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Ergonomics — Accessible design — Sound pressure levels of auditory signals for consumer products

Ergonomie — Conception accessible — Niveaux de pression acoustique des signaux auditifs pour produits de consommation courante

Reference number
ISO 24501:2010(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 24501 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment.*

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Introduction

People conduct their daily lives surrounded by various consumer products. Consumer products, as defined in ISO 20282-1, include home electrical appliances, information and telecommunication products, gas-heating equipment, toys, sanitary equipment, and health-care products, many of which use auditory signals. These auditory signals can be indistinct because of the hearing loss which occurs with ageing or because of interfering sounds in the surroundings. Also, with age, our visual ability declines gradually. Auditory signals with an appropriate sound level can assist product users with auditory or visual impairment in using the product correctly and safely.

This International Standard specifies methods for determining an appropriate sound level range of auditory signals, so that all product users, including people with age-related hearing loss, can hear them properly against interfering sounds. This sound level range specification was determined, based on results of experiments in which people of all ages participated. Auditory signals whose sound pressure level is in that range are expected to be audible and comfortably loud for most users in the presence of interfering sounds.

This International Standard should be applied as appropriate to products, depending on the product type and its conditions of use. It does not apply to machines and equipment used for professional work.

This International Standard adopts the principles of accessible design given in ISO/IEC Guide 71 and amplified in ISO/TR 22411.

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Ergonomics — Accessible design — Sound pressure levels of auditory signals for consumer products

1 Scope

This International Standard specifies methods for determining the sound pressure level range of auditory signals so that the users of consumer products, including people with age-related hearing loss, can hear the signal properly in the presence of interfering sounds.

Auditory signals, in this International Standard, refer to sounds with a fixed frequency (also called beep sounds) and do not include variable frequency sounds, melodic sounds, or voice guides.

This International Standard is applicable to auditory signals which are heard at an approximate maximum distance of 4 m from the product, as long as no physical barrier exists between the product and the user. It is not applicable to auditory signals heard through a head receiver or earphones, or to those heard with the ear located very near to the sound source because of the interference of the head with sound propagation.

This International Standard does not specify the sound pressure level of auditory signals regulated by other statutes, such as those for fire alarms, gas leakages and crime prevention, nor does it specify auditory signals particular to a communication tool such as telephones.

This International Standard does not specify auditory danger signals for public or work areas which are covered in ISO 7731, ISO 8201, and ISO 11429.

2 Normative references

The following referenced standards are indispensable for the application of this document. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 24500:2010, *Ergonomics — Accessible design — Auditory signals for consumer products*

IEC 60050-801, *International electrotechnical vocabulary — Chapter 801: Acoustics and electroacoustics*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 24500 and IEC 60050-801 and the following apply.

3.1
product actuation sound
sound generated by actuation of the consumer product which incorporates the auditory signal to be designed

EXAMPLE A cooling-fan noise.

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3.2
living environment sound
sound generated in the room where the consumer product which incorporates the auditory signal to be designed is used

NOTE This includes a sound generated by user behaviour (e.g. sound of water generated when washing dishes in a kitchen) or an actuation sound of some other product incorporating the auditory signal to be designed (e.g. actuation sound of a vacuum cleaner).

3.3
interfering sound
product actuation sound or living environment sound which is likely to have the greatest effect on audibility of the auditory signal to be designed

3.4
ambient noise
sound other than the sound to be measured as an auditory signal or as an interfering sound at the measurement location

EXAMPLE Outside traffic noise.

4 Symbols

For the purposes of this document, the following symbols apply.

$L_{S,A}$ A-weighted sound pressure level of an auditory signal, in decibels, measured using the method specified in Annex A.

$L_{N,A}$ A-weighted sound pressure level of interfering sound, in decibels, measured using the method specified in Annex B.

$L_{S,oct}$ level of the frequency band, in decibels, which has the maximum value among octave-band sound pressure levels of auditory signals, measured using the method specified in Annex A.

$L_{N,oct}$ octave-band sound pressure level, in decibels, of interfering sound at the same frequency band as $L_{S,oct}$, measured using the method specified in Annex B.

$L_{S,1/3oct}$ level of the frequency band, in decibels, which has the maximum value among one-third-octave-band sound pressure levels of auditory signals, measured using the method specified in Annex A.

$L_{N,1/3oct}$ one-third-octave-band sound pressure level, in decibels, of interfering sound at the same frequency band as $L_{S,1/3oct}$, measured using the method specified in Annex B.

5 Range of sound pressure levels of auditory signals

5.1 General

The range of sound pressure levels of auditory signals shall be determined following the procedure in 5.2 or 5.3, depending on whether the masking effect of interfering sound is taken into consideration or not.

When an auditory signal with a fixed sound level is used, the level shall be selected to fall in the range specified by application of the method. When the sound level is controllable by the user, the level shall be variable to cover the entire range.

NOTE It is important for designers to consider the implication of adjustable volume controls with respect to caution signals, if the adjustable range extends below the lower end specified by application of the method. An example of the record of measurement conditions and results is shown in Annex C. Some examples of measurement and range setting of the sound pressure level of auditory signals are shown in Annex D.

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5.2 When not considering the masking effect of an interfering sound

5.2.1 General

For a case in which the masking effect of interfering sound can be ignored because its level is very low, only the users' hearing-ability change which occurs with ageing is considered for setting the range of the sound pressure level of the auditory signal.

The range of the sound pressure level shall be determined in accordance with either method using octave-band analysis or one-third-octave-band analysis, both of which are described in 5.2.2. For the methods for measuring the sound pressure level using octave-band analysis and one-third-octave-band analysis, see Annex A.

NOTE The method using one-third-octave-band analysis provides a more accurate range of sound pressure levels because the auditory signal is analysed more precisely with a narrower frequency bandwidth.

5.2.2 Method using octave-band analysis or one-third-octave-band analysis

The range of the sound pressure level of the auditory signal determined using octave-band analysis or one-third-octave-band analysis shall be as described below.

a) Lower end of $L_{S,oct}$ or $L_{S,1/3oct}$

The lower end of $L_{S,oct}$ or $L_{S,1/3oct}$ shall be determined as follows.

1) The lower end of $L_{S,oct}$ and $L_{S,1/3oct}$ shall be as given in Tables 1 and 2, respectively.

Table 1 — Lower end of $L_{S,oct}$

Centre frequency of band Hz	250	500	1 000	2 000	4 000 [b]
Sound pressure level dB	30 [a]	25	25	35	60

[a] The value of this frequency band is applied only to extremely quiet conditions.

[b] The fundamental frequency of the auditory signal should not be higher than 2 500 Hz (see ISO 24500). The values of those frequency bands are for auditory signals of specific products only (e.g. very small products in which only a tiny, high-frequency sound device can be implemented).

Table 2 — Lower end of $L_{S,1/3oct}$

Centre frequency of band Hz	250 to 315	400 to 1 250	1 600	2 000	2 500	3 150 [b]	4 000 [b]
Sound pressure level dB	30 [a]	25	30	35	40	50	60

[a] The value of this frequency band is applied only to extremely quiet conditions.

[b] The fundamental frequency of the auditory signal should not be higher than 2 500 Hz (see ISO 24500). The values of those frequency bands are for auditory signals of specific products only (e.g. very small products in which only a tiny, high-frequency sound device can be implemented).

2) Make the lower-end level higher than the value specified in 1) by 5 dB, to ensure signal perception in the case of reception and start signals, starting position signals, end signals (case of hearing at a position distant from the product), and strong caution signals with repeat counts of fewer than five times, in accordance with the classification of auditory signals specified in Clause 5 of ISO 24500:2010.

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b) Upper end of $L_{S,oct}$ or $L_{S,1/3oct}$

The upper end of $L_{S,oct}$ or $L_{S,1/3oct}$ shall be determined as follows.

i) The upper end shall be 70 dB for auditory signals with a frequency of 2 500 Hz or lower.

ii) Make the upper-end level higher than the value specified in i) by 5 dB, to ensure signal perception in the case of end signals (case of hearing at a position distant from the product) and strong caution signals in accordance with the classification of auditory signals specified in Clause 5 of ISO 24500:2010.

5.3 When taking the masking effect of interfering sound into consideration

For a case in which the masking effect of assumed interfering sound in the environment for use of the product and the users' hearing-ability change with ageing are considered, the range of the sound pressure level of the auditory signal shall be determined so that any of the methods in 5.3.1 to 5.3.3 is met. For the procedures of octave-band analysis and one-third-octave-band analysis, see Annexes A and B.

The method in 5.3.1 provides a less accurate range of sound pressure levels than the methods in 5.3.2 and 5.3.3 and should be used only when the latter two are not available.

The method in 5.3.3 provides a more accurate range of sound pressure levels than the method in 5.3.2 does, because the auditory signal and interfering sound are analysed more precisely with a narrower frequency bandwidth.

5.3.1 Method using A-weighted sound pressure level measurement

The range of the sound pressure level of the auditory signal determined using A-weighted sound pressure level measurement shall be as described below.

a) Lower end of $L_{S,A}$

The lower end of $L_{S,A}$ shall be determined as follows.

1) The relative sound pressure level of the auditory signal to interfering sound ($L_{S,A} - L_{N,A}$) shall be −5 dB.

NOTE Only the energy of the interfering sound within the frequency band (called critical band) around the signal frequency affects the audibility of the signal. Therefore, the sound pressure level of the auditory signal can be lower than that of the interfering sound.

2) The lower end shall be made higher than the value specified in 1) by 5 dB, to ensure signal perception in the case of reception and start signals, starting position signals, end signals (case of hearing at a position distant from the product), and strong caution signals with repeat counts of fewer than five times in accordance with the classification of auditory signals specified in Clause 5 of ISO 24500:2010.

b) Upper end of $L_{S,A}$

The upper end of $L_{S,A}$ shall be determined as follows.

i) The relative sound pressure level of the auditory signal to interfering sound ($L_{S,A} - L_{N,A}$) shall be 15 dB.

ii) The maximum upper end shall be 75 dB when the upper end exceeds 75 dB as a result of the setting in i).

iii) Make the upper-end level higher than the values specified in i) and ii) by 5 dB, to ensure signal perception in the case of end signals (case of hearing at a position distant from the product) and strong caution signals in accordance with the classification of auditory signals specified in Clause 5 of ISO 24500:2010.

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5.3.2 Method using octave-band analysis

The range of the sound pressure level of the auditory signal determined using octave-band analysis shall be as described below.

a) Lower end of $L_{S,oct}$

The lower end of $L_{S,oct}$ shall be determined as follows.

1) The relative sound pressure level of the auditory signal to interfering sound ($L_{S,oct} - L_{N,oct}$) shall be the value given in Table 3.

Table 3 — Lower end of relative sound pressure level ($L_{S,oct} - L_{N,oct}$) of auditory signal to interfering sound

Centre frequency Hz	250 to 1 000	2 000	4 000 [a]
Relative sound pressure level of auditory signal to interfering sound dB	5	0	5

[a] The fundamental frequency of the auditory signal should not be higher than 2 500 Hz (see ISO 24500). The value of this frequency band is for auditory signals of specific products only (e.g. very small products in which only a tiny, high-frequency sound device can be implemented).

2) As a result of the setting in 1), the lower end can be lower than the value given in Table 1. In that case, the value given in Table 1 shall be taken as the lower end.

3) Make the lower-end level higher than the value specified in 1) and 2) by 5 dB, to ensure signal perception in the case of reception and start signals, starting position signals, end signals (case of hearing at a position distant from the product) and strong caution signals with repeat counts of fewer than five times in accordance with the classification of auditory signals specified in Clause 5 of ISO 24500:2010.

b) Upper end of $L_{S,oct}$

The upper end of $L_{S,oct}$ shall be determined as follows.

i) The relative sound pressure level of the auditory signal to interfering sound ($L_{S,oct} - L_{N,oct}$) shall be 25 dB.

ii) The maximum upper end shall be 75 dB when the upper end exceeds 75 dB as a result of the setting in i).

iii) Make the upper-end level higher than the value specified in i) and ii) by 5 dB, to ensure signal perception in the case of end signals (case of hearing at a position distant from the product) and strong caution signals in accordance with the classification of auditory signals specified in Clause 5 of ISO 24500:2010.

5.3.3 Method using one-third-octave-band analysis

The range of the sound pressure level determined using one-third-octave-band analysis shall be as described below.

a) Lower end of $L_{S,1/3oct}$

The lower end of $L_{S,1/3oct}$ shall be determined as follows.

1) The relative sound pressure level of the auditory signal to interfering sound ($L_{S,1/3oct} - L_{N,1/3oct}$) shall be the value given in Table 4.

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Table 4 — Lower end of relative sound pressure level ($L_{S,1/3oct} - L_{N,1/3oct}$) of auditory signal to interfering sound

Centre frequency Hz	250 to 1 250	1 600 to 2 500	3 150 to 4 000 [a]
Relative sound pressure level of auditory signal to interfering sound dB	10	5	10

[a] The fundamental frequency of the auditory signal should not be higher than 2 500 Hz (see ISO 24500). The value of those frequency bands is for auditory signals of specific products only (e.g. very small products in which only a tiny, high-frequency sound device can be implemented).

2) As a result of the setting in 1), the lower end can be lower than the value given in Table 2. In that case, the value given in Table 2 shall be taken as the lower end.

3) Make the lower-end level higher than the value specified in 1) and 2) by 5 dB, to ensure signal perception in the case of reception and start signals, starting position signals, end signals (case of hearing at a position distant from the product), and strong caution signals with repeat counts of fewer than five times in accordance with the classification of auditory signals specified in Clause 5 of ISO 24500:2010.

b) Upper end of $L_{S,1/3oct}$

The upper end of $L_{S,1/3oct}$ shall be determined as follows.

i) The relative sound pressure level of the auditory signal to interfering sound ($L_{S,1/3oct} - L_{N,1/3oct}$) shall be 30 dB.

ii) The maximum upper end shall be 75 dB when the upper end exceeds 75 dB as a result of the setting in i).

iii) Make the upper-end level higher than the value specified in i) and ii) by 5 dB, to ensure signal perception in the case of end signals (case of hearing at a position distant from the product) and strong caution signals in accordance with the classification of auditory signals specified in Clause 5 of ISO 24500:2010.

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Annex A
(normative)

Method for measuring the sound pressure level of an auditory signal

A.1 Introduction

This annex specifies the method for measuring the sound pressure level of an auditory signal for the purpose of determining a range of the sound pressure levels of auditory signals , as specified in Clause 5.

A.2 Measuring method of the sound pressure level of an auditory signal

A.2.1 Type of measurement

One of the following three types of measurement shall be performed:

a) measurement of A-weighted sound pressure level;

b) measurement of one-octave-band level; or

c) measurement of one-third-octave-band level.

Method a) should be used only when the sound level of auditory signals is measured, taking the masking effect of interfering sound into account, and when the other two methods are not available.

The same method shall be chosen for both the measurement of an auditory signal and interfering sound (see Annex B).

A.2.2 Measuring devices

The measuring device shall be as described below:

a) a sound level meter as specified in IEC 61672-1;

b) filters as specified in IEC 61260 for performing octave-band analysis or one-third-octave-band analysis.

A.2.3 Measurement room and installation of product

The measurement room and installation of the product shall be as described below.

a) The measurement shall be performed in a room where sound reflections from room surfaces are as small as possible.

b) The ambient noise level shall be sufficiently low, so as not to affect the measurement results [see A.2.5 a) 4) and A.2.5 b) iv)].

c) Unless there is an installation method particular to a product, such as hanging on a wall, the product shall be installed on a table or a floor which is stable. Products with particular installation methods shall be installed according to the instructions.

d) For a case in which the product is hand-held or the sounding source is incorporated in a remote-control device, the product or the remote-control device may be supported with a suitable holder instead of being placed directly on a table or floor.

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A.2.4 Measurement position

The measurement position shall be as described below.

a) The microphone of the sound level meter shall be placed towards the control unit of the product at the position which would correspond to the head centre of the user who is reaching for the product to operate it. The distance between the microphone and the control unit of the product shall be 500 mm.

b) The measurement position shall be determined as depicted in Figure A.1 according to the respective cases, such as the case in which the control unit is located at the front side of the product, in which the control unit is located at the upper part of the product, and in which the control unit of the product or the remote control device is located on a wall, etc.

c) If the measurement position shown in Figure A.1 differs considerably from the head centre of the user at the time of operation because of the construction of the product, a suitable position other than that depicted in Figure A.1 may be determined as the measurement position.

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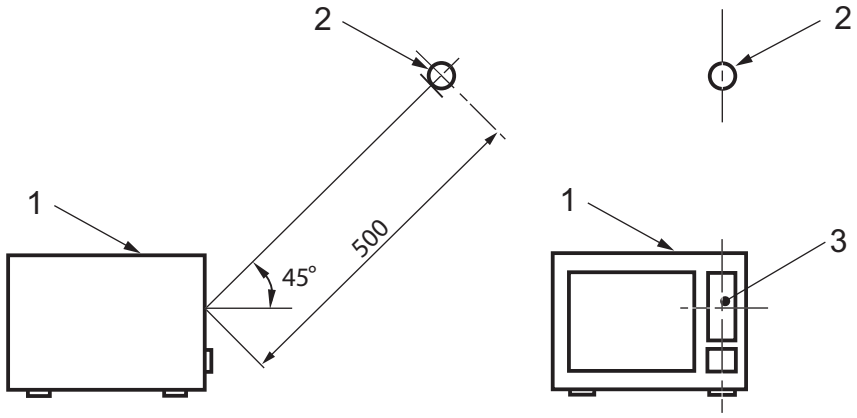
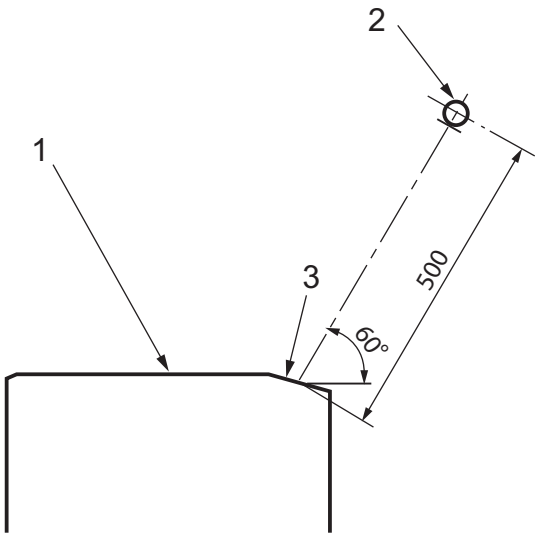
Dimensions in millimetres



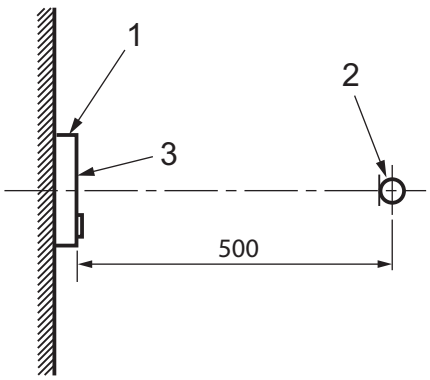
Key

1 product
2 microphone
3 control unit

a) For the case in which the control unit is located at the front side of the product: left, side view; right, front view



b) For the case in which the control unit is located at the upper part of the product (side view)



c) For the case in which the control unit of the product or the remote control device is located on a wall (side view)

Key

1 product
2 microphone
3 control unit

Figure A.1 — Measurement positions of an auditory signal

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A.2.5 Measurement of sound pressure level

Measurement of the sound pressure level of the auditory signal shall be performed as described below.

a) Measurement of the A-weighted sound pressure level

The measurement shall be performed as follows when the measurement method of A-weighted sound pressure levels of an auditory signal is used.

1) The frequency-weighting characteristic of the sound level meter shall be the A-weighting. The time-weighting characteristic shall be F (Fast).

2) Allow the auditory signal to sound continuously in the absence of product activation and measure the A-weighted sound pressure level. Read the maximum value of indication of the sound level meter when it is only possible for it to sound for a short period of not longer than 0,5 s.

3) Repeat the measurement at least four times and read the indicated value of the sound level meter each time. The average of those indicated values shall be taken as $L_{S,A}$.

4) Measure the ambient noise level at the measurement position to confirm that it is at least 10 dB lower than the sound pressure level of the auditory signal. At this time, stop generation of the auditory signal and the actuation of the product.

NOTE The signal measurement can be inaccurate if $L_{S,A}$ is not higher than the ambient noise level by more than 10 dB.

b) Measurement of octave-band level or one-third-octave-band level

The measurement shall be performed as follows when the measurement method of one-octave-band level or of one-third-octave-band level is used.

i) The frequency-weighting characteristic of the sound level meter shall be Z-weigting or FLAT. The time-weighting characteristic shall be F (Fast).

ii) Allow the auditory signal to sound continuously in the absence of product activation and measure the octave-band level or one-third-octave-band level. Read the maximum value of indication of the octave-band-filter output or one-third-octave-band-filter output when it is only possible for it to sound for a short period of not longer than 0,5 s.

iii) Repeat the measurement at least four times and read the indicated value of octave-band-filter output or one-third-octave-band-filter output each time. Average those indicated values; the value of the frequency band which shows the maximum sound pressure level shall be taken as $L_{S,oct}$ or $L_{S,1/3oct}$.

iv) Measure the ambient noise level at the measurement position to confirm that it is at least 10 dB lower than the sound pressure level of the auditory signal. At this time, stop generation of the auditory signal and the actuation of the product.

NOTE The signal measurement can be inaccurate if the difference between $L_{S,oct}$ or $L_{S,1/3oct}$ and the ambient noise level of the same frequency band is less than 10 dB.

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Annex B
(normative)

Method for measuring the sound pressure level of interfering sound

B.1 Introduction

This annex specifies the method for measuring the sound pressure level of interfering sound for the purpose of determining a range of sound pressure levels of auditory signals, as specified in 5.2.

B.2 Measuring method of sound pressure level of an interfering sound

B.2.1 Type of measurement

The same method as chosen for the measurement of the sound pressure level of the auditory signal shall be used (see Annex A).

B.2.2 Measuring device

The measuring device shall be as described below:

a) a sound level meter as specified in IEC 61672-1;

b) filters as specified in IEC 61260 for performing octave-band analysis or one-third-octave-band analysis.

B.2.3 Measurement room

The measurement location shall be as described below.

a) For a product actuation sound to be measured, perform the measurement in a room where sound reflections from the walls other than that on which a product is installed are as small as possible.

b) For a living environment sound to be measured, perform the measurement inside a general dwelling house or in a room of a simulated dwelling house.

c) The ambient noise level shall be sufficiently low, so as not to affect the measurement results [see B.2.5 a) 6) and B.2.5 b) vi)].

B.2.4 Measurement position

The measurement position shall be as described below.

a) When a product actuation sound is measured, direct the microphone of the sound level meter towards the control unit of the product at the position which would correspond to the head centre of a user when using the product as depicted in Figure A.1. When, for the measurement of an auditory signal, the position other than that in Figure A.1 is determined as the measurement position, the measurement position of the product actuation sound shall be the same position as that. The critical point is when the signal and noise are measured at the same position.

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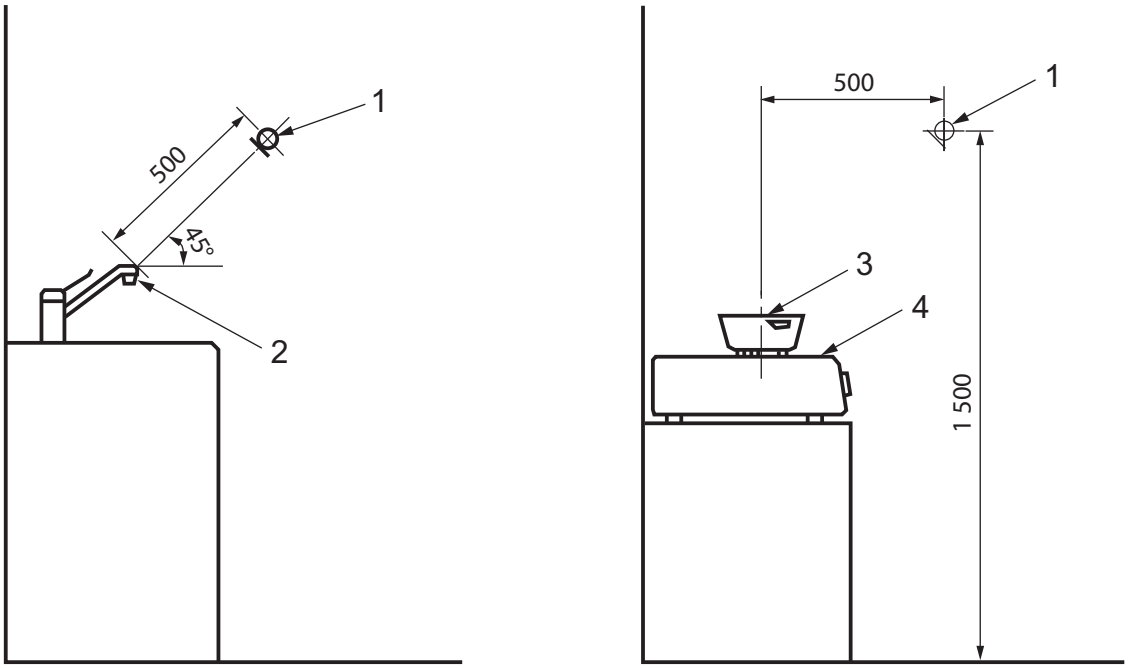
b) When a living-environment sound is measured, direct the microphone of the sound level meter towards the sound source at the position which corresponds to the head centre of a user who hears the living environment sound.

EXAMPLE When a sound of water generated when washing dishes in a sink or a sound generated when cooking using a cooking stove is to be measured, the positions shown in Figure B.1 may be determined as the measurement positions, respectively.

c) For an auditory signal presumed to be heard in another room, a suitable position in the room may be determined as the measurement position and the sound pressure level may be measured using the method described in B.2.5.

Dimensions in millimetres



a) For the case of a sound generated when washing dishes in a sink

b) For the case of a sound generated when cooking using a cooking stove

Key

1 microphone
2 water tap
3 pan
4 cooking stove

Figure B.1 — Measurement positions of living environment sound in a kitchen

B.2.5 Measurement of sound pressure level

Measurement of the sound pressure level of the interfering sound shall be performed as described below.

a) Measurement of A-weighted sound pressure level

The measurement shall be performed as follows when the measurement method of A-weighted sound pressure level is used.

1) The frequency-weighting characteristic of the sound level meter shall be the A-weighting. The time-weighting characteristic shall be F (Fast).

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2) Generate the intended interfering sound and measure the equivalent continuous A-weighted sound pressure level.

3) The measuring time shall be at least 15 s.

4) For an interfering sound that varies greatly over time, measure the period when the most typical sound is generated.

5) Repeat the measurement at least four times, and read the indicated value of the sound level meter each time. The average of those indicated values shall be taken as $L_{N,A}$.

6) Measure the ambient noise at the measurement position to confirm that it is at least 10 dB lower than the sound pressure level of the interfering sound. At this time, stop generation of interfering sound.

NOTE The sound measurement can be inaccurate if $L_{N,A}$ is not higher than the ambient noise level by more than 10 dB.

7) If a large variation of interfering sound level is expected, the measurement shall be repeated several times, changing the conditions in which the interfering sound is generated (e.g. the flow of water from the water tap when measuring a noise from a kitchen sink).

b) Measurement of octave-band level or one-third-octave-band level

The measurement shall be performed as follows when the measurement method of one-octave or one-third-octave-band level is used.

i) The frequency-weighting characteristic of the sound level meter shall be Z-weighting or FLAT. The time-weighting characteristic shall be F (Fast).

ii) Generate the intended interfering sound and measure the octave-band level or one-third-octave-band level.

iii) The measuring time shall be at least 15 s.

iv) For an interfering sound that varies greatly over time, measure the period when the most typical sound is generated.

v) Repeat the measurement at least four times and read the indicated value of octave-band-filter output or one-third-octave-band-filter output each time. Average those indicated values; the value of frequency band which shows the maximum sound pressure level shall be taken as $L_{N,oct}$ or $L_{N,1/3oct}$.

vi) Measure the ambient noise at the measurement position to confirm that it is at least 10 dB lower than the sound pressure level of the interfering noise. At this time, stop generation of the interfering sound.

NOTE The sound measurement can be inaccurate if the difference between $L_{N,oct}$ or $L_{N,1/3oct}$ and the ambient noise level of the same frequency band is less than 10 dB.

vii) If a large variation of interfering sound level is expected, the measurement shall be repeated several times, changing the conditions in which the interfering sound is generated (e.g. the flow of water from the water tap when measuring a noise from a kitchen sink).

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Annex C
(informative)

Example of the record of measurement conditions and results

C.1 Introduction

The measurement conditions and results should be recorded as appropriate. This annex shows an example of a measurement record.

a) Measurement date and location

EXAMPLE Measurement date: day, month, year.

Measurement location: XX Co. Ltd., model room XX.

b) Product and model number

EXAMPLE Product and model number: microwave oven, model number XX-XXXX.

c) Measurement device and model number

EXAMPLE Measurement device and model number: sound level meter, model number XX, one-third-octave-band analyser, model number XXXX-XX.

d) Measurement position of an auditory signal

EXAMPLE Measurement position of an auditory signal: the microphone was located at the position shown in Figure X, in relation to the product.

e) Interfering sound

EXAMPLE Interfering sound: sound of water in the sink in a kitchen. Water flow, XX L/min.

f) Measurement position of interfering sound

EXAMPLE Measurement position of interfering sound: the microphone was located at the position equivalent to that in Figure X to the end of the water tap in the sink.

g) Measuring method of sound pressure level of an auditory signal and interfering sound

EXAMPLE Measuring method of sound pressure level of an auditory signal and interfering sound: measurement using one-third-octave-band analysis.

h) Measurement results of sound pressure level of an auditory signal and interfering sound

1) $L_{S,A}$, $L_{S,oct}$ or $L_{S,1/3oct}$

2) $L_{N,A}$, $L_{N,oct}$ or $L_{N,1/3oct}$

When the octave-band analysis or one-third-octave-band analysis is used, the frequency band to be measured shall be written in parentheses.

EXAMPLE 1 Sound pressure level of an auditory signal: $L_{S,1/3oct}$ = 62 dB (2 000 Hz).

EXAMPLE 2 Sound pressure level of interfering sound: $L_{N,1/3oct}$ = 51 dB (2 000 Hz).

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C.2 Example of recording sheet

Measurement conditions and results should be recorded in a sheet. An example is shown in Table C.1.

Table C.1 — Example of recording sheet

Date		**Location**	
Product	Name		
	Model number		
Measurement device	Name		
	Model number		
Auditory signal	Measurement position		
Interfering sound	Sound source		
	Measurement position		
Measurement method			
Sound pressure level	Auditory signal		
	Interfering sound		

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Annex D
(informative)

Examples of measurement and range setting of the sound pressure level of auditory signals

D.1 Introduction

This annex describes examples of measurement and range setting of the sound pressure level of auditory signals.

A microwave oven is presented as an example of the measurement and range setting of sound pressure level of a reception and start signal and of an end signal which announces the end of cooking. The microwave oven is assumed to be used in a kitchen and the sound of water generated when washing dishes in a sink is assumed to be the main interfering sound.

For the sound pressure level of the reception and start signal, an example is shown in which the sound pressure level is measured and its range is set using one-third-octave-band analysis.

For the sound pressure level of the end signal, two examples are shown in which the sound pressure levels of the end signal and the interfering sound are measured and the signal-level range is determined using the A-weighted sound pressure level or one-third-octave-band analysis.

D.2 Example of the measurement and range setting of sound pressure level of the reception and start signal

An example of the measurement and range setting of the sound pressure level of the reception and start signal is given as follows:

a) Product

   Microwave oven

b) Measuring device

   Sound level meter with a one-third-octave-band analyser

c) Measurement position of the reception and start signal

   The microphone was installed with its orientation towards the product as shown in Figure A.1 a).

d) Measuring method of the sound pressure level of the reception and start signal

   Measurement using one-third-octave-band analysis

e) Measurement result of the sound pressure level of the reception and start signal

   The measurement result of the sound pressure level of the reception and start signal is given in Figure D.1.

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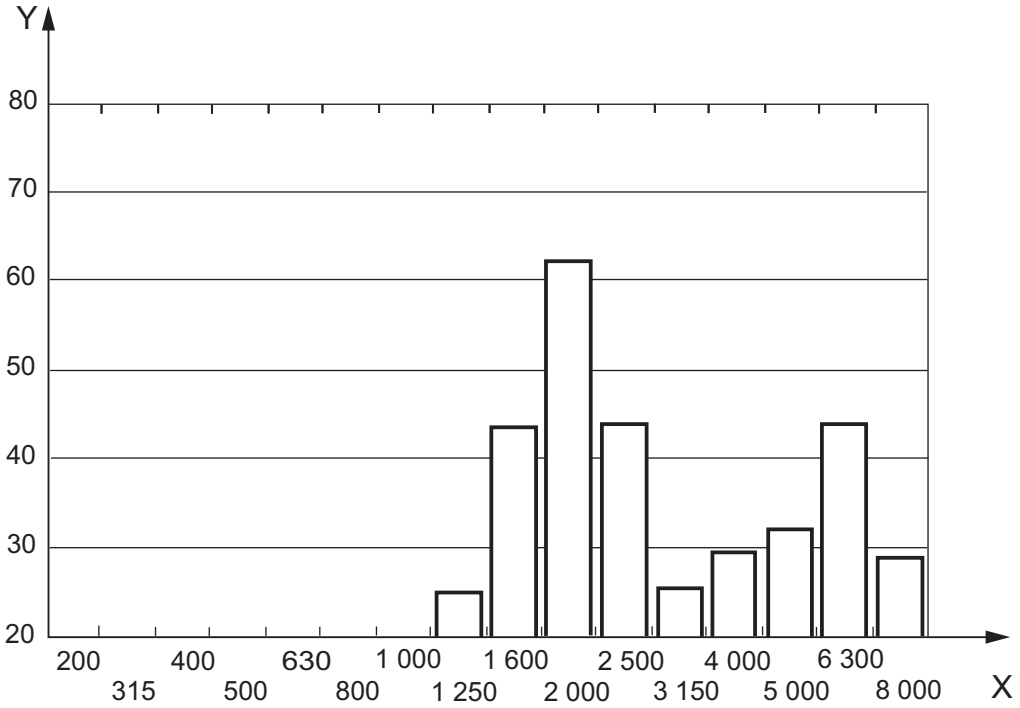

Key

X one-third-octave-band centre frequency, Hz

Y one-third-octave-band level, dB

NOTE 1 $L_{S,1/3oct} = 62$ dB (2 000 Hz).

NOTE 2 $L_{N,1/3oct}$: no interfering sound.

Figure D.1 — Measurement result of the reception and start signal

f) Setting of sound pressure level of the reception and start signal

The reception and start signal is an auditory signal which is given when the user attempts to operate a product which is currently turned off. Therefore, it is not necessary to take the actuation sound of the product into consideration. The masking effect of the living environment sound which exists simultaneously is assumed to be very small. The method described in 5.2.1, which does not take the masking effect of interfering sound into consideration, is applied to the setting of the sound pressure level.

The lower end of $L_{S,1/3oct}$ is 40 dB, which is obtained by adding 5 dB to the value in Table 2 (35 dB) in accordance with 5.2.1 a) 2). On the other hand, the upper end of $L_{S,1/3oct}$ is 70 dB in accordance with 5.2.1 b) i). Therefore, the measurement value of $L_{S,1/3oct}$ of the reception and start signal (62 dB) is between the lower end (40 dB) and the upper end (70 dB). The auditory signal is audible for many users, including people with age-related hearing loss.

If the product has a variable control of auditory-signal level and a signal frequency is 2 000 Hz, the sound level range should cover 40 dB to 70 dB at the narrowest.

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D.3 Examples of measurement and range setting of sound pressure level of end signal

D.3.1 Example of measurement using the method of A-weighted sound pressure level

An example of measurement using the method of A-weighted sound pressure level is as follows.

a) Product

Microwave oven

b) Measuring device

Sound level meter

c) Measurement position of the end signal

The microphone was installed with its orientation towards the product as shown in Figure A.1 a).

d) Interfering sound

The sound of water generated in the sink of a kitchen. Water flow, 9,6 L/min

e) Measurement position of the interfering sound

The microphone was installed at the position equivalent to that shown in Figure B.1 a) towards the end of a water tap in the sink.

f) Measuring method of sound pressure level of the end signal and the interfering sound

Measurement of A-weighted sound pressure level

g) Measurement results of sound pressure level of the end signal and the interfering sound

1) $L_{S,A} = 73$ dB

2) $L_{N,A} = 64$ dB

h) Setting of sound pressure level of the end signal

The sound of water generated in a sink is assumed to be a main interfering sound generated in a kitchen. It is desirable that the end signal, which indicates the end of cooking, be distinctly audible against the sound. The method described in 5.3.1 using A-weighted sound pressure level analysis is applied to the setting of the sound pressure level.

The lower end of $L_{S,A}$ is 64 dB ($64 - 5 + 5 = 64$), which is obtained by adding the relative sound pressure level (–5 dB) in accordance with 5.3.1 a) 1) and 5 dB in accordance with 5.3.1 a) 2) to the value of $L_{N,A}$ (64 dB). On the other hand, the upper end of $L_{S,A}$ is calculated as 79 dB by adding the relative sound pressure level (15 dB) to the value of $L_{N,A}$ (64 dB) in accordance with 5.3.1 b) i). This value is reduced to 75 dB in accordance with 5.3.1 b) ii), but is made to be 80 dB by adding 5 dB in accordance with 5.3.1 b) iii). Therefore, the value of $L_{S,A}$ (73 dB) of the reception and start signal is between the lower end (64 dB) and the upper end (80 dB). Even though an interfering sound (sound of water in a sink) exists, the auditory signal is audible for many users, including people with age-related hearing loss.

If the product has a variable control of auditory-signal level, the A-weighted sound level range should cover 64 dB to 80 dB at the narrowest.

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D.3.2 Example of measurement by the method using one-third-octave-band analysis

An example of measurement by the method using one-third-octave-band analysis is given as follows.

a) Product

Microwave oven

b) Measuring device

Sound level meter with a one-third-octave-band analyser

c) Measurement position of the end signal

The microphone was installed with its orientation towards the product as shown in Figure A.1 a).

d) Interfering sound

The sound of water generated in the sink of a kitchen. Water flow, 9,6 L/min.

e) Measurement position of the interfering sound

The microphone was installed at the position equivalent to that in Figure B.1 a) towards the end of a water tap in the sink.

f) Measuring method of sound pressure level of the end signal and the interfering sound

Measurement using one-third-octave-band analysis

g) Measurement result of sound pressure level of the end signal and the interfering sound

The measurement result of sound pressure level of the end signal and the interfering sound is given in Figure D.2.

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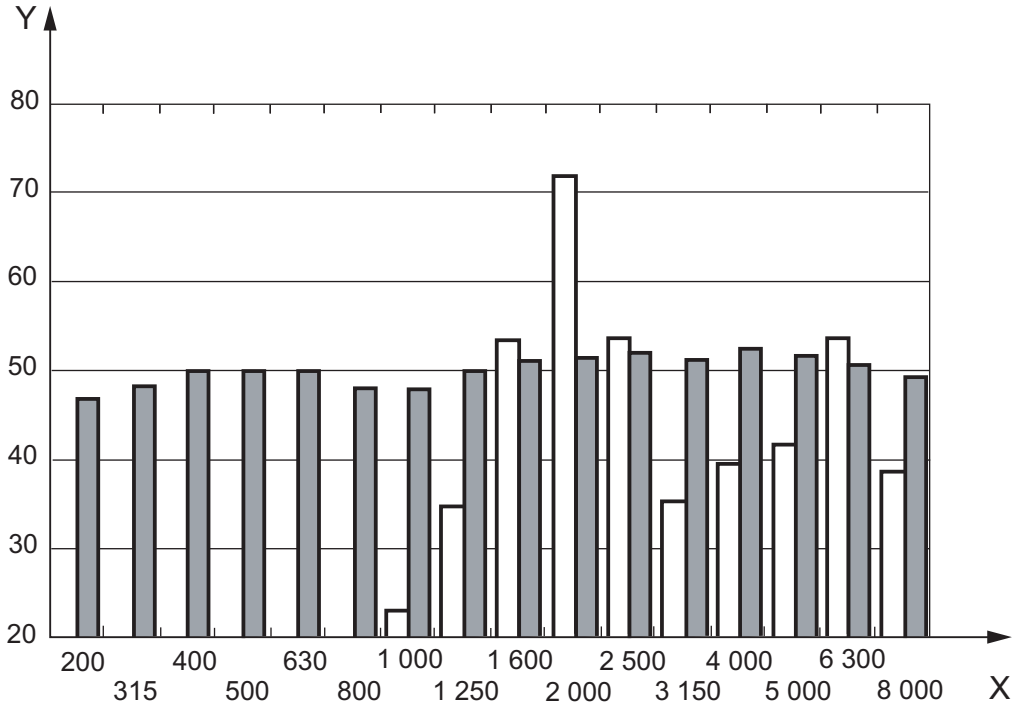

Key

X one-third-octave-band centre frequency, Hz

Y one-third-octave-band level, dB

Unshaded bars: auditory signal

Shaded bars: interfering sound

NOTE 1 $L_{S,1/3oct}$ = 72 dB (2 000 Hz).

NOTE 2 $L_{N,1/3oct}$ = 52 dB (2 000 Hz).

Figure D.2 — Measurement result of the end signal and the interfering sound

h) Setting of sound pressure level of the end signal

The sound of water generated in a sink is assumed to be a main interfering sound generated in a kitchen. It is desirable that the end signal, which indicates the end of cooking, be distinctly audible against the sound. The method in 5.3.3 using the one-third-octave-band level is applied to the setting of the sound pressure level.

The lower end of $L_{S,1/3oct}$ is 62 dB ($52 + 5 + 5 = 62$), which is obtained by adding the relative sound pressure level (5 dB) in accordance with Table 4 and 5 dB in accordance with 5.3.3 a) 3) to the value of $L_{N,1/3oct}$ (52 dB). On the other hand, the upper end of $L_{S,1/3oct}$ is calculated as 82 dB by adding the relative sound pressure level (30 dB) to the value of $L_{N,1/3oct}$ (52 dB) in accordance with 5.3.3 b) i). This value is reduced to 75 dB in accordance with 5.3.3 b) ii), but is made to be 80 dB by adding 5 dB in accordance with 5.3.3 b) iii). Therefore, the value of $L_{S,1/3oct}$ (72 dB) of the end signal is between the lower end (62 dB) and the upper end (80 dB). Even though the interfering sound (sound of water in a sink) exists, the auditory signal is audible for many users, including people with age-related hearing loss.

If the product has a variable control of auditory-signal level and the signal frequency is 2 000 Hz, the sound level range should cover 62 dB to 80 dB at the narrowest.

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