014. The sweep rate shall correspond to one decade in frequency in not less than 2 s.

10.3.4 The time-averaged level of the output signal is measured for an averaging time, T_{avg}, which starts no later than the time when the sweep frequency is less than the lowest midband frequency and where the relative attenuation of a filter is at least 55 dB, and ends at a time not less than when the sweep frequency is greater than the highest midband frequency where the relative attenuation of the filter is again at least 55 dB.

The averaging time shall be sufficiently long to also contain parts of the output signal delayed by the operation of the filter. See Annex G in IEC 61260-1:2014 for more information. Annex B gives an example of how the test may be performed.

10.3.5 The measured time-average or equivalent-continuous output signal level for each filter in the set shall be compared with the calculated value, L_{c}, given in Formula (17) in IEC 61260-1:2014.

10.3.6 For each filter in a filter set, the acceptance limits for the deviation of a measured time-averaged output signal level, L_{out}, from the corresponding constant theoretical time-averaged output signal level, L_{c}, as determined according to Formula (17) in IEC 61260-1:2014, are ± 0,4 dB for class 1 filters and ± 0,6 dB for class 2 filters.

10.3.7 Both the amplitude and the sweep-rate shall be considered when the uncertainty of measurement is calculated.

NOTE See Annex A for further information about uncertainties related to tests by sinusoidal sweeps.

11 Linear operating range, measurement range, level range control and overload indicator

11.1 Linearity of the response of a filter resulting from changes in the level of the signal at the input shall be tested with steady sinusoidal signals with specified level and frequency. The linearity shall be measured at the exact midband frequency. The level linearity deviation shall be determined in accordance with 5.13 in IEC 61260-1:2014.

11.2 For an input signal at midband frequency and reference input signal level, the level linearity deviation is zero on the reference level range.

11.3 The level linearity shall be tested for three filters in a set of filters. The filters for the test shall be selected by the laboratory performing the test, if not required otherwise. The filters selected shall represent filters in the lower, in the middle and in the higher range of midband frequencies for the set of filters. For a set of filters covering the audible range of frequencies, it is recommended to test filters with frequencies close to 31,5 Hz,1 kHz and 16 kHz.

11.4 The level range control shall be set to select the reference level range. The level of the input signal shall first be set to the specified reference input signal level. The corresponding output level shall be used for calculating the level linearity deviation for all input levels at any level range for the particular filter.

11.5 The test shall be performed on the reference level range for levels from the specified lower boundary of the specified linear operating range up to a level where the overload indicator displays an overload. Adjust the level of the input signal with steps that are not greater than 5 dB. The difference between successive steps of the input signal level shall be reduced to 1 dB when the distance to the lower or upper boundaries of a linear operating range is less than 5 dB and when the level is above the upper boundary. The boundaries are as stated in the instruction manual for the filter. If no overload is displayed, the filter does not conform to the requirements.

11.6 The averaging time during a measurement shall be long enough to establish a stable indication considering the actual frequency and the influence of internally generated noise at low input signal levels.

11.7 The measured level linearity deviation shall not exceed the acceptance limits given in 5.13 in IEC 61260-1:2014 for all measured levels between the lower boundary of the linear operating range, as stated in the instruction manual for the filter, and up to the highest level, measured as described above, without an overload indication.

11.8 An overload shall not be indicated if the level of the input signal is below the stated upper boundary of each appropriate linear operating range.

11.9 For the same three filters as selected above, test each available level range in the following way: based on the same reference level, adjust the input level to be 30 dB below upper boundary of the linear operating range for each of the selected range settings. The measured level linearity deviation shall not exceed the acceptance limits given in 5.13.3 and 5.13.4 of IEC 61260-1:2014.

12 Test of lower limit of linear operating range

12.1 The test in Clause 12 is an abbreviated test to verify that the self-generated noise in the filter is lower than the lower limit of the linear operating range. The test shall be performed on the reference level range and on the level range with the highest sensitivity.

12.2 Short-circuit the input terminal or use similar means to ensure that the level of the input signal is below the lower limit of the specified linear operating range. Record the output level from each filter in the set. The output level shall not exceed the specified lower limit for the appropriate filter and range.

13 Measurement of relative attenuation

13.1 The relative attenuation on the reference level range shall be tested for the same three filters as selected in Clause 11.

13.2 The measurements of relative attenuation are made as the response to constant amplitude sinusoidal signals at various frequencies. The level of the input signals shall be (1 ± 0,1) dB below the specified upper boundary of the linear operating range.

13.3 The normalized frequency $\Omega_k = f_k/f_m$, of the sinusoidal test signal for each filter with midband frequency, f_m, shall be calculated by the following formula:

$$\Omega_k = 1 + \frac{G^{1/(2b)} - 1}{G^{1/2} - 1}(R_k - 1) \quad (1)$$

where

G is the octave frequency ratio;

b is the inverse of the bandwidth designator;

R_k is a frequency parameter defined in Table 1;

k is a whole number in the range 0, 1,...7

The list of normalized frequencies for test shall be extended by:

$$\Omega_{-k} = 1/\Omega_k \tag{2}$$

Where Ω_k and Ω_{-k} have the same acceptance limits on relative attenuation.

NOTE 1 The specifications in this clause are an abbreviation of the general requirements in 5.10 and Table 1 of IEC 61260-1:2014.

NOTE 2 For octave-band filters, $\Omega_k = R_k$.

NOTE 3 Annex C shows an example calculation for one-third-octave-band filters.

Table 1 – Frequency parameter *R* and acceptance limits on relative attenuation for fractional-octave-band filters

Index k	**Frequency parameter** R_k	**Minimum; maximum acceptance limits on relative attenuation** dB	
		Class 1	**Class 2**
0	$G^0 = 1$	-0,4; +0,4	-0,6; +0,6
1	$G^{1/8}$	-0,4; +0,5	-0,6; +0,7
2	$G^{1/4}$	-0,4; +0,7	-0,6; +0,9
3	$G^{3/8}$	-0,4; +1,4	-0,6; +1,7
4	G	+16,6; +∞	+15,6; +∞
5	G^2	+40,5; +∞	+39,5; +∞
6	G^3	+60; +∞	+54; +∞
7	G^4	+70; +∞	+60; +∞

13.4 Each of the filters selected for test of relative attenuation shall be tested with the normalized frequency as specified in 13.3 for k in the range −7, −6...7 as long as the frequencies applied are above 0,5 times the exact midband frequency of the filter in the set with the lowest midband frequency, and below 1,5 times the midband frequency of the filter in the set with the highest midband frequency for all filters in the filter set.

13.5 Deviation between actual and requested frequency shall be considered when stating the uncertainty for testing of relative attenuation. The expanded uncertainty of measurement shall not exceed the corresponding maximum-permitted uncertainty of measurement given in Annex B of IEC 61260-1:2014.

13.6 The measured relative attenuation shall not exceed the acceptance limits given in Table 1 for the appropriate class of filter.

14 Documentation

The documentation of the periodic test shall contain at least the following information, as applicable, unless national regulations require otherwise:

a) the date(s) when the periodic tests were performed;

b) the statement: ‘Periodic tests were performed in accordance with procedures from IEC 61260-3;

c) a statement of the availability of (and, if available, a reference to) evidence, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of filter submitted for periodic testing successfully completed the applicable pattern-evaluation tests given in IEC 61260-2;

d) the name and location of the laboratory performing the periodic tests;

e) the name of the manufacturer or supplier, model designation, serial number, and performance class of the filter and, if applicable, the version of the internal operating software loaded in the filter;

f) if the filter is a multi-channel device, a designation of which channels were selected for testing;

g) a unique description of the instruction manual relating to the filter including, as applicable, the publication date and version number; for instruction manuals downloaded from an Internet website, the date of the download as well as any unique descriptive information;

h) a statement of the reference level and reference level range for the filter;

i) a description of the configuration of the filter for the tests including any connecting cables that were provided to operate the filter;

j) the ranges of the air temperature and relative humidity measured during the testing;

k) when evidence was publicly available to show that pattern-evaluation tests had been performed in accordance with IEC 61260-2 to demonstrate that the model of filter conformed to all applicable specifications of IEC 61260-1 and the results of all periodic tests according to this standard were satisfactory, a statement as follows:

   "The filter submitted for testing successfully completed the periodic tests of IEC 61260-3, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organization responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61260-2, to demonstrate that the model of filter fully conformed to the class Y specifications in IEC 61260-1:2014 the filter submitted for testing conforms to the class Y specifications of IEC 61260-1:2014."

l) when no evidence was publicly available to show that pattern-evaluation tests had been performed in accordance with IEC 61260-2 to demonstrate that the model of filter conformed to all applicable specifications of IEC 61260-1 and the results of all periodic tests according to this standard were satisfactory, a statement as follows:

   "The filter submitted for testing successfully completed the periodic tests of IEC 61260-3, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the filter to the full specifications of IEC 61260-1:2014 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of filter fully conformed to the class Y specifications in IEC 61260-1:2014 and (b) because the periodic tests of IEC 61260-3 cover only a limited subset of the specifications in IEC 61260-1:2014."

m) when the results of the periodic tests for the filter are not satisfactory for the designated performance class, a statement as follows:

   "The filter submitted for periodic testing did not successfully complete the class Y tests of IEC 61260-3. The filter did not conform to the class Y specifications of IEC 61260-1:2014."

   In addition, the documentation shall indicate which tests were not successfully completed and the reasons therefore.

   NOTE Examples of reasons why tests were not successfully completed can be "Measured level linearity deviations exceeded the applicable acceptance limits" or "Measured deviations from the design goal for relative attenuation exceeded the applicable acceptance limits."

n) When all tests carried out as specified in IEC 61260-3 do meet the requirements of IEC 61260-1, during testing, but the test laboratory uncovers evidence that other filters in the set of filters do not comply with the requirements of IEC 61260-1, a statement as follows:

"The filter submitted for testing successfully completed the periodic tests of IEC 61260-3 to the class Y specifications. However, during the test it was found evident that ...(description of the observation) ... did not conform to the general requirements in IEC 61260-1. The filter did not conform to the class Y specifications of IEC 61260-1:2014."

In the above statements, replace class Y with class 1 or class 2, as appropriate.

o) If results of measurements of deviations from the design goals are provided by a laboratory to a customer, each test result should give the measured deviation from the design goal along with the associated acceptance limits and actual expanded uncertainty for each measurement.

Annex A
(informative)

Uncertainty related to test by sinusoidal sweeps

A.1 General

A.1.1 For time invariant filters, a constant-amplitude sinusoidal signal with a frequency increasing at an exponential rate may be used for measurement of the effective bandwidth deviation. The uncertainty in measured output level will depend on the uncertainty in the amplitude and the uncertainty in the sweep rate for the test signal. This informative annex gives information of how the uncertainties in the test signal may be obtained.

A.1.2 If a close approximation to an exponential sweep with a constant amplitude sinusoidal signal from a lower frequency, f_{start}, to a higher frequency f_{end} can be assumed, Formula (17) in IEC 61260-1:2014 may be used for the estimation of the uncertainty in the measured output level. The following symbols are used:

$u_{L_{\text{in}}}$ standard uncertainty of the input level L_{in} (amplitude);

$u_{T_{\text{sweep}}}$ standard uncertainty of elapsed time T_{sweep} (time) for the sweep from the start frequency, f_{start}, to the end frequency, f_{end};

$u_{T_{\text{avg}}}$ standard uncertainty of the averaging time, T_{avg} (time) used to measure the response;

$u_{f_{\text{end}}}$ standard uncertainty of the end frequency for the sweep f_{end} (frequency);

$u_{f_{\text{start}}}$ standard uncertainty of the start frequency for the sweep f_{start} (frequency).

Additional uncertainties, such as uncertainty related to how close the sweep is to an exponential sweep, uncertainty related to the frequency, shape or distortion of the signal and uncertainty related to the adjustment and reading of the values, may apply.

A.1.3 The relation between the standard uncertainty $u_{L_{\text{C}}}$ in the output level, L_{C}, and the standard uncertainties defined above, may be found from the referred Formula (17) in IEC 61260-1:2014

$$u_{L_{\text{C}}} = \left[\left(\frac{\partial L_{\text{C}}}{\partial L_{\text{in}}} \right)^2 \cdot u_{L_{\text{in}}}{}^2 + \left(\frac{\partial L_{\text{C}}}{\partial T_{\text{sweep}}} \right)^2 \cdot u_{T_{\text{sweep}}}{}^2 + \left(\frac{\partial L_{\text{C}}}{\partial T_{\text{avg}}} \right)^2 \cdot u_{T_{\text{avg}}}{}^2 + \left(\frac{\partial L_{\text{C}}}{\partial f_{\text{end}}} \right)^2 \cdot u_{f_{\text{end}}}{}^2 + \left(\frac{\partial L_{\text{C}}}{\partial f_{\text{start}}} \right)^2 \cdot u_{f_{\text{start}}}{}^2 \right]^{1/2} \text{dB} \qquad \text{(A.1)}$$

This may be simplified to:

$$u_{L_{\text{C}}} = \left[u_{L_{\text{in}}}{}^2 + \left(\frac{10}{\ln(10)} \right)^2 \times \left(\frac{u_{T_{\text{sweep}}}}{T_{\text{sweep}}} \right)^2 + \left(\frac{10}{\ln(10)} \right)^2 \times \left(\frac{u_{T_{\text{avg}}}}{T_{\text{avg}}} \right)^2 + \left(\frac{10}{\ln\left(f_{\text{end}} / f_{\text{start}} \right) \times \ln(10)} \right) \times \left[\left(\frac{u_{f_{\text{end}}}}{f_{\text{end}}} \right)^2 + \left(\frac{u_{f_{\text{start}}}}{f_{\text{start}}} \right)^2 \right] \right]^{1/2} \text{dB}$$

(A.2)

A.2 Digitally generated signal

A.2.1 The sweep signal may be generated as a digital signal with a constant sampling frequency where each sample of the signal is computed by a mathematical operation with known uncertainty. The signal may be converted by a digital-to-analogue system to generate the required analogue test signal. The uncertainty in the test signal will then be the combined uncertainty in the mathematically generated digital signal, the uncertainty in the sampling frequency and the uncertainty in the digital-to analogue-converter.

A.2.2 The sampling frequency of the system may be verified by playing a mathematically generated signal with a known and constant frequency and measuring the frequency by a frequency counter. The uncertainty in the sweep rate will mainly be determined from the accuracy in the mathematically generated sweep and the uncertainty in the sampling frequency.

A.2.3 The amplitude uncertainty of the digital-to-analogue system may be measured with a mathematically generated signal with fixed frequency and known amplitude. The level of the signal may then be measured by a voltmeter. The amplitude uncertainty should be tested at all frequencies where high accuracy is relevant for the requested sweep. This will normally cover the combined frequency range for the lowest band-edge frequency to the highest band-edge frequency in the set of filters to be tested.

A digital sweep signal s_n with effective value 1,0 may be generated by the formula below where n is the sample number and f_s is the sampling frequency. n is then a sequence of whole numbers from zero up to the whole number closest to $f_s \times T_{\text{sweep}}$. The sweep rate, r, is given by:

$$r = \frac{1}{T_{\text{sweep}}} \times \ln\left(\frac{f_{\text{end}}}{f_{\text{start}}}\right) \qquad \text{(A.3)}$$

The samples may be calculated by the formula:

$$s_n = \sqrt{2}\,\sin\left(\frac{2\pi}{r} \times f_{\text{start}} \times \left[\exp\left(\frac{r}{f_{\text{s}}}n\right) - 1\right]\right) \qquad \text{(A.4)}$$

A.3 Test signal from a signal generator

A.3.1 Signal generators able to generate a constant-amplitude sinusoidal signal with a frequency increasing at an exponential rate are available. However, some generators deliver only a crude approximation to the exponential sweep with an unknown uncertainty in the sweep rate. With sufficient information from the manufacturer of the generator, an uncertainty calculation as described in Clause B.1 may be applied. If such information is not available, or the information is not suitable, the sweep rate and uncertainty in level has to be measured.

A.3.2 The test signal from the generator may be measured by a system where the signal is sampled at a known sampling frequency by an analogue-to-digital system with known uncertainty in measurement. By signal analysis of the recorded signal, the instantaneous level of the sweep signal and the instantaneous frequency and thus the sweep rate may be determined. See [1][1] for further information.

A.3.3 Some generators deliver the end frequency just before the sweep is started. This creates an unwanted transient, and such generators are therefore not regarded suitable for the test.

1 Numbers in square brackets refer to the Bibliography.

A.3.4 Some sweep generators may halt at the end frequency a specified time before the sweep is ended and the frequency returned to the start frequency. This may be very convenient to prevent the return to the start frequency from disturbing the measurement.

A.3.5 The formula (A.2) may be used for the following example calculation for uncertainty in the test signal.

The input signal is measured to be constant within an uncertainty of 0,03 dB, and is adjusted by reading a display with resolution 0,1 dB. This gives

$$u_{L_{\text{in}}} = \sqrt{\left({0{,}1\,\text{dB}} \middle/ {2\sqrt{3}} \right)^2 + (0{,}03\,\text{dB})^2} \approx 0{,}042\,\text{dB}$$

The following values and uncertainties are assumed:

$$T_{\text{sweep}} = 20\,\text{s} \qquad u_{T_{\text{sweep}}} = 0{,}05\,\text{s}$$

$$T_{\text{avg}} = 20\,\text{s} \qquad u_{T_{\text{avg}}} = 0{,}02\,\text{s}$$

$$f_{\text{end}} = 50\,000\,\text{Hz} \qquad u_{f_{\text{end}}} = 5\,\text{Hz}$$

$$f_{\text{start}} = 0{,}5\,\text{Hz} \qquad u_{f_{\text{start}}} = 0{,}05\,\text{Hz}$$

This gives $u_{L_c} \approx 0{,}057\,\text{dB}$ or an expanded uncertainty of the test signal of 0,115 dB.

If the result is indicated on a display which also has a resolution of 0,1 dB, this uncertainty from the resolution has to be added. The expanded uncertainty of the displayed value will then be 0,128 dB. Some uncertainties may be added to account for the approximation to an exponential sweep and for repeatability.

A.4 Comparing measurements

If the filter is time-invariant, the effective bandwidth deviation may be measured by two methods: the exponential sweep method as described in this informative annex, and by the frequency-by frequency measurement described in 7.2.3 of IEC 61260-2:2016. The effective bandwidth deviations calculated from the results are expected to coincide within the uncertainty of measurement.

Annex B
(informative)

Test of effective bandwidth deviation with the use of an exponential sweep – Example

B.1 General

This example shows how an exponential sweep may be used for measurement of the effective bandwidth deviation. The filters to be tested are assumed to be a set of one-third-octave bandpass filters in the range from 6,3 Hz to 20 kHz. The filters are contained in an integrating-averaging sound level meter, and the display device in the sound level meter is used for reading the averaged output level.

B.2 Example

B.2.1 A signal generator with verified performance is assumed to delivers the test signal. The output from the generator is coupled to the input terminal of the filter. The generator is set to deliver 1 V at 1 kHz. The sound level meter/filter is set to the reference level range. The sensitivity of the sound level meter is adjusted to display 120 dB for this input level according to the assumed recommendations from the manufacturer. The sound level meter then displays signal level in decibels relative to 1 µV. The upper boundary of the reference level range is assumed to be 130 dB. The sweep shall be performed at 3 dB below this level or at 127 dB relative to 1 µV.

B.2.2 The signal generator is set up for a sweep from 0,01 Hz to 1 MHz with the amplitude corresponding to the requested level 127 dB. This corresponds to a sweep range of 8 decades. The required sweep rate corresponds to at least 2 s per decade. If the sweep time is set to 30 s, this corresponds to 3,75 s per decade. The signal generator allows the sweep to be started manually. Before the sweep is started, the generator delivers a signal with the frequency selected as the start frequency. When the sweep is ended, the frequency is immediately returned to the start frequency. This may create a deviation in the measured level if the transient from the return of the frequency is a part of the averaging period.

B.2.3 The sweep time in the generator and the averaging time for the sound level meter are both set to 30 s. The sweep is manually started about 0,5 s to 1,5 s <u>after</u> the integration in the sound level meter is started. Therefore the averaging is ended before the sweep is finished by the same amount of time. The sweep frequency when the averaging is finished will therefore be in the range 398 kHz to 736 kHz, which is well above the upper bandedge frequency 22,39 kHz for the filter with the highest midband frequency and also above the frequency where the attenuation is at least 55 dB. The transient when the sweep frequency is returned to the start frequency will, with these settings, be outside the averaging interval.

B.2.4 The expected output level, L_{C}, may be computed from Formula (17) in IEC 61260-1:2014:

$$L_{\mathrm{C}} = L_{\mathrm{in}} - A_{\mathrm{ref}} + 10\,\lg\left[\frac{T_{\mathrm{sweep}}}{T_{\mathrm{avg}}}\;\frac{\lg\left(f_2/f_1\right)}{\lg\left(f_{\mathrm{end}}/f_{\mathrm{start}}\right)}\right]\ \mathrm{dB} \qquad \text{(B.1)}$$

where

L_{in} = 127 dB re 1 µV;

A_{ref} = 0 dB.

The ratio between the sweep time and averaging time is:

$$\frac{T_{\text{sweep}}}{T_{\text{avg}}} = \frac{30\,\text{s}}{30\,\text{s}} = 1 \qquad \text{(B.2)}$$

The ratio between the upper and lower bandedge frequency of the filter is for one-third-octave filter:

$$\frac{f_2}{f_1} = \frac{10^{0,05}}{10^{-0,05}} = 1,259... \qquad \text{(B.3)}$$

The ratio between the end frequency and the start frequency for the sweep is:

$$\frac{f_{\text{end}}}{f_{\text{start}}} = \frac{1\text{MHz}}{0,01\text{Hz}} = 10^8 \qquad \text{(B.4)}$$

This gives the following value for L_C:

$$L_\text{C} = 127\,\text{dB} - 19,03\,\text{dB} = 107,97\,\text{dB} \qquad \text{(B.5)}$$

B.2.5 The difference between the measured output level and the level, L_C, calculated above, is regarded as the effective bandwidth deviation.

B.2.6 The one-third-octave filter with the lowest midband frequency will typically have the longest impulse-response. The averaging period will end 6 s to 7 s after the sweep frequency is equal to the lowest midband frequency, 6,3 Hz. Normally the tail of the impulse response for this filter will be very small when the averaging ends. If this is not the case, the test may be modified to a test where both the sweep time and averaging time are increased, e.g. both set to 100 s. In this case, since the sweep time and averaging time are equal, the calculation in Clause B.2.4 remains valid.

Annex C
(informative)

Normalized frequencies for test of one-third-octave-band filters

C.1 General

This annex provides an example calculation of the normalized frequencies for testing of one-third-ocave-band filters. The 15 test frequencies specified in 13.4 are calculated and listed in Table C.1 together with the applicable acceptance levels.

C.2 Example calculation

For example, let k = 1. From Table 1, the frequency parameter is

$$R_1 = G^{1/8} = 10^{3/80} \tag{C.1}$$

The corresponding normalized frequency is

$$\Omega_1 = 1 + \frac{G^{1/6} - 1}{G^{1/2} - 1}(R_1 - 1) \tag{C.2}$$

Formula (C.2) may be reduced to

$$\Omega_1 = 1 + \frac{10^{1/20} - 1}{10^{3/20} - 1}(10^{3/80} - 1) \approx 1{,}026\ 67 \tag{C.3}$$

The corresponding inverse normalized frequency is

$$\Omega_{-1} = \frac{1}{\Omega_1} \approx 0{,}974\ 02 \tag{C.4}$$

The normalized frequencies for the specified frequencies corresponding to k = -7, -6, ...7 are given in Table C.1 together with the corresponding acceptance limits.

The frequency in hertz may be found by multiplying the normalized frequency with the midband frequency, f_m, of the filter being tested.

Table C.1 – Normalized test frequencies and acceptance limits on relative attenuation for one-third-octave-band filters

Index k	Normalized frequency $\Omega_k = f/f_m$	Minimum; maximum acceptance limits on relative attenuation dB	
		Class 1	Class 2
-7	0,185 46	+70; +∞	+60; +∞
-6	0,327 48	+60; +∞	+54; +∞
-5	0,531 43	+40,5; +∞	+39,5; +∞
-4	0,772 57	+16,6; +∞	+15,6; +∞
-3	0,919 58	-0,4; +1,4	-0,6; +1,7
-2	0,947 19	-0,4; +0,7	-0,6; +0,9
-1	0,974 02	-0,4; +0,5	-0,6; +0,7
0	1,000 00	-0,4; +0,4	-0,6; +0,6
1	1,026 67	-0,4; +0,5	-0,6; +0,7
2	1,055 75	-0,4; +0,7	-0,6; +0,9
3	1,087 46	-0,4; +1,4	-0,6; +1,7
4	1,294 37	+16,6; +∞	+15,6; +∞
5	1,881 73	+40,5; +∞	+39,5; +∞
6	3,053 65	+60; +∞	+54; +∞
7	5,391 95	+70; +∞	+60; +∞

Bibliography

[1] BORK, I., Exponential sweep check using Hilbert-Transform, *Acta Acustica united with Acustica*, 2014, vol. 100, p. 659-666.

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