

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

This European Standard EN 61260:1995, with the incorporation of amendment A1:2001, has the status of a British Standard

ICS 17.140.50

Committees responsible for this British Standard

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- British Association of Otolaryngologists
- British Hearing Aid Industry Association
- British Medical Association
- British Society of Audiology
- British Telecommunications plc
- Confederation of British Industry
- Department of Health
- Department of Trade and Industry (National Physical Laboratory)
- Health and Safety Executive
- Institute of Acoustics
- Institute of Sound and Vibration Research
- Institution of Electrical Engineers
- Medical Research Council
- Ministry of Defence
- Royal Aeronautical Society
- Royal National Institute for Deaf people
- Society of Environmental Engineers
- University of Exeter

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National foreword

This British Standard has been prepared by Technical Committee EPL/29 and is the English language version of EN 61260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters*, including amendment A1:2001, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 61260, first edition 1995, including amendment 1, and supersedes BS 2475:1964, *Specification for octave and one-third octave band-pass filters*, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated by tags **A1** **A1**. Tags indicating changes to IEC text carry the number of the amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

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English version

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

(includes amendment A1:2001)
(IEC 61260:1995 + A1:2001)

Electroacoustique —
Filtres de bande d'octave et de bande d'une fraction
d'octave
(inclut l'amendement A1:2001)
(CEI 61260:1995 + A1:2001)

Elektroakustik —
Bandfilter für Oktaven und Bruchteile von Oktaven
(enthält Änderung A1:2001)
(IEC 61260:1995 + A1:2001)

This European Standard was approved by CENELEC on 1995-09-20. Amendment A1 was approved by CENELEC on 2001-12-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The text of document 29/292/DIS, future edition 1 of IEC 1260, prepared by IEC TC 29, Electroacoustics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61260 on 1995-09-20.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1996-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1996-07-01

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given for information only. In this standard, Annex ZA is normative and Annex A, Annex B and Annex C are informative. Annex ZA has been added by CENELEC.

Foreword to amendment A1

The text of document 29/496/FDIS, future amendment 1 to IEC 61260:1995, prepared by IEC TC 29, Electroacoustics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 61260:1995 on 2001-12-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2002-09-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2004-12-01

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given for information only. In this amendment, Annex ZA is normative and Annex C and Annex D are informative. Annex ZA has been added by CENELEC.

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1 Scope

1.1 This International Standard provides performance requirements and methods for testing the performance of analogue, sampled-data, and digital implementations of bandpass filters that comprise a filter set or spectrum analyser. The extent of the passband region of a filter's relative attenuation characteristic is a constant percentage of the midband frequency for all filters of a given bandwidth. An instrument complying with the requirements of this International Standard may contain any number of bandpass filters covering any desired frequency range.

1.2 Performance requirements are provided for three filter classes designated class 0, class 1, and class 2. Allowed tolerances increase as the class number increases.

1.3 Bandpass filters complying with the performance requirements of this standard may be part of various measurement systems or may be an integral component of a specific instrument and shall operate in real time. Performance requirements apply to any method that is selected by the manufacturer to implement the design of the filters.

1.4 Instruments complying with 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, and steady; broadband and discrete frequency; and long and short durations. For applications involving transient signals, different realizations of filters meeting the requirements of this standard may give different results.

2 Normative references

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

IEC 60050(801):1994, *International Electrotechnical Vocabulary (IEV) — Chapter 801: Acoustics and electro-acoustics*.

IEC 60651:1979, *Sound level meters*.
Amendment 1:1993

A1 Text deleted **A1**

IEC 60804:1985, *Integrating-averaging sound level meters*.
Amendment 1, 1989
Amendment 2, 1993

A1 IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test — Basic EMC publication*.

IEC 61000-4-3:1995, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 3: Radiated, radio-frequency, electromagnetic field immunity test*.¹⁾
Amendment 1 (1998)

IEC 61000-6-1:1997, *Electromagnetic compatibility (EMC) — Part 6: Generic standards — Section 1: Immunity for residential, commercial and light-industrial environments*.

IEC 61000-6-2:1999, *Electromagnetic compatibility (EMC) — Part 6: Generic standards — Section 2: Immunity for industrial environments*. **A1**

ISO 266:1975, *Acoustics — Preferred frequencies for measurements*.

OIML:1978, *Vocabulary of legal metrology — Fundamental terms*.

A1 CISPR/IEC 61000-6-3:1996, *Electromagnetic compatibility (EMC) — Part 6: Generic standards — Section 3: Emission standard for residential, commercial and light-industrial environments*.

¹⁾ There exists a consolidated edition 1.2 (2001) that includes IEC 61000-4-3 (1998) and its amendment 1 (1998) and amendment 2 (2000).

CISPR 16-1:1999, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1: Radio disturbance and immunity measuring apparatus.*

CISPR 22:1997, *Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement.* ^[A1]

3 Definitions

^[A1] For the purpose of this International Standard, the definitions contained in IEC 61000-4-2, IEC 61000-4-3, IEC 61000-6-1, IEC 61000-6-2 and CISPR 61000-6-3 as well as the following definitions apply. ^[A1]

NOTE For definitions of additional terms in this standard, reference should be made to IEC 60050(801) and the OIML Vocabulary of legal metrology.

3.1

bandpass filter

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

3.2

octave ratio

nominal frequency ratio of 2:1; general symbol G

NOTE 1 This standard permits two options, designated base-ten and base-two, for determining an octave-band, or fractional-octave-band, frequency ratio.

NOTE 2 For base-ten systems, $G_{10} = 10^{3/10}$ (1)

NOTE 3 For base-ten systems, $G_2 = 2$ (2)

NOTE 4 The base-ten system is preferred.

3.3

bandwidth designator

reciprocal of a positive integer, including 1, to designate the fraction of an octave band; symbol $1/b$

3.4

reference frequency

frequency of 1 000 Hz, exactly; symbol f_r

3.5

exact midband frequency

in hertz, a frequency that has a specified relationship to the reference frequency such that the ratio of the exact midband frequencies of any two contiguous bandpass filters is the same for all filters in a filter set of a specified bandwidth; symbol f_m . When the denominator of the bandwidth designator is an odd number, exact midband frequencies of any filter in a set of filters are determined from:

$$f_m = (G^{x/b}) (f_r) \quad (3)$$

and when the denominator of the bandwidth designator is an even number, exact midband frequencies of any filter in a set of filters are determined from:

$$f_m = (G^{(2x+1)/(2b)}) (f_r) \quad (4)$$

where x is any integer, positive, negative, or zero

NOTE 1 Exact midband frequencies determined from equation (3) or (4) permit the output of narrow-fractional-octave-band filters to be combined to yield the band level of a filter of wider-bandwidth with a corresponding exact midband frequency and corresponding bandedge frequencies.

NOTE 2 With the base-ten system, midband frequencies included within any 10:1 frequency range are the same as within any other 10:1 frequency range except for the position of the decimal sign. With the base-two system, midband frequencies are unique and do not repeat.

NOTE 3 As examples, for one-third-octave-band filters, the exact midband frequency for the band with a nominal midband frequency of 5 000 Hz is 5 011,872 Hz to three decimal places by the base-ten system and 5 039,684 Hz by the base-two system, or a difference of approximately 0,6 %. At a nominal midband frequency of 50 000 Hz, the exact midband frequency is 50 118,723 Hz by the base-ten system and 50 796,834 Hz by the base-two system, or an approximate difference of 1,4 %.

NOTE 4 When the denominator of the bandwidth designator is an odd number, one of the filters in a complete filter set may have a midband frequency of 1 000 Hz. When the denominator of the bandwidth designator is an even number, the bandedge frequency of one adjacent pair of filters in a complete filter set may be at 1 000 Hz and therefore none of the filters will have a midband frequency of 1 000 Hz.

NOTE 5 Exact midband frequencies for octave-band and one-third-octave-band filters are given in Table A.1 for the usual range of audio frequencies.

3.6

nominal midband frequencies

in hertz, rounded midband frequencies for the designation of bandpass filters

3.7

bandedge frequencies

in hertz, frequencies of the lower and upper edges of the passband of a bandpass filter such that the exact midband frequency is the geometric mean of the lower and upper bandedge frequencies; symbols f_1 and f_2 , respectively. Bandedge frequencies are determined from:

$$f_1 = (G^{-1/(2b)}) (f_m) \quad (5)$$

and

$$f_2 = (G^{+1/(2b)}) (f_m) \quad (6)$$

where

G represents an octave frequency ratio calculated according to equation (1) for base-ten systems or (2) for base-two systems;

f_m is an exact midband frequency determined from equation (3) or (4).

3.8

normalized frequency

for a bandpass filter, ratio of frequency to the exact midband frequency; symbol f/f_m

3.9

filter bandwidth

in hertz, for a given filter, upper bandedge frequency f_2 minus the corresponding lower bandedge frequency f_1 calculated from equations (5) and (6)

3.10

octave-band filter

bandpass filter for which the nominal ratio of upper bandedge frequency to lower bandedge frequency is two

3.11

fractional-octave-band filter

bandpass filter for which the ratio of upper bandedge frequency f_2 to lower bandedge frequency f_1 is an octave ratio raised to an exponent equal to the applicable bandwidth designator

NOTE In symbols, a bandedge frequency ratio is $f_2/f_1 = G^{1/b}$.

3.12

filter attenuation

in decibels, for a bandpass filter, at any frequency, the level of the time-mean-square input signal minus the level of the indicated time-mean-square output signal, with both signal levels relative to the same reference quantity; symbol A

NOTE In symbols, a time-mean-square input signal level L_{in} , in decibels, is represented by:

$$L_{in} = 10 \lg \left(\left[(1/T) \int_0^T v_{in}^2(t) dt \right] / v_0^2 \right) \text{ dB} \quad (7)$$

where

- $V_{in}(t)$ is the instantaneous input signal as a function of time t ;
- T is the elapsed time for integration;
- V_o is an appropriate reference quantity such as 20 μV .

a corresponding expression applies for the level of the time-mean-square output signal

3.13

reference attenuation

in decibels, for all bandpass filters in an instrument, nominal filter attenuation in the passband as specified by the manufacturer for determining relative attenuation; symbol A_{ref}

3.14

relative attenuation

in decibels, for a bandpass filter, at any frequency, filter attenuation minus the reference attenuation; symbol ΔA

NOTE At any normalized frequency f/f_m , relative attenuation $\Delta A(f/f_m)$, in decibels, is determined from:

$$\Delta A(f/f_m) = A(f/f_m) - A_{ref} \quad (8)$$

where

- $A(f/f_m)$ is the filter attenuation at normalized frequency f/f_m ;
- A_{ref} is the reference attenuation.

exact midband frequencies f_m are calculated from equation (3) or (4)

3.15

normalized effective bandwidth

for constant-amplitude sinusoidal electrical input signals, integral over normalized frequency of the ratio of the time-mean-square signal indicated by the readout device at the output of the filter set to the time-mean-square input signal; the ratio of time-mean-square signal is normalized by multiplying by a constant equal to $10^{0,1A_{ref}}$ where A_{ref} is the reference attenuation, in decibels; symbol B_e

NOTE The analytical expression for normalized effective bandwidth is given in 4.5.2.

3.16

normalized reference bandwidth

for a bandpass filter, ratio of filter bandwidth to the exact midband frequency; symbol B_r

NOTE Normalized reference bandwidth B_r is determined from:

$$B_r = (f_2 - f_1)/f_m \quad (9)$$

$$= [G^{+1/(2b)} - G^{-1/(2b)}]$$

3.17

filter integrated response

in decibels, ten times the logarithm to the base 10 of the ratio of the normalized effective bandwidth of a filter to the normalized reference bandwidth; symbol ΔB

NOTE The analytical expression for ΔB is given in 4.5.1.

3.18

reference level range

in decibels, one of the available level ranges specified by the manufacturer for testing electrical performance characteristics

3.19**reference input signal level**

in decibels, level of the input signal, specified by the manufacturer, on the reference level range

3.20**level difference**

in decibels, for a bandpass filter on any level range, output signal level minus the input signal level plus the nominal attenuation of the level range control, if applicable

3.21**reference level difference**

in decibels, on the reference level range, level difference for an input signal at the applicable reference input signal level at the midband frequency

3.22**level linearity error**

in decibels, on any level range, a level difference at the midband frequency minus the reference level difference

3.23**linear operating range**

in decibels, for a stated filter bandwidth and a stated level range, the extent of steady sinusoidal input signal levels over which level linearity errors are maintained within specified tolerances from a lower boundary to an upper boundary

3.24**level range control**

a device for adjusting the sensitivity of an instrument in response to changes in the level of the input signal in order to maintain the overall operation of the instrument within the linear operating range

3.25**measurement range**

in decibels, for any nominal midband frequency, the upper boundary of the input signal level for the linear operating range on the least-sensitive level range minus the lower boundary of the input signal level for the linear operating range on the most-sensitive level range

3.26**analogue filter**

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

3.27**sampled-data filter**

computational process that operates on samples of the 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**real-time operation**

an operational mode or capability of a sampled-data filter system to produce bandpass-filtered output signal levels and for which, on average, the computing associated with each sampling interval is completed in a time period less than or equal to the sampling interval such that all input data are processed within the sampling interval and all samples of an input signal contribute with equal weight to the resulting filtered output signal levels

3.30**aliased frequency components**

spurious frequency components in the output signal from a sampled-data bandpass filter that result when a time-varying, but continuous, input signal is sampled at a rate that is too low compared with the highest frequency component of the input signal