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Fire detection and fire alarm systems —

Part 24: Fire alarm loudspeakers

Systèmes de détection d'incendie et d'alarme —

Partie 24: Haut-parleurs pour systèmes d'alarme vocale

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

This second edition cancels and replaces the first edition (ISO 7240-24:2010), of which it constitutes a minor revision.

It also incorporates the Amendment ISO 7240-24:2010/Amd, 1:2013.

ISO 7240 consists of the following parts, under the general title *Fire detection and fire alarm systems*:

— *Part 1: General and definitions*

— *Part 2: Control and indicating equipment*

— *Part 3: Audible alarm devices*

— *Part 4: Power supply equipment*

— *Part 5: Point-type heat detectors*

— *Part 6: Carbon monoxide fire detectors using electro-chemical cells*

— *Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization*

— *Part 8: Point-type fire detectors using a carbon monoxide sensor in combination with a heat sensor*

— *Part 9: Test fires for fire detectors* [Technical Specification]

— *Part 10: Point-type flame detectors*

— *Part 11: Manual call points*

— *Part 12: Line type smoke detectors using a transmitted optical beam*

— *Part 13: Compatibility assessment of system components*

— *Part 14: Design, installation, commissioning and service of fire detection and fire alarm systems in and around buildings*

— *Part 15: Point-type fire detectors using smoke and heat sensors*

— *Part 16: Sound system control and indicating equipment*

— *Part 17: Short-circuit isolators*

— *Part 18: Input/output devices*

— *Part 19: Design, installation, commissioning and service of sound systems for emergency purposes*

— *Part 20: Aspirating smoke detectors*

— *Part 21: Routing equipment*

— *Part 22: Smoke-detection equipment for ducts*

— *Part 23: Visual alarm devices*

— *Part 24: Fire alarm loudspeakers*

— *Part 25: Components using radio transmission paths*

— *Part 27: Point-type fire detectors using a scattered-light, transmitted-light or ionization smoke sensor, an electrochemical-cell carbon-monoxide sensor and a heat sensor*

— *Part 28: Fire protection control equipment*

The following part is under preparation:

— *Part 29: Video fire detectors*

Introduction

The purpose of a fire alarm loudspeaker as a component of a fire alarm system (see ISO 7240-19) is to provide intelligible warning to people in or within the vicinity of a building in which a fire emergency has occurred and to enable such person(s) to take appropriate measures in accordance with a predetermined evacuation plan.

The primary reason for using a fire alarm system, instead of coded warnings given by aural alarm indicators (see ISO 7240-3), is to reduce the time taken for those at risk to recognize that an emergency exists and to give clear instructions about what to do next. This means that fire alarm loudspeakers are required to achieve a minimum acoustical performance, as well as constructional and environmental requirements, to be suitable for use in a fire alarm system.

This part of ISO 7240 recognizes that the exact nature of the acoustical requirements for fire alarm loudspeakers varies according to the nature of the space into which they are installed. It therefore specifies the minimum requirements that apply to fire alarm loudspeakers and a common method for testing their operational performance against parameters specified by the manufacturers.

This part of ISO 7240 gives common requirements for the construction and robustness of fire alarm loudspeakers as well as their performance under climatic and mechanical conditions that are likely to occur in the service environment. As the types of loudspeaker considered in this part of ISO 7240 are passive electromechanical devices not involving sensitive electronic circuits, electromagnetic compatibility (EMC) tests have not been included. The loudspeakers have been classified for either an indoor or an outdoor application environment category.

This part of ISO 7240 requires that manufacturers specify certain characteristics in a consistent manner so that designers can make objective decisions about which loudspeaker to use in specific applications.

Fire detection and fire alarm systems —

Part 24: Fire alarm loudspeakers

1 Scope

This part of ISO 7240 specifies requirements, test methods and performance criteria for loudspeakers intended to broadcast a warning of fire between a fire detection and alarm system and the occupants of a building (see ISO 7240-1:2014, Figure 1, item C).

This part of ISO 7240 specifies loudspeakers for two types of application environment: type A, generally for indoor use, and type B, generally for outdoor use.

This part of ISO 7240 does not cover loudspeakers for special applications, for example, loudspeakers for use in hazardous applications, if such applications require additional or other requirements or tests other than those given in this part of ISO 7240.

This part of ISO 7240 is not intended to cover addressable loudspeakers or loudspeakers with active components.

Audible alarm indicators are covered in ISO 7240-3.

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.

ISO 7240-1, *Fire detection and alarm systems — Part 1: General and definitions*

IEC 60068-1, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing — Part 2-1: Tests — Test A: Cold*

IEC 60068-2-2, *Environmental testing — Part 2-2: Tests — Test B: Dry heat*

IEC 60068-2-6, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-42, *Environmental testing — Part 2-42: Tests — Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-75, *Environmental testing — Part 2-75: Tests — Test Eh: Hammer tests*

IEC 60068-2-78, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

IEC 60268-1, *Sound system equipment — Part 1: General*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP code)*

IEC 60695-11-10, *Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods*

IEC 60695-11-20, *Fire hazard testing — Part 11-20: Test flames — 500 W flame test methods*

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

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

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions and symbols given in ISO 7240-1 and the following apply.

3.1 Terms and definitions

3.1.1
1/3 octave
frequency band as defined in IEC 61260

3.1.2
coverage angle
smallest angle between two directions on either side of the reference axis at which the sound pressure level is 6 dB less than the sound pressure level on the reference axis

Note 1 to entry: This angle is measured in the vertical and horizontal planes.

3.1.3
free-field condition
acoustical environment in which the sound pressure decreases with the distance, r, from a point source according to a $1/r$ law, with an accuracy of ±10 %, in the region that is occupied by the sound field between the loudspeaker system and the microphone during the measurements

EXAMPLE An anechoic room, a quiet outdoor space.

3.1.4
frequency response
sound pressure level at a distance of 4 m from the reference point on the reference axis, produced at 1/3 octave frequency bands, from 100 Hz to 10 kHz (centre frequencies)

Note 1 to entry: This is also referred to as magnitude or amplitude response.

3.1.5
ground plane measurement
measurement under half-space free-field conditions used to simulate a free-field condition in which the loudspeaker is mounted above an acoustically totally reflective boundary surface and aimed so that its reference axis points towards a measurement microphone that is placed directly on the boundary surface

Note 1 to entry: In order to achieve measurement results that are comparable with a free-field condition, ground-plane measurements need to be corrected by −6 dB at all frequencies.

3.1.6
half-space free-field condition
acoustical environment that is confined by a plane of sufficient size and in which the free-field exists in a hemisphere, so that the sound pressure from a point source mounted in the surface of that plane decreases in the manner defined in the free-field condition

EXAMPLE A half-space anechoic room.

3.1.7
horizontal plane
virtual plane of the loudspeaker containing the reference axis, as specified by the manufacturer

Note 1 to entry: There may be several horizontal planes corresponding to several reference axes.

EXAMPLE See Annex C.

3.1.8
loudspeaker enclosure
any parts of the outer physical envelope of the loudspeaker that prevents or restricts access of solid foreign objects to the sound transducer, internal components and cable termination block

3.1.9
maximum sound pressure level
total sound pressure level at 4 m from the reference point on the reference axis of a loudspeaker supplied with a simulated program signal at the rated noise power

3.1.10
measuring distance
distance between the reference point and the measuring microphone

3.1.11
pink noise
random noise signal with a spectral density that decreases by 3 dB per octave, giving constant energy per octave

3.1.12
rated impedance
value of pure resistance, stated by the manufacturer, that is substituted for the loudspeaker when defining the required power of the source

3.1.13
rated noise power
electrical power calculated from the formula U_{n}^2/R, where U_{n} is the rated noise voltage and R is the rated impedance

Note 1 to entry: For transformer-coupled loudspeakers, the rated noise power is the highest power setting specified by the manufacturer.

Note 2 to entry: The rated noise power is also called power-handling capacity.

3.1.14
rated noise voltage
RMS voltage, as specified by the manufacturer, of the simulated program signal that the loudspeaker can sustain without thermal or mechanical damage

Note 1 to entry: See Annex B.

Note 2 to entry: For transformer-coupled loudspeakers, the rated noise voltage typically equals 50 V, 70 V or 100 V.

3.1.15
reference axis
virtual axis of the loudspeaker as specified by the manufacturer

Note 1 to entry: There may be several reference axes.

EXAMPLE See Annex C.

3.1.16
reference plane
virtual plane perpendicular to the reference axis as specified by the manufacturer

EXAMPLE See Annex C.

3.1.17
reference point
point at the intersection of the reference plane and the reference axis

EXAMPLE See Annex C.

3.1.18
sensitivity
sound pressure level, *S*, of a loudspeaker supplied with a 1 W pink noise signal from 100 Hz to 10 kHz measured at a distance of 4 m from the reference point on the reference axis

3.1.19
simulated program signal
signal whose mean power spectral density closely resembles the average of the mean power spectral densities of a wide range of audio signals

EXAMPLE See Annex B.

3.1.20
type A loudspeaker
loudspeaker that is primarily intended for indoor applications

Note 1 to entry: Type A loudspeakers may be suitable for some protected outdoor situations.

3.1.21
type B loudspeaker
loudspeaker that is primarily intended for outdoor applications

Note 1 to entry: Type B loudspeakers may be more suitable than type A for some indoor situations where high temperature or humidity is present.

3.1.22
vertical plane
virtual plane of the loudspeaker perpendicular to the horizontal plane and containing the reference axis

EXAMPLE See Annex C.

3.2 Abbreviated terms

DC direct current

RMS root mean square

4 Requirements

4.1 Compliance

In order to conform to this part of ISO 7240, loudspeakers shall:

a) meet the requirements of Clause 4, which shall be verified by visual inspection or engineering assessment;

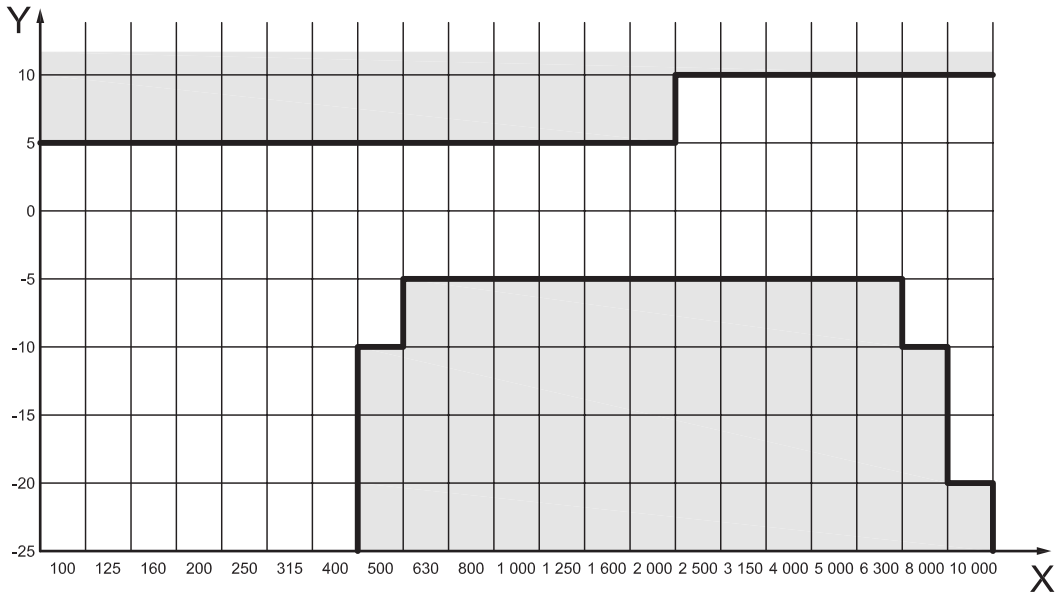
b) be tested as specified in Clause 5, and shall meet the requirements of the tests;

c) meet the requirements of Clauses 7 and 8, which shall be verified by visual inspection.

4.2 Frequency response limits

The loudspeaker frequency response shall fit within the unshaded area shown in Figure 1.

NOTE If the frequency response shown in Figure 1 can be achieved only by means of a frequency equalizer that is specified by the manufacturer for normal use [see Clause 8 h)], it is acceptable to insert a dedicated equalizer in the measurement setup (see 5.1.6).



Key

X 1/3 octave band centre frequency, expressed in hertz

Y relative level, expressed in decibels

Figure 1 — Frequency response limit

4.3 Durability

The loudspeaker shall be rated for at least 100 h operation at the rated noise power specified by the manufacturer (refer to the test procedure described in 5.6).

4.4 Construction

4.4.1 Provision for external conductors

4.4.1.1 The loudspeaker shall provide space within its enclosure for entry and termination of external conductors. Entry holes for conductors or cables shall be provided or the location where such holes can be made shall be indicated by providing a template or some other suitable means.

4.4.1.2 Terminals for connecting external conductors shall be designed so that they are clamped between metal surfaces without being damaged.

4.4.2 Materials

The loudspeaker shall be constructed of material(s) capable of withstanding the tests specified in Clause 5. In addition, the material(s) of plastic enclosures shall conform to the following flammability requirements:

a) IEC 60695-11-10 Class V-2 or HB75 for devices operating from a voltage source less than or equal to 30 V RMS or 42,4 V DC and dissipating less than 15 W;

b) IEC 60695-11-20 Class 5VB for devices operating from a voltage source greater than 30 V RMS or 42,4 V DC and dissipating more than 15 W.

4.4.3 Ingress protection

The degree of protection provided by the enclosure of loudspeakers shall conform to the following requirements:

— for type A, indoor applications: Code IP21C of IEC 60529;

— for type B, outdoor applications: Code IP33C of IEC 60529.

4.4.4 Access

Means shall be provided to limit access for removal of parts of or the whole device and to make adjustment to the mode of operation, e.g. special tool, codes, hidden screws, seals.

5 Tests

5.1 General

5.1.1 Atmospheric conditions for tests

5.1.1.1 Unless otherwise stated in a test procedure, carry out the testing after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing described in IEC 60068-1 as follows:

temperature: (15 to 35) °C;

relative humidity: (25 to 75) %;

air pressure: (86 to 106) kPa.

5.1.1.2 The temperature and humidity shall be substantially constant for each environmental test where the standard atmospheric conditions are applied.

5.1.2 Operating conditions for tests

5.1.2.1 Unless otherwise stated in a test procedure, the test specimen shall be

a) set to its highest power setting,

b) preconditioned in accordance with Annex A, and

c) mounted in the acoustical environment as described in Annex A and as specified by the manufacturer [see Clause 8 j)].

5.1.2.2 If different settings, except power settings, are available on the loudspeaker, such as tone control or adjustable parts (excluding external mounting bracket), the manufacturer shall specify the configuration(s) to be tested.

5.1.2.3 The details of the settings shall be given in the test report (see Clause 6).

5.1.3 Mounting arrangements

5.1.3.1 For environmental conditioning tests, unless otherwise specified, the specimen shall be mounted by its normal means of attachment in accordance with the manufacturer's instructions.

If these instructions describe more than one method of mounting, the method considered as the most unfavourable shall be chosen for each test.

5.1.3.2 For some loudspeakers, due to their size, it might not be practical to conduct all of the environmental tests.

In such cases, testing may be carried out on a smaller representative specimen, where this is deemed to produce a valid result for a given test.

5.1.4 Tolerances

5.1.4.1 The tolerances for the environmental test parameters shall be given in the basic reference standards for the test (e.g. the relevant part of IEC 60068).

5.1.4.2 If a specific tolerance or deviation limit is not specified in a requirement or test procedure, then a deviation limit of ±5 % shall be applied.

5.1.5 Frequency response measurement and sensitivity calculation

5.1.5.1 Measuring arrangement

Measurements shall be made in accordance with Annex A.

5.1.5.2 Measurements

5.1.5.2.1 Measure the sound pressure level, $L_{m,i}$, in 1/3 octave bands from 100 Hz to 10 kHz, at the measuring distance on the reference axis, when the loudspeaker is supplied with a band-filtered noise signal of constant voltage.

5.1.5.2.2 Levels, $L_{m,i}$, shall be the average true RMS values over a period of at least

— 10 s for 1/3 octave bands from 100 Hz to 400 Hz,

— 3 s for 1/3 octave bands from 500 Hz to 1,6 kHz, and

— 1 s for 1/3 octave bands from 2 kHz to 10 kHz.

5.1.5.2.3 Perform the measurement by supplying the loudspeaker

a) either sequentially with a 1/3 octave band filtered pink noise signal such that the square of the RMS voltage divided by the rated impedance equals 1 W. In this case, the measured sound pressure levels in each 1/3 octave band ($L_{m,i}$) shall be corrected ($L_{c,i}$) as given in Formula (1):

$$L_{c,i} = L_{m,i} - 10 \times \log_{10}(21) \quad (1)$$

b) or with a pink noise signal such that the square of the RMS voltage divided by the rated impedance equals 1 W spread over the full range of frequencies (from 100 Hz to 10 kHz, 1/3 octave bands) and analysing the microphone output signal by means of 1/3 octave filters as given in Formula (2):

$$L_{c,i} = L_{m,i} \tag{2}$$

NOTE The method described in a) is better suited for loudspeakers with low power drive unit(s), typically 1 W or less. The method described in b) is preferred for loudspeakers with higher power drive unit(s).

5.1.5.2.4 For loudspeakers with a rated noise power of less than 1 W, a pink noise signal of less than 1 W may be used providing $L_{c,i}$ is corrected accordingly.

5.1.5.2.5 Plot the frequency response with the sound pressure levels, $L_{c,i}$, as a function of frequency in 1/3 octave bands. Adjust the 0 dB reference of the tolerance field (see Figure 1) to give the best fit with the frequency response curve.

5.1.5.3 Sensitivity calculation

The sensitivity, S, expressed in decibels, shall be given by Formula (3):

$$S = 10 \times \log_{10}\left[\sum_{i=1}^{21} 10^{\left(\frac{L_{c,i}}{10}\right)}\right] \tag{3}$$

where $L_{c,1}$ to $L_{c,21}$ are the 1/3 octave sound pressure levels from 100 Hz to 10 kHz from the frequency response curve.

5.1.6 Frequency response measurement and sensitivity calculation for loudspeakers requiring dedicated system equalization

5.1.6.1 General

This test method shall be used for loudspeakers that have been designed to operate with an associated active equalization network.

NOTE Testing of active equalizers is not covered by this part of ISO 7240.

5.1.6.2 Measuring arrangement

5.1.6.2.1 Make the measurements in accordance with Annex A.

5.1.6.2.2 An active equalizer inserted between the clipping network and the power amplifier shall be used in the measurements.

5.1.6.3 Measurements

Perform the measurement described in 5.1.5.2.

5.1.7 Provision for tests

5.1.7.1 The following shall be provided for testing compliance with this part of ISO 7240:

a) seven specimens of type A or nine specimens of type B loudspeaker with any mounting, accessories, etc.;

b) data required in Clause 8.

5.1.7.2 The specimens submitted shall be representative of the manufacturer's normal production with regard to their construction and settings.

5.1.8 Test schedule

5.1.8.1 The specimens shall be tested and inspected in accordance with the schedule given in Table 1.

5.1.8.2 All the specimens shall first be submitted to the reproducibility test described in 5.2.

On completion of the reproducibility test, the specimen with the least sensitivity shall be numbered 1 and the rest arbitrarily numbered from 2 to 7 for type A or 2 to 9 for type B.

5.1.8.3 Unless otherwise specified in the test procedure, the loudspeaker setting(s) selected for conducting the reproducibility test shall be used for the other tests.

Table 1 — Schedule of tests

Test	Subclause	Specimen number[abcd]	
		Type A	Type B
Rated impedance	5.3	1	1
Horizontal and vertical coverage angles	5.4	1	1
Maximum sound pressure level	5.5	1	1
Rated noise power (durability)	5.6	2	2
Dry heat (operational)	5.7	3	3
Dry heat (endurance)	5.8	—	8
Cold (operational)	5.9	3	3
Damp heat, cyclic (operational)	5.10	3	3
Damp heat, steady-state (endurance)	5.11	3	3
Damp heat, cyclic (endurance)	5.12	—	9
SO_2 corrosion (endurance)	5.13	4	4
Shock (operational)	5.14	5	5
Impact (operational)	5.15	6	6
Vibration, sinusoidal (operational)	5.16	7	7
Vibration, sinusoidal (endurance)	5.17	7	7
Enclosure protection	5.18	1, 2	1, 2

[a] Where after one of the tests specified in 5.7 to 5.18, the curve obtained differs from the one measured before the test by more than ±3 dB and differs with the frequency response performance requirement in 4.2, a new specimen shall be used for the next test on the schedule for that specimen. The frequency response shall be first measured as specified in 5.1.5 or, if applicable, 5.1.6.

[b] In the interest of test economy, it is permitted to use the same specimen for more than one environmental test. However, it is necessary to recognize that this increases the test time and exposes the specimen to a more severe test regime. It should be noted that, in the event of failure, it might not be possible to identify which test exposure caused the failure.

[c] When the same specimen is submitted to more than one environmental test, the frequency response test may be carried out after each individual test or at the end of the group of test. In any case, the result after environmental test(s) shall always be compared with the result obtained during the reproducibility test.

[d] It is also permitted that a manufacturer submit a separate specimen for each environmental test. In this case, all the specimens shall be submitted to the reproducibility test (5.2).

5.2 Reproducibility

5.2.1 Object of the test

To show that the acoustical performance of the loudspeaker does not vary unduly from specimen to specimen and to establish performance data for comparison with the performance data measured during and/or after the environmental tests specified in this part of ISO 7240.

5.2.2 Test procedure

5.2.2.1 Measure and plot the frequency response of all the specimens as described in 5.1.5 or, if applicable, 5.1.6.

5.2.2.2 Calculate the sensitivity, *S*, as described in 5.1.5 or, if applicable, 5.1.6 for each specimen.

5.2.3 Requirements

5.2.3.1 The frequency response curve fits within the limits shown in 4.2;

5.2.3.2 The sound pressure levels in the 1/3 octave bands with centre frequencies from 500 Hz to 4 kHz are within ±4 dB of the manufacturer's specified curve.

5.2.3.3 The sensitivity, *S*, is not less than the value specified by the manufacturer.

5.3 Rated impedance

5.3.1 Object of the test

To check that the rated impedance specified by the manufacturer is achieved.

5.3.2 Test procedure

5.3.2.1 Supply the loudspeaker with a constant sinusoidal voltage or current swept over the range from 89 Hz to 11,2 kHz.

5.3.2.2 Select a voltage or current level such that the loudspeaker operates within its linear region.

5.3.2.3 Measurements of impedance can be strongly influenced by the drive level.

If the level is either too low or too high, inaccurate results can be obtained. These data should be examined for consistency at several drive levels in order to establish the best conditions.

5.3.2.4 Measure the following within the full frequency range:

— for the constant voltage method, the RMS current, *I*;

— for the constant current method, the RMS voltage, *U*.

5.3.2.5 Calculate the lowest impedance modulus, Z_{min}, given by the ratio of the RMS voltage to the RMS current, over the full frequency range for each tap setting as follows:

a) for the constant voltage method, as given in Formula (4):

$$Z_{1,\min} = \frac{U}{I_{\max}} \tag{4}$$

where

U is the applied constant voltage;

I_{max} is the measured maximum current;

b) for the constant current method, as given in Formula (5):

$$Z_{2,\min} = \frac{U_{\min}}{I} \tag{5}$$

where

I is the applied constant current;

U_{min} is the measured minimum voltage.

5.3.3 Requirements

Neither $Z_{1,min}$ or $Z_{12,min}$ shall be less than 80 % of the rated impedance specified by the manufacturer for each tap setting.

5.4 Horizontal and vertical coverage angles

5.4.1 Object of the test

To check that the horizontal and vertical coverage angles specified by the manufacturer [see Clause 8 c)] are achieved.

5.4.2 Test procedure

5.4.2.1 General

5.4.2.1.1 Measure the horizontal and vertical coverage angles as described in Annex A.

5.4.2.1.2 Use octave band filters centred on 500 Hz, 1 kHz, 2 kHz and 4 kHz.

5.4.2.1.3 Perform the measurements by supplying the loudspeaker either

a) with a pink noise signal spread over the full range of frequencies from 89 Hz to 11,2 kHz and analysing the microphone output signal by means of octave band filters centred on 500 Hz, 1 kHz, 2 kHz and 4 kHz, or

b) sequentially with an octave band filtered pink noise signal with centre frequencies of 500 Hz, 1 kHz, 2 kHz and 4 kHz.

5.4.2.1.4 The measurement level should be chosen such that the loudspeaker operates within its linear region.

5.4.2.2 Horizontal coverage angle

5.4.2.2.1 Measure the sound pressure level for each octave band at the measuring distance in accordance with Annex A.

The measurement value shall be the average RMS value over a period of at least the following:

— 10 s for the 500 Hz octave band;

— 3 s for the other octave bands.

5.4.2.2.2 Rotate the measuring microphone or the loudspeaker in the horizontal plane in an arc about the reference point to one side until the sound pressure level is −6 dB from that recorded on the reference axis.

Then, rotate the microphone or the loudspeaker to the opposite side of the reference point until the sound pressure level is −6 dB.

5.4.2.2.3 Record the total angular movement in degrees as the horizontal coverage angle for each octave band.

5.4.2.3 Vertical coverage angle

Repeat the procedure as specified in 5.4.2.2 for the vertical plane. Record the total angular movement, expressed in degrees, as the vertical coverage angle for each octave band.

5.4.3 Requirements

The measured horizontal and vertical coverage angles shall be within ±5° of the values specified by the manufacturer.

5.5 Maximum sound pressure level

5.5.1 Object of the test

To check that the maximum sound pressure level specified by the manufacturer is achieved.

5.5.2 Test procedure

5.5.2.1 General

5.5.2.1.1 Measure the maximum sound pressure level as described in Annex A.

5.5.2.1.2 The clipped noise at the terminals of the loudspeaker under test shall have a peak-to-RMS ratio of between 1,8 and 2,2.

NOTE Peak-to-RMS ratio is commonly called crest factor.

5.5.2.1.3 The power amplifier shall have an output impedance not greater than 1/3 of the rated impedance of the loudspeaker system in accordance with 5.3.

The amplifier shall be capable of supplying the loudspeaker with a peak voltage of a sinusoidal signal that is at least 2,2 times the rated noise voltage of the loudspeaker.

5.5.2.1.4 Supply the loudspeaker with the simulated program signal at the rated noise power and over the full range of frequencies (from 100 Hz to 10 kHz 1/3 octave bands).

5.5.2.2 Measurement of maximum sound pressure level

Measure the maximum sound pressure level, L_{max}, expressed in decibels, by integration over a period of at least 30 s, at the measuring distance, on the reference axis.

5.5.3 Requirements

L_{max} is not less than the value specified by the manufacturer.

5.6 Rated noise power (durability)

5.6.1 Object of the test

To check that the rated noise power specified by the manufacturer is achieved.

5.6.2 Test procedure

5.6.2.1 General

Measure the rated noise power as described in Annex B.

5.6.2.2 Conditioning

5.6.2.2.1 Place the loudspeaker in the test room, maintaining standard atmospheric conditions.

Operate the speaker at the rated noise voltage specified by the manufacturer for a continuous period of 100 h.

5.6.2.2.2 After the test, maintain the loudspeaker in standard atmospheric conditions for 24 h.

5.6.2.3 Measurements during conditioning

For loudspeakers that incorporate protective devices, continuously monitor the RMS current consumption, with an integration time between 3 s and 10 s, of a loudspeaker throughout the duration of the test.

5.6.2.4 Final measurements

5.6.2.4.1 Measure the frequency response in accordance with 5.1.5 or, if applicable, 5.1.6.

5.6.2.4.2 Measure the rated impedance in accordance with 5.3.

5.6.3 Requirements

5.6.3.1 The RMS current consumption of a specimen that incorporates protective devices shall not be reduced by more than 25 % at any time during the conditioning.

5.6.3.2 At the end of the recovery period,

a) the frequency response does not deviate from the one measured before the test by more than ±3 dB, between and including 500 Hz and 8 kHz, and

b) the frequency response complies with the frequency response performance requirement in 4.2.

5.6.3.3 The lowest impedance modulus is not lower than 80 % of the impedance specified by the manufacturer.

5.7 Dry heat (operational)

5.7.1 Object of the test

To demonstrate the ability of the specimen to function correctly at high ambient temperatures, which can occur for short periods in the service environment.

5.7.2 Test procedure

5.7.2.1 General

Use the test apparatus and perform the procedure specified in IEC 60068-2-2, Test Bb, and in 5.7.2.2 to 5.7.2.5.

5.7.2.2 State of specimen during conditioning

Maintain the specimen in the quiescent state during the conditioning, except during the last hour, when it shall be supplied with a simulated program signal at half the rated noise voltage.

5.7.2.3 Conditioning

Apply the following conditioning:

temperature: (55 ± 2) °C for type A or (70 ± 2) °C for type B;

duration: 16 h.

NOTE Test Bb specifies rates of change of temperature of <1 °C/min for the transitions to and from the conditioning temperature.

5.7.2.4 Measurements during conditioning

Monitor the specimen for audible output during the final hour of the conditioning.

5.7.2.5 Final measurements

Measure the frequency response of the specimen as specified in 5.1.5 or, if applicable, 5.1.6 after the recovery period specified in IEC 60068-2-2.

5.7.3 Requirements

5.7.3.1 The specimen shall operate continuously during the last hour of conditioning.

5.7.3.2 The frequency response curve fits within the limits specified in 4.2.

5.7.3.3 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.8 Dry heat (endurance)

5.8.1 Object of the test

To demonstrate the ability of the loudspeaker to withstand long-term ageing effects.

5.8.2 Test procedure

5.8.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-2, Test Ba or Bb, and in 5.8.2.2 to 5.8.2.4.

5.8.2.2 State of the specimen during conditioning

Do not supply power to the specimen during the conditioning.

5.8.2.3 Conditioning

Apply the following conditioning:

temperature: (70 ± 2) °C for type B only;

duration: 21 d.

NOTE Test Bb specifies rates of change of temperature of <1 °C/min for the transitions to and from the conditioning temperature.

5.8.2.4 Final measurements

Measure the frequency response of the specimen as specified in 5.1.5 or, if applicable, 5.1.6 after the recovery period specified in IEC 60068-2-2.

5.8.3 Requirements

The frequency response curve fits within the limits specified in 4.2.

The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.9 Cold (operational)

5.9.1 Object of the test

To demonstrate the ability of the loudspeaker to function correctly at low ambient temperatures appropriate to the anticipated service environment.

5.9.2 Test procedure

5.9.2.1 General

Use the test procedure and perform the procedure as specified in IEC 60068-2-1, Test Ab for non-dissipating specimens, or Test Ad for heat-dissipating specimens, and in 5.9.2.2 to 5.9.2.5.

5.9.2.2 State of specimen during conditioning

Maintain the specimen in the quiescent state during the conditioning, except during the last hour, when it shall be supplied with a simulated program signal at half the rated noise voltage.

5.9.2.3 Conditioning

Apply the following conditioning:

temperature: (–10 ± 3) °C for type A or (–25 ± 3) °C for type B;

duration: 16 h.

5.9.2.4 Measurements during conditioning

Monitor the specimen for audible output during the final half hour of conditioning.

5.9.2.5 Final measurements

Measure the frequency response of the specimen as described in 5.1.5 or, if applicable, 5.1.6 after the recovery period specified in IEC 60068-2-1.

5.9.3 Requirements

5.9.3.1 The specimen shall operate continuously during the last hour of conditioning.

5.9.3.2 The frequency response curve fits within the limits specified in 4.2.

5.9.3.3 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.10 Damp heat, cyclic (operational)

5.10.1 Object of the test

To demonstrate the immunity of the specimen to an environment with high relative humidity, where condensation can occur on the device.

5.10.2 Test procedure

5.10.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-30, using the Variant 1 test cycle and controlled recovery conditions, and in 5.10.2.2 to 5.10.2.5.

5.10.2.2 State of the specimen during conditioning

Maintain the specimen in the quiescent state during the conditioning, except during the last half hour of the high temperature phase of the last cycle, when it shall be supplied with a simulated program signal at half the rated noise voltage.

5.10.2.3 Conditioning

Apply the following conditioning:

lower temperature: (25 ± 3) °C at ≥95 % RH;

upper temperature: (40 ± 2) °C for type A or (55 ± 2) °C for type B;

relative humidity at upper temperature: (93 ± 3) %;

number of cycles: 2.

5.10.2.4 Measurements during conditioning

Monitor the specimen for audible output during the final half hour of the high temperature phase in the last cycle.

5.10.2.5 Final measurements

Measure the frequency response of the specimen as described in 5.1.5 or, if applicable, 5.1.6 after the recovery period specified in IEC 60068-2-30.

5.10.3 Requirements

5.10.3.1 The specimen shall operate continuously during the last hour of conditioning at the upper temperature.

5.10.3.2 The frequency response curve fits within the limits specified in 4.2.

5.10.3.3 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.11 Damp heat, steady-state (endurance)

5.11.1 Object of the test

To demonstrate the ability of the specimen to withstand the long-term effects of humidity in the service environment (e.g. changes in electrical properties due to absorption, chemical reactions involving moisture, galvanic corrosion).

5.11.2 Test procedure

5.11.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-78, Test Cab, and in 5.11.2.2 to 5.11.2.4.

5.11.2.2 State of the specimen during conditioning

Do not supply the specimen with power during the conditioning.

5.11.2.3 Conditioning

Apply the following conditioning:

temperature:	(40 ± 2) °C;
relative humidity:	(93 ± 3) %;
duration:	21 d.

5.11.2.4 Final measurements

Measure the frequency response of the specimen as described in 5.1.5 or, if applicable, 5.1.6 after the recovery period specified in IEC 60068-2-78, Test Cab.

5.11.3 Requirements

5.11.3.1 The frequency response curve fits within the limits specified in 4.2.

5.11.3.2 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.12 Damp heat, cyclic (endurance)

5.12.1 Object of the test

To demonstrate the ability of the loudspeaker to withstand the long-term effects of high humidity and condensation.

5.12.2 Test procedure

5.12.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-30, using the Variant 1 test cycle and controlled recovery conditions, and in 5.12.2.2 to 5.12.2.4.

5.12.2.2 State of the specimen during conditioning

Do not supply the specimen with power during the conditioning.

5.12.2.3 Conditioning

Apply the following conditioning:

temperature: (55 ± 2) °C for type B only;

number of cycles: 6.

5.12.2.4 Final measurements

Measure the frequency response of the specimen as specified in 5.1.5 or, if applicable, 5.1.6 after the recovery period specified in IEC 60068-2-30.

5.12.3 Requirements

5.12.3.1 The frequency response curve fits within the limits specified in 4.2.

5.12.3.2 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.13 Sulfur dioxide (SO_2) corrosion (endurance)

5.13.1 Object of the test

To demonstrate the ability of the specimen to withstand the corrosive effect of sulfur dioxide as an atmospheric pollutant.

5.13.2 Test procedure

5.13.2.1 General

Use the test apparatus and procedure as generally specified in IEC 60068-2-42, except for the relative humidity of the test atmosphere, which shall be maintained at (93 ± 3) % instead of (75 ± 5) %, and in 5.13.2.2 to 5.13.2.4.

5.13.2.2 State of the specimen during conditioning

Do not supply it with power during the conditioning, but equip it with untinned copper wires of the appropriate diameter, connected to a sufficient number of terminals to allow the final measurement to be made without making further connections to the specimen.

5.13.2.3 Conditioning

Apply the following conditioning:

temperature: (25 ± 2) °C;

relative humidity: (93 ± 3) %;

SO_2 concentration: (25 ± 5) µl/l;

duration: 21 d.

5.13.2.4 Final measurements

5.13.2.4.1 Immediately after the conditioning, subject the specimen to a drying period of 16 h at (40 ± 2) °C, ≤50 % RH, followed by a recovery period of at least 1 h in the standard atmospheric conditions.

5.13.2.4.2 After the recovery period, measure the frequency response of the specimen as specified in 5.1.5 or, if applicable, 5.1.6.

5.13.3 Requirements

5.13.3.1 The frequency response curve fits within the limits specified in 4.2.

5.13.3.2 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.14 Shock (operational)

5.14.1 Object of the test

To demonstrate the immunity of the specimen to mechanical shocks that are likely to occur in the anticipated service environment.

5.14.2 Test procedure

5.14.2.1 General

Use the test apparatus and perform the procedure generally as specified in IEC 60068-2-27, Test Ea, but carry out the conditioning specified in 5.14.2.3, together with 5.14.2.2 and 5.14.2.4.

5.14.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture and maintain it in the quiescent state.

5.14.2.3 Conditioning

5.14.2.3.1 For specimens with a mass <4,75 kg, apply the following conditioning:

shock pulse type:	half sine;
pulse duration:	6 ms;
peak acceleration:	$10(100 - 20M)$ m/s^2 (where M is the mass of the specimen, expressed in kilograms);
number of directions:	six;
pulses per direction:	three.

5.14.2.3.2 Do not test specimens with a mass >4,75 kg.

5.14.2.3.3 Apply three shocks in each direction of three mutually perpendicular axes (i.e. a total of 18 shocks).

One of the three axes shall be perpendicular to the normal mounting plane of the equipment.

5.14.2.4 Final measurements

Measure the frequency response of the specimen as specified in 5.1.5 or, if applicable, 5.1.6.

5.14.3 Requirements

5.14.3.1 The frequency response curve fits within the limits specified in 4.2.

5.14.3.2 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.15 Impact (operational)

5.15.1 Object of the test

To demonstrate the immunity of the specimen to mechanical impacts upon its surface that it can sustain in the normal service environment, and that it can reasonably be expected to withstand.

5.15.2 Test procedure

5.15.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-75, Test Eh or Test Ehb, and in 5.15.2.2 to 5.15.2.4.

5.15.2.2 State of the specimen during conditioning

Maintain the specimen in the quiescent state during the conditioning period.

5.15.2.3 Conditioning

5.15.2.3.1 Apply the impact to each accessible surface of the specimen at any point(s) considered likely to suffer damage or to impair the operation of the specimen.

5.15.2.3.2 Take care to ensure that the results from one series of three blows do not influence subsequent series.

In case of doubt with regard to the influence of preceding blows, the defect shall be disregarded and a further three blows shall be applied to the same position on a new specimen.

5.15.2.3.3 Use the following test parameters during the conditioning:

impact energy: (0,5 ± 0,04) J;

number of impacts: three.

5.15.2.4 Final measurements

Measure the frequency response of the specimen as specified in 5.1.5 or, if applicable, 5.1.6.

5.15.3 Requirements

5.15.3.1 The frequency response curve fits within the limits specified in 4.2.

5.15.3.2 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.16 Vibration, sinusoidal (operational)

5.16.1 Object of the test

To demonstrate the immunity of the specimen to vibration at levels considered appropriate to the normal service environment.

5.16.2 Test procedure

5.16.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and in 5.16.2.2 to 5.16.2.5.

5.16.2.2 State of the specimen during conditioning

5.16.2.2.1 Mount the specimen on a rigid structure.

Apply the vibration in each of three mutually perpendicular axes, in turn, and so that one of the three axes is perpendicular to the normal mounting plane of the specimen.

5.16.2.2.2 Supply the specimen with a simulated program signal at half the rated noise voltage.

5.16.2.3 Conditioning

5.16.2.3.1 Apply the following conditioning:

frequency range:	(10 to 150) Hz;
acceleration amplitude:	5 m/s^2 (approximately 0,5 g_n);
number of axes:	three;
sweep rate:	1 octave/min;
number of sweep cycles:	1/axis.

5.16.2.3.2 Apply the vibration in each of three mutually perpendicular axes, in turn.

One of the three axes shall be perpendicular to the normal mounting plane of the equipment.

5.16.2.3.3 Apply one sweep cycle (i.e. a sweep of the frequency range from min. to max. to min.) for each of the specified functional modes.

5.16.2.3.4 The vibration (operational) and vibration (endurance) tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis.

It is necessary to make only one final measurement.

5.16.2.4 Measurements during conditioning

Monitor the specimen for audible output during the conditioning period.

5.16.2.5 Final measurements

Measure the frequency response of the specimen as specified in 5.1.5 or, if applicable, 5.1.6.

5.16.3 Requirements

5.16.3.1 The specimen operates continuously during the conditioning period.

5.16.3.2 The frequency response curve fits within the limits specified in 4.2.

5.16.3.3 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.17 Vibration, sinusoidal (endurance)

5.17.1 Object of the test

To demonstrate the ability of the specimen to withstand the long-term effects of vibration at levels appropriate to the service environment.

5.17.2 Test procedure

5.17.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and in 5.17.2.2 to 5.17.2.4.

5.17.2.2 State of the specimen during conditioning

5.17.2.2.1 Mount the specimen on a rigid structure.

Apply the vibration in each of three mutually perpendicular axes, in turn, and so that one of the three axes is perpendicular to the normal mounting plane of the specimen.

5.17.2.2.2 Do not supply the specimen with power during the conditioning.

5.17.2.3 Conditioning

5.17.2.3.1 Apply the following conditioning:

frequency range:	(10 to 150) Hz;
acceleration amplitude:	10 m/s^2 (≈1,0 g_n);
number of axes:	three;
sweep rate:	1 octave/min;
number of sweep cycles:	20/axis.

5.17.2.3.2 Apply the vibration in each of three mutually perpendicular axes in turn.

One of these axes shall be perpendicular to the normal mounting plane of the equipment.

5.17.2.3.3 The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis.

It is necessary to make only one final measurement.

5.17.2.4 Final measurements

Measure the frequency response of the specimen as specified in 5.1.5 or, if applicable, 5.1.6.

5.17.3 Requirements

5.17.3.1 The frequency response curve fits within the limits specified in 4.2.

5.17.3.2 The frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test.

5.18 Ingress protection

5.18.1 Object of the test

To demonstrate that the degree of protection provided by the enclosure of the loudspeaker, with regard to the ingress of solid foreign objects and the harmful effects due to the ingress of water, meets the requirements of 4.4.3.

5.18.2 Enclosure of the loudspeaker

For the purposes of this test, the enclosure of the loudspeaker shall be taken as being comprised of any parts of the outer physical envelope of the specimen that prevent or restrict access of solid foreign objects to the sound transducer, internal components and cable termination block.

5.18.3 Test procedure

5.18.3.1 General

Use the test apparatus and perform the procedures as specified in IEC 60529 and 5.18.3.2 to 5.18.3.4. Conduct the following tests:

a) protection against solid foreign objects indicated by the first characteristic numeral;

b) protection against access to hazardous parts indicated by the additional letter;

c) protection against water indicated by the second characteristic numeral.

5.18.3.2 State of the specimen during conditioning

5.18.3.2.1 Mount the specimen, including all wiring termination boxes that form part of the loudspeaker when installed, as specified in IEC 60529.

5.18.3.2.2 For tests of protection against solid foreign objects and of protection against access to hazardous parts, do not supply power to the specimen.

5.18.3.2.3 For tests of protection against water, apply the test when the specimen is supplied with the simulated program signal at half the rated noise voltage.

5.18.3.3 Conditioning

Apply the test conditions specified in IEC 60529 for the following IP codes:

a) type A: IP21C;

b) type B: IP33C.

5.18.3.4 Final measurements

At the end of the conditioning period for the test for protection against water

— measure the frequency response of the specimen as specified in 5.1.5 or, if applicable, 5.1.6, and

— examine the specimen for ingress of water inside the enclosure.

5.18.4 Requirements

5.18.4.1 The specimen shall satisfy the acceptance conditions for the test for protection against solid foreign objects as specified in IEC 60529:1989, 13.3.

5.18.4.2 The specimen shall satisfy the acceptance conditions for the test evaluating the protection against access to hazardous parts as specified in IEC 60529:1989, 15.3.

5.18.4.3 Following the conditioning period for the test for protection against water, confirm that

a) the frequency response curve fits within the limits specified in 4.2,

b) the frequency response curve between and including 500 Hz and 8 kHz does not deviate by more than ±3 dB from that measured during the reproducibility test, and

c) no water penetrated the enclosure or, if water has penetrated the enclosure, that the device incorporates adequate provision for drainage.

6 Test report

The test report shall contain, as a minimum, the following information:

a) the identification of the device tested;

b) a reference to this part of ISO 7240, i.e. ISO 7240-24:2016;

c) the results of the test: the individual response and the minimum, maximum and arithmetic mean values where appropriate;

d) the conditioning period and the conditioning atmosphere;

e) the temperature and the relative humidity in the test room throughout the test;

f) the details of the settings during the tests;

g) the details of any deviation from this part of ISO 7240 or from the International Standards to which reference is made;

h) the details of any functions regarded as optional.

7 Marking

7.1 Each fire alarm loudspeaker shall be clearly marked with the following information:

a) the number of this part of ISO 7240 (i.e. ISO 7240-24);

b) the classification (i.e. type A or type B);

c) the name or trademark of the manufacturer or supplier;

d) the manufacturer or supplier model designation (type or number);

e) the wiring terminal designations;

f) for transformer-coupled loudspeakers, the rated noise voltage;

g) for direct-coupled loudspeakers, the rated impedance;

h) the rated noise power (at the highest power setting);

i) the power settings (e.g. transformer tapping options for transformer-coupled loudspeakers);

j) the mark(s) or code(s) (e.g. a serial number or batch code), by which the manufacturer can identify at least the date or batch and place of manufacture.

7.2 Where any marking on the device uses symbols or abbreviations not in common use, these shall be explained in the data supplied with the device.

7.3 It is not necessary that the marking be discernible when the device is installed and ready for use but shall be visible during installation and shall be accessible during maintenance.

7.4 The markings shall not be placed on screws or other easily removable parts.

8 Data

8.1 The following information shall be supplied with the device, or shall be given in a data sheet or technical manual identified on, or with, each device:

a) frequency response for each stated reference axis;

b) sensitivity for the stated reference axis (see 5.1.5), measured at 4 m, and (optionally) converted to 1 m equivalent distance by adding 12 dB to the value obtained at the measuring distance of 4 m. Where the sensitivity is also stated at 1 m, the manufacturer shall clearly indicate the measured sensitivity and the calculated sensitivity;

c) horizontal and vertical coverage angles at 500 Hz, 1 kHz, 2 kHz, 4 kHz for each stated reference plane, measured as described in 5.4.2;

d) maximum sound pressure level (at highest power setting) for each stated reference plane, measured as described in 5.5.2;

e) reference axis, reference plane and horizontal plane;

f) rated noise power, measured as described in 5.6.2;

g) rated impedance for each tapping, measured as described in 5.3.2;

h) 1/3 octave band frequency response of any dedicated active equalization that can be required;

i) any other information necessary to enable correct installation, operation and maintenance of the device;

j) acoustical measurement environment used for the specifications listed in this data sheet, e.g. free-field, half-space free-field, standard baffle.

8.2 If different settings, except power settings, are available on the loudspeaker, such as tone control or adjustable parts, the manufacturer shall specify the applicable configuration(s) for each setting.

Annex A
(normative)

Acoustical measurements

A.1 Measurement environments

A.1.1 General

A.1.1.1 Acoustical measurements (see 5.1.5 and 5.1.6) shall be made under free-field or half-space free-field conditions.

A half-space free-field condition or a standard baffle under free-field conditions shall be used for loudspeakers that are designed for flush mounting. Free-field conditions can be simulated by the use of the ground-plane method.

A.1.1.2 Flush-mounted loudspeakers, for example ceiling loudspeakers, shall be measured under half-space free-field conditions.

They shall be flush-mounted into the boundary surface of a half-space free-field or on the standard baffle (see A.1.4) and measured under free-field conditions. A standard baffle shall not be used in a ground-plane measurement.

A.1.1.3 All other loudspeakers shall be measured under free-field conditions or in a ground-plane arrangement that simulates a free-field condition.

A.1.1.4 The arrangement of the measurement environment, including instrumentation, shall be as shown in Figure A.1.

A.1.2 Free-field condition

A.1.2.1 An environment shall be considered to be equivalent to a free-field environment if the sound pressure decreases with the distance, r, from a point source according to a $1/r$, law, with an accuracy of ±10 %, in the region that is occupied by the sound field between the loudspeaker system and the measuring microphone.

Free-field environment conditions shall be deemed to exist if this requirement is met along the axes joining the measuring microphone and the reference point on the loudspeaker.

NOTE An anechoic room or quiet outdoor spaces are regarded as being free-field environments.

A.1.2.2 Free-field conditions shall exist over the whole frequency range of measurement.

A.1.3 Half-space free-field condition

A.1.3.1 An environment shall be considered to be equivalent to a half-space free-field condition if the free-field condition exists in a half space.

EXAMPLE A loudspeaker flush-mounted into the surface that confines the half space.

NOTE 1 Due to the smaller radiation space, the results of a half-space free-field measurement can be up to 6 dB higher than results for sound pressure levels in the low-frequency region. The extent of this effect primarily depends on the directivity of the loudspeaker.

NOTE 2 A half-space anechoic room is regarded as being a half-space free-field environment.

A.1.3.2 Half-space free-field conditions shall exist over the whole frequency range of measurement.

A.1.4 Standard baffle

The standard baffle shall be made with a plane front surface that is acoustically reflective. The baffle shall have the dimensions shown in Figure A.2. The standard baffle shall be of a material of thickness adequate to ensure negligible vibration, such as plywood of at least 19 mm thickness. The loudspeaker shall be mounted as specified by the manufacturer.

NOTE For an identical loudspeaker, a measurement with a standard baffle can result in slightly higher on-axis sound pressure levels between 100 Hz and 500 Hz compared to a half-space measurement (see A.1.3).

A.1.5 Ground-plane measurement

A.1.5.1 In a ground-plane measurement arrangement, the loudspeaker shall be mounted above the acoustically reflective boundary surface, typically the floor, and aimed such that the reference axis is pointed at the measurement microphone.

The microphone shall be placed directly on the boundary surface such that its reflection sums coherently with the direct sound (see Figure A.3). Consequently, a ground-plane measurement shall be corrected by −6 dB in order to achieve results that are equivalent to a measurement under free-field conditions.

NOTE Ground-plane measurements can be carried out indoors as well as outdoors in half-space free-field conditions.

A.1.5.2 The test sample shall be mounted above the reflective boundary surface such that the radiation characteristics are not affected except for a linear increase in level by 6 dB compared to a free-field measurement.

NOTE For example, if a line-source-type loudspeaker is mounted vertically above the reflective floor, the effective acoustic length of the array is doubled, thus, changing both frequency response and vertical opening angles. In this example, the effect can be minimized by mounting the loudspeaker horizontally so that the effective acoustic length is not doubled and spatial radiation characteristics are not changed as much.

A.1.6 Comparative measurements

A.1.6.1 For practical reasons, as an alternative to measurements in free-field and half-space free-field conditions, comparative measurements of frequency response before and after environmental tests can be made using a non-free-field environment.

A.1.6.2 The frequency-dependent difference obtained in this comparative measurement shall be added to the result obtained in the reproducibility measurement (see 5.2).

This result shall be taken as being equivalent to the frequency response that would be obtained in free-field or half-space free-field conditions after environmental conditioning.

A.1.6.3 The mounting arrangement for the test sample and measuring microphone shall be the same before and after the environmental conditioning.

A.1.6.4 The room used for non-free-field comparative measurements shall

— be sufficiently large to allow placing the specimen under test and the microphone at the required measurement distance of 4 m (see A.2.1) and at a distance from nearby reflecting surfaces that minimizes interference effects, and

— have no parallel and acoustically reflective walls that cause flutter echoes.

A.2 Measurement method

A.2.1 Measuring distance

A measuring distance of 4 m shall be used.

A.2.2 Background noise

For acoustical measurements, a signal-to-noise ratio of at least 20 dB shall be achieved in every frequency band.

NOTE Loudspeakers with a very low rated noise power, typically below 1 W, require a very quiet environment.

A.2.3 Preconditioning

Permanent changes can take place in a loudspeaker as a result, for example, of motion of the diaphragm. Therefore, the loudspeaker shall be preconditioned before measurements by application of a simulated program signal, in accordance with Annex B, at the rated noise voltage for at least 1 h. The period of preconditioning shall be followed by a recovery period of at least 1 h, during which the loudspeaker shall be disconnected, before proceeding with the measurement.

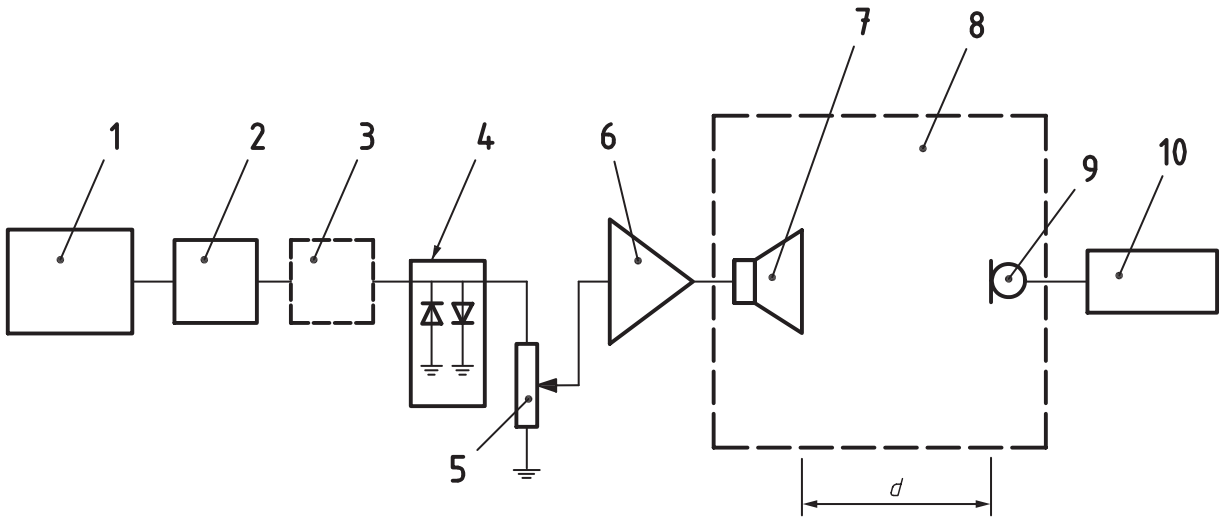
A.2.4 Measuring equipment

A.2.4.1 Acoustic measurements shall be made using a free-field microphone having a known calibration for all frequencies of interest.

The sound level measuring equipment, including the microphone, shall conform to IEC 61672-1, class 1.

A.2.4.2 Where 1/3 octave or octave filters are used, they shall conform to IEC 61260, class 1.

A.2.4.3 The signal generator, the amplifier supplying the signal to the loudspeaker, and the measuring equipment at the microphone amplifier shall have an amplitude frequency response within ±0,5 dB in the relevant frequency range, with negligible amplitude nonlinearity under test conditions. All measuring instruments shall be capable of true RMS measurements.

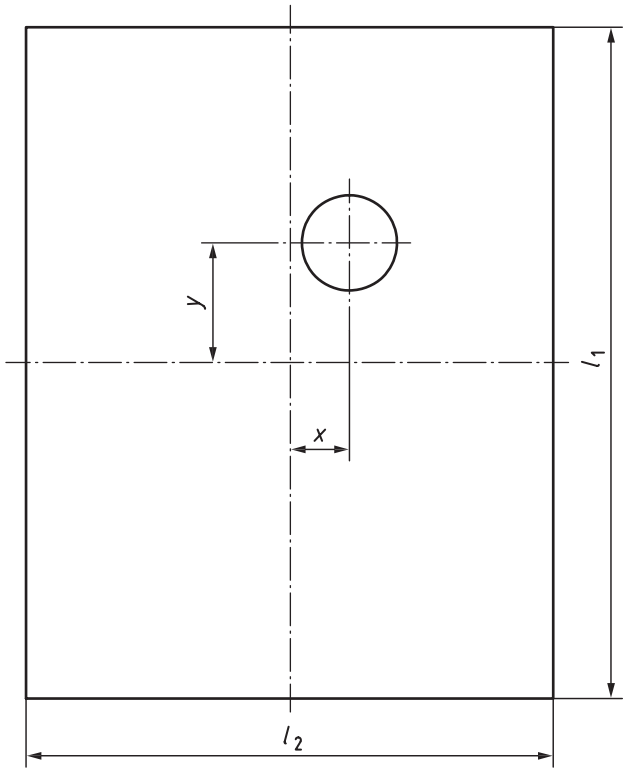


Key

1	pink noise generator	7	specimen under test
2	1/3 octave band filters	8	free field environment, e.g. anechoic chamber
3	active equalizer (optional)	9	microphone
4	clipping network (where used for a particular test)	10	sound level measuring equipment
5	output level adjust	*d*	measuring distance
6	amplifier		

Figure A.1 — Arrangement for acoustical measurements on loudspeakers

Dimensions in millimetres

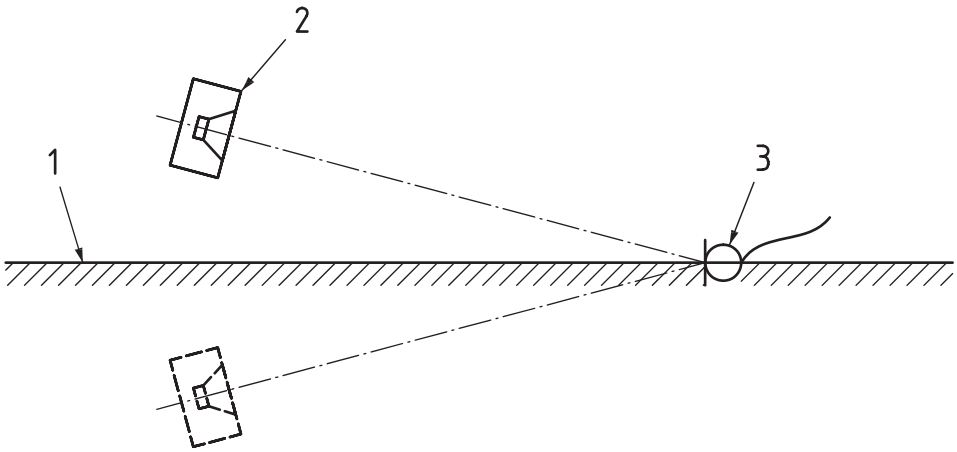


Key

l_1 = 1 650
l_2 = 1 350
x = 150
y = 225

NOTE The centre of the circle indicates the centre position of the specimen under test.

Figure A.2 — Standard baffle, dimensions



Key

1 reflective surface
2 specimen under test
3 microphone

Figure A.3 — Arrangement for ground plane measurement

Annex B
(normative)

Measuring rated noise power (durability)

B.1 Measurement environment

B.1.1 General

The arrangement for measuring rated noise power (see 5.6), including instrumentation, shall be as shown in Figure B.1.

B.1.2 Test room

The test shall be carried out in a test room with a volume not less than 8 m^3.

B.1.3 Measuring equipment

B.1.3.1 To prevent unintended clipping in the amplifier, a clipping network shall be used to limit the signal into the amplifier.

A typical clipping network consists of two diodes, e.g. 1N4148. The maximum RMS input voltage shall not exceed 0,32 V.

B.1.3.2 The signal (see B.2) at the terminals of the loudspeaker under test shall have a peak-to-RMS ratio between 1,8 and 2,2.

This can be verified by measurement of the true peak and RMS voltages. The measurement bandwidth and averaging time shall be sufficient to ensure a correct reading over the measurement period (see 5.1.5.2)

B.1.3.3 The power amplifier shall have an output impedance not greater than 1/3 of the rated impedance of the loudspeaker system.

The amplifier shall be capable of supplying the loudspeaker with a peak voltage of a sinusoidal signal that is at least 2,2 times the rated noise voltage of the loudspeaker. The harmonic content of the output voltage shall not exceed 10 % when measured with a sinusoidal signal at the terminals of the loudspeaker

B.2 Simulated program signal

B.2.1 For measuring rated noise power, a band-pass filtered version of the program signal described in IEC 60268-1 shall be used.

B.2.2 Figure B.2 and Table B.1 give the weighted power spectrum of the IEC 60268-1 program signal when measured with 1/3 octave filters, excluding the band-pass filter from 89 Hz to 11,2 kHz (item 2 of Figure B.1).

B.2.3 Figure B.3 and Table B.2 give the weighted power spectrum of the IEC 60268-1 program signal when measured with 1/3 octave filters, including the band-pass filter from 89 Hz to 11,2 kHz (item 2 of Figure B.1).

B.2.4 The simulated program signal used in this part of ISO 7240 may be obtained from a pink noise source by means of the filter circuit shown in Figure B.3 and an additional band pass filter with cut-off frequencies of 89 Hz and 11,2 kHz.

The band-pass filter shall have Butterworth characteristics and shall have slopes of 24 dB per octave

B.3 Normal measuring conditions

Measurements made with 1/3 octave band signals shall, if appropriate, be made with the relative level in each frequency band corresponding to that indicated in Table B.1 and Figure B.2 or Table B.2 and Figure B.3.

NOTE The power level of the band-passed signal measured over the full frequency range is approximately 11,9 dB higher than the indicated zero relative level, which is measured over a single 1/3 octave band.

B.4 Measurement conditions for loudspeakers requiring dedicated system equalization

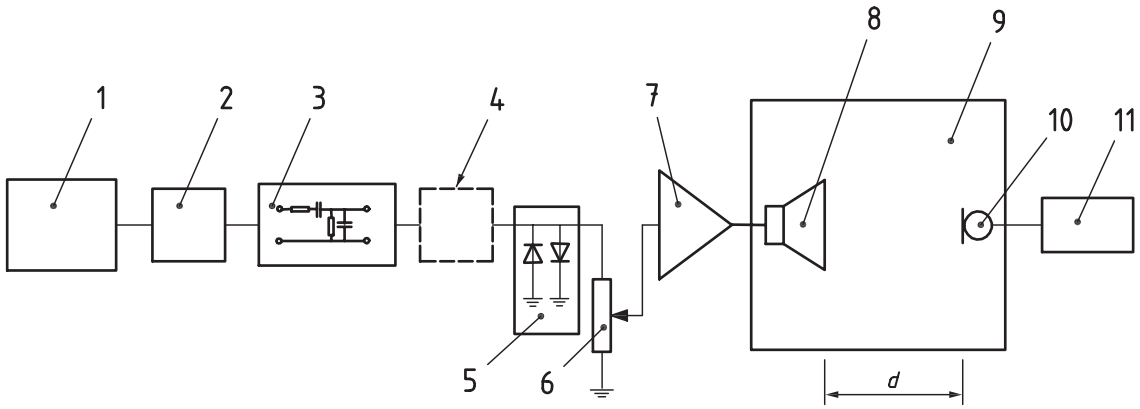
If loudspeakers are used in conjunction with dedicated active equalization, the measurement of the rated noise power shall be conducted as follows:

a) an active equalizer that is capable of providing the required equalization shall be used;

b) the active equalizer shall be inserted in the measurement chain between the clipping network and the power amplifier;

c) the measuring equipment and test signal shall be as described in B.2 and B.3;

d) the output signal of the power amplifier shall be adjusted such that the rated noise voltage is reached.



Key

1	pink noise generator with a peak to RMS ratio between 1,8 and 2,2	7	amplifier
2	band pass filter	8	loudspeaker under test
3	simulated program filter network (see B.2)	9	test room
4	active equalizer (optional)	10	microphone
5	clipping network (where used for a particular test)	11	sound level measuring equipment
6	output level adjust	*d*	measuring distance

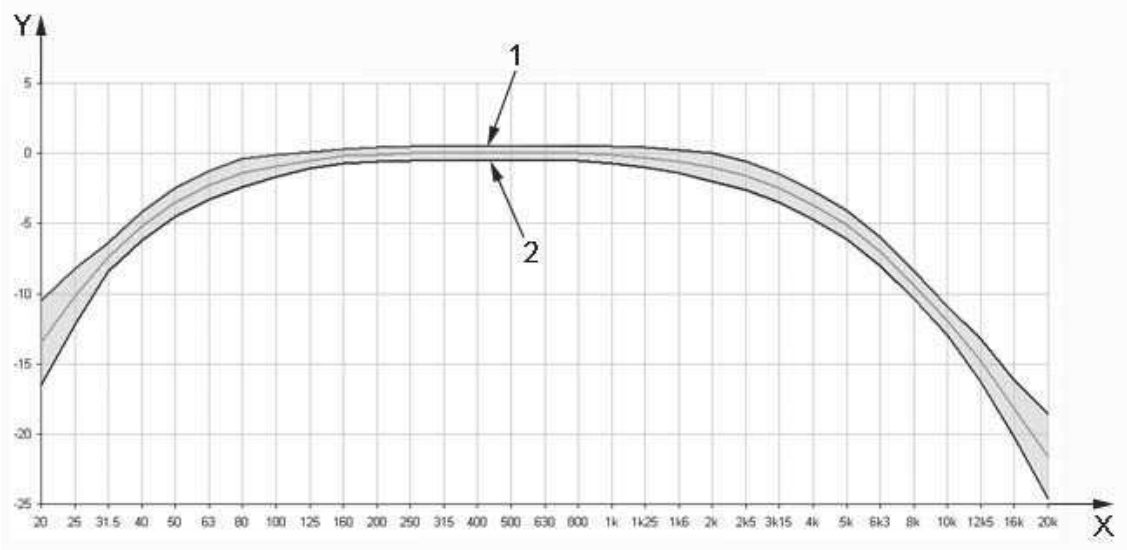
Figure B.1 — Arrangement for measuring rated noise power

Table B.1 — Power spectrum of simulated program signal excluding the band-pass filter from 89 Hz to 11,2 kHz

Frequency	Relative level	Tolerance limits dB		Frequency	Relative level	Tolerance limits dB	
Hz	dB	+	–	Hz	dB	+	–
20	–13,5	3,0	3,0	800	0	0,5	0,5
25	–10,2	2,0	2,0	1 000	–0,1	0,6	0,6
31,5	–7,4	1,0	1,0	1 250	–0,3	0,7	0,7
40	–5,2	1,0	1,0	1 600	–0,6	0,8	0,8
50	–3,5	1,0	1,0	2 000	–1,0	1,0	1,0
63	–2,3	1,0	1,0	2 500	–1,6	1,0	1,0
80	–1,4	1,0	1,0	3 150	–2,5	1,0	1,0
100	–0,9	0,8	0,8	4 000	–3,7	1,0	1,0
125	–0,5	0,6	0,6	5 000	–5,1	1,0	1,0
160	–0,2	0,5	0,5	6 300	–7,0	1,0	1,0
200	–0,1	0,5	0,5	8 000	–9,4	1,0	1,0
250	0	0,5	0,5	10 000	–11,9	1,0	1,0
315	0	0,5	0,5	12 500	–14,8	1,5	1,5
400	0	0,5	0,5	16 000	–18,2	2,0	2,0
500	0	0,5	0,5	20 000	–21,6	3,0	3,0
630	0	0,5	0,5	—	—	—	—

Table B.2 — Power spectrum of simulated program signal including the band-pass filter from 89 Hz to 11,2 kHz

Frequency	Relative level	Tolerance limits dB		Frequency	Relative level	Tolerance limits dB	
Hz	dB	+	–	Hz	dB	+	–
20	–66,2	3,0	3,0	800	0	0,5	0,5
25	–53,9	2,0	2,0	1 000	–0,1	0,6	0,6
31,5	–42,8	1,0	1,0	1 250	–0,3	0,7	0,7
40	–32,8	1,0	1,0	1 600	–0,6	0,8	0,8
50	–23,2	1,0	1,0	2 000	–1,0	1,0	1,0
63	–14,2	1,0	1,0	2 500	–1,6	1,0	1,0
80	–6,7	1,0	1,0	3 150	–2,5	1,0	1,0
100	–2,4	0,8	0,8	4 000	–3,7	1,0	1,0
125	–0,8	0,6	0,6	5 000	–5,1	1,0	1,0
160	–0,2	0,5	0,5	6 300	–7,0	1,0	1,0
200	–0,1	0,5	0,5	8 000	–9,7	1,0	1,0
250	0	0,5	0,5	10 000	–13,6	1,0	1,0
315	0	0,5	0,5	12 500	–20,4	1,5	1,5
400	0	0,5	0,5	16 000	–31,1	2,0	2,0
500	0	0,5	0,5	20 000	–39,9	3,0	3,0
630	0	0,5	0,5	—	—	—	—



Key

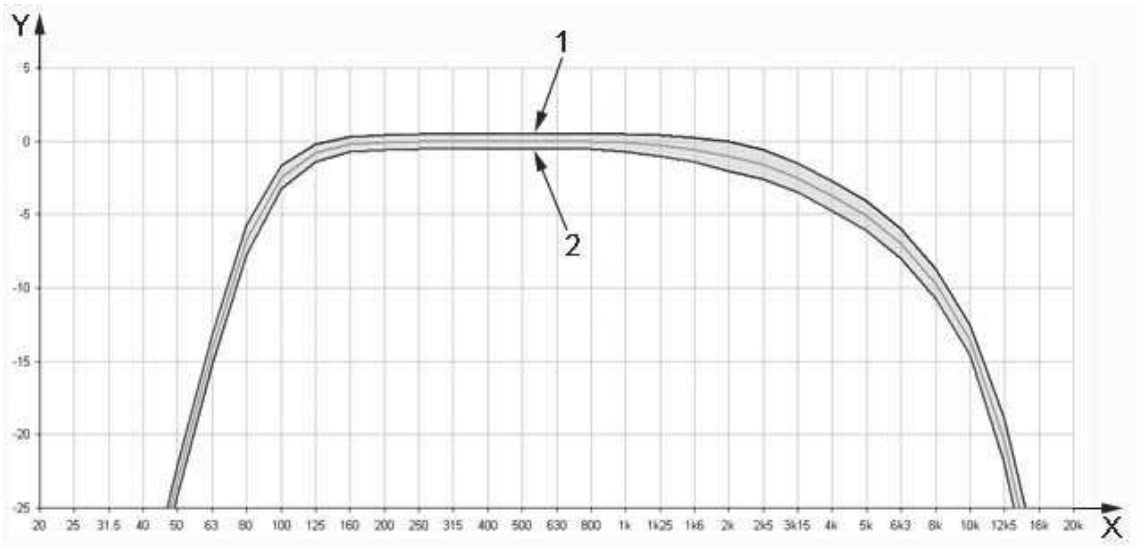
1 upper tolerance limit of power in the frequency range of the simulated program signal

2 lower tolerance limit of power in the frequency range of the simulated program signal

X frequency, expressed in hertz

Y relative power level, P_r, expressed in decibels

Figure B.2 — Power spectrum of simulated program signal excluding the band-pass filter from 89 Hz to 11,2 kHz



Key

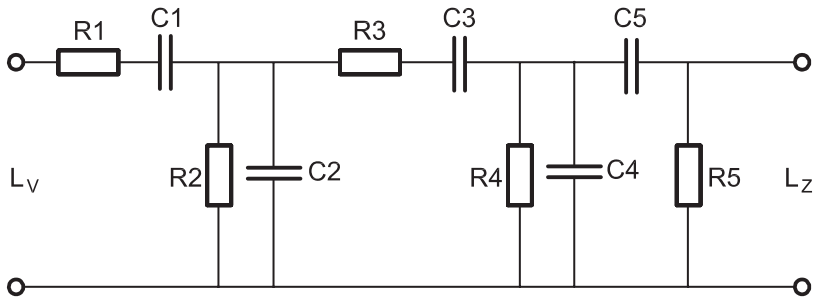
1 upper tolerance limit of power in the frequency range of the simulated program signal

2 lower tolerance limit of power in the frequency range of the simulated program signal

X frequency expressed in hertz

Y relative power level, P_r, expressed in decibels

Figure B.3 — Power spectrum of simulated program signal including the band-pass filter from 89 Hz to 11,2 kHz



Components

C1 capacitor with capacitance C = 2,2 µF

C2 capacitor with capacitance C = 91 nF

C3 capacitor with capacitance C = 2,2 µF

C4 capacitor with capacitance C = 68 nF

C5 capacitor with capacitance C = 0,47 µF

R1 resistor with resistance R = 430 Ω

R2 resistor with resistance R = 3,3 kΩ

R3 resistor with resistance R = 330 Ω

R4 resistor with resistance R = 3,3 kΩ

R5 resistor with resistance R = 10 kΩ

Connections and supplies

L_V EMF source (pink noise)

L_Z load impedance, <100 kΩ

NOTE 1 The output impedance of the source is included in the value of the resistance for R1 (430 Ω). The effect of the load impedance may be taken into account by adjusting the resistance of R5 (10 kΩ).

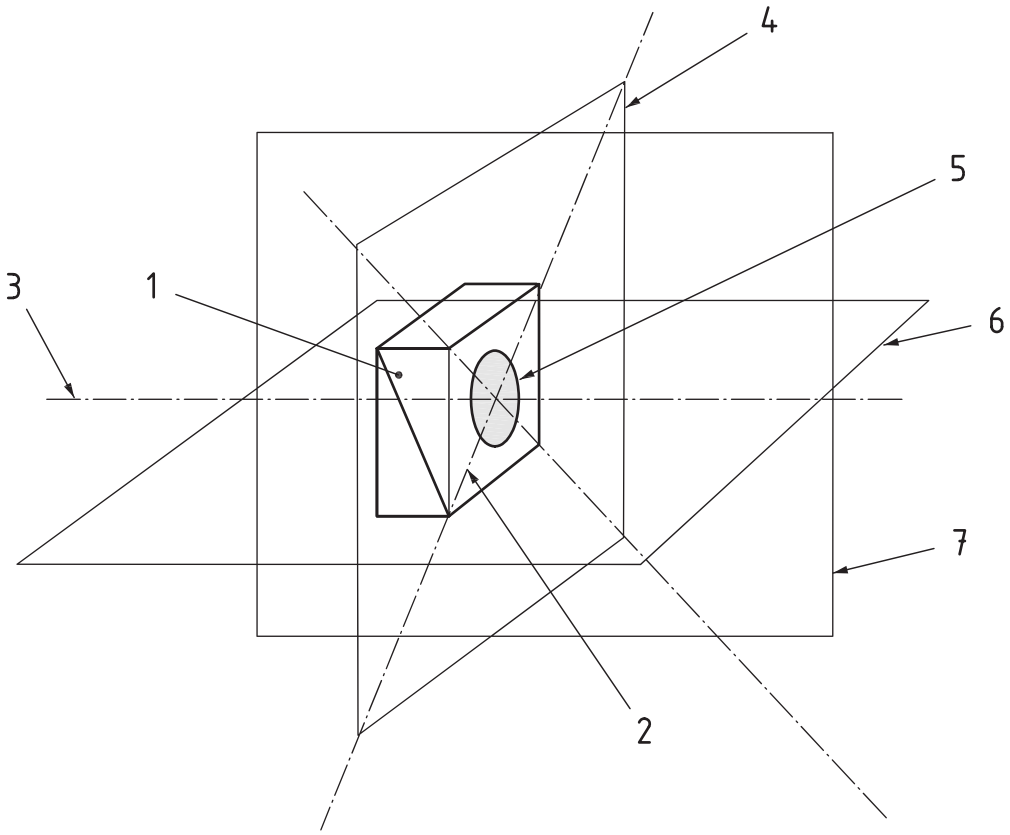
NOTE 2 The tangent of the loss angle of capacitors should not exceed 5×10^{-3}.

Figure B.4 — Filter for simulated program signal for pink noise source

Annex C
(informative)

Loudspeaker physical references

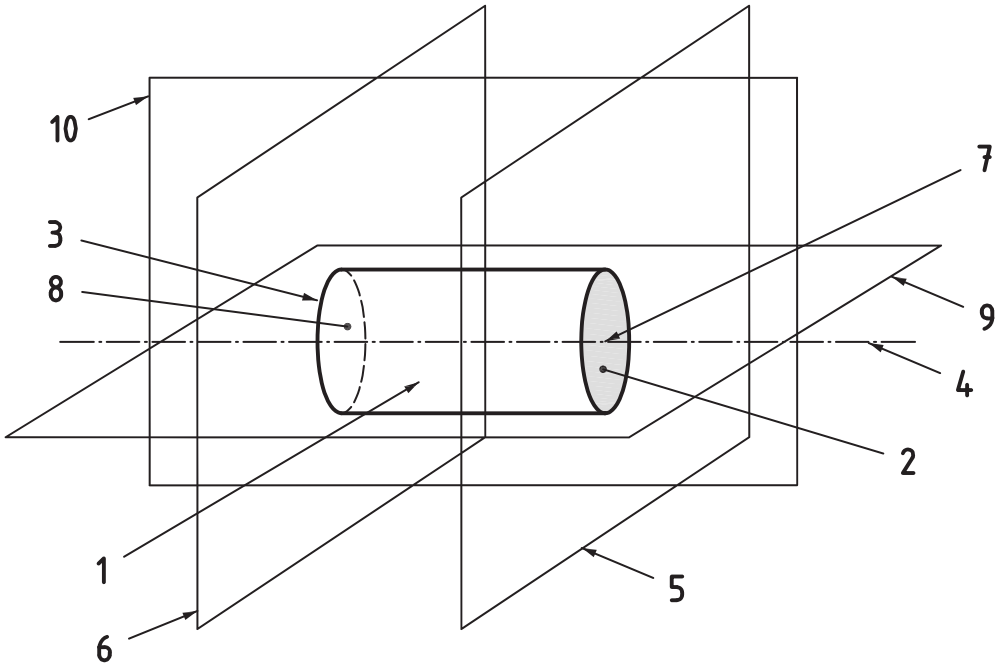
Figures C.1 and C.2 illustrate the definitions of reference planes, reference axes and reference points for loudspeakers (see 3.1.7, 3.1.15, 3.1.16, 3.1.17 and 3.1.22). Figure C.1 shows a typical simple loudspeaker comprised of a single enclosure and a single drive unit. Figure C.2 shows physical references for a more complex bi-directional loudspeaker, comprised of a single enclosure and two driver units.



Key

1 loudspeaker enclosure
2 loudspeaker front
3 reference axis
4 reference plane
5 reference point
6 horizontal plane
7 vertical plane

Figure C.1 — Typical single-enclosure, single-drive unit loudspeaker



Key

1	loudspeaker enclosure	6	reference plane 2
2	loudspeaker front 1	7	reference point 1
3	loudspeaker front 2	8	reference point 2
4	reference axis	9	horizontal plane
5	reference plane 1	10	vertical plane

Figure C.2 — Typical bi-directional loudspeaker with two drivers

Bibliography

[1] ISO 9001, *Quality management systems — Requirements*

[2] ISO 7240-3, *Fire detection and alarm systems — Part 3: Audible alarm devices*

[3] ISO 7240-19, *Fire detection and alarm systems — Part 19: Design, installation, commissioning and service of sound systems for emergency purposes*

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