
British Standard Methods for Determination of airborne acoustical noise emitted by household and similar electrical appliances

Part 1. General requirements for testing

[IEC title: Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances. Part 1: General requirements]

Méthodes de détermination du bruit aérien émis par les appareils électrodomestiques et analogues

Partie 1. Règles générales d'essai

Verfahren zur Bestimmung der Luftschallemission an Elektrogeräten für den Haushalt und ähnliche Zwecke

Teil 1. Allgemeine Prüfanforderungen

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National foreword

This Part of BS 6686 has been prepared under the direction of the Light Electrical Engineering Standards Committee. It is identical with IEC 704-1 : 1982 'Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances. Part 1 : General requirements' published by the International Electrotechnical Commission (IEC), which has been endorsed by CENELEC as HD 423.1 : 1982.

BS 6686 : Part 1 will need to be read with one or more of the standards published separately under Part 2, for particular appliances. The first of these, on vacuum cleaners, should be published in 1987.

Terminology and conventions. The test of the international standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

Wherever page numbers are quoted, they are IEC page numbers.

The comma has been used as a decimal marker in figures 1 to 7. In British Standards, as elsewhere in the text of the international standard, it is current practice to use a full point on the baseline as the decimal marker.

The following print types have been used in the standard:

Methods proper: Roman.

Explanatory matter: smaller Roman.

Cross-references

International standard	Corresponding British Standard
ISO 3741-1975	BS 4196 Sound power levels of noise sources Part 1 : 1981 Precision methods for determination of sound power levels for broad-band sources in reverberation rooms (Identical)
ISO 3742-1975	Part 2 : 1981 Precision methods for determination of sound power levels for discrete-frequency and narrow-band sources in reverberation rooms (Identical)
ISO 3743-1976	Part 3 : 1981 Engineering methods for determination of sound power levels for sources in special reverberation test rooms (Identical)
ISO 3744-1981	Part 4 : 1981 Engineering methods for determination of sound power levels for sources in free-field conditions over a reflecting plane (Identical)
ISO 3745-1977	Part 5 : 1981 Precision methods for determination of sound power levels in anechoic and semi-anechoic rooms (Identical)
IEC 225 : 1966	BS 2475 : 1964 Octave and one-third octave band-pass filters (Technically equivalent)
IEC 651 : 1979	BS 5969 : 1981 Specification for sound level meters (Identical)

The Technical Committee has reviewed the provisions of ISO 2204 and IEC 50(08) to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. A related British Standard to IEC 50(08): 1960 is BS 661 : 1969 'Glossary of acoustical terms'. ISO 6926 is in preparation.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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INTRODUCTION

Although the noise levels produced by household appliances do not generally present a hazard to the hearing of the operator or other exposed persons, the need for standardized procedures for the determination of the noise emitted has been recognized for a long time. Such procedures should be specified not only for special types of appliances, but the principles should be applicable to the majority of appliances in general use.

The potential users of such methods will be manufacturers of household appliances, testing laboratories, labelling organizations, and consumers' unions. Generally, the determination of noise levels is only part of a comprehensive testing procedure covering many aspects of the properties and performance of the appliance. It is therefore important that the requirements for noise measurements (e.g., test environment, instrumentation, and amount of labour involved) should be kept at a modest level.

In most cases, the results of noise measurements will be used for noise level indication purposes (e.g., for noise labelling), i.e. the results will be utilized for comparing the noise emitted by a specific appliance with the noise emitted by other appliances of the same family. In other cases, the results will be taken as basis for engineering action, for example, in the development stages of a new piece of equipment or in deciding on means for sound insulation. For all purposes, it is important to specify procedures with known accuracy so that the results of measurements taken by different laboratories can be compared.

These conditions have, as far as possible, been taken into account in the preparation of this code. The acoustic measuring methods are based on those described in ISO Standard 3743 "Acoustics — Determination of sound power levels of noise sources — Engineering methods for special reverberation test rooms" and ISO 3744 "Acoustics — Determination of sound power levels of noise sources — Engineering methods for free-field conditions over a reflecting plane".

The adoption of these methods permits the use of anechoic (or more correctly, semi-anechoic) chambers and specially adapted reverberant rooms. The result of the measurements is the sound power level of the appliance. Within the measuring uncertainty specific of these methods, the results from determination under free-field conditions over a reflecting plane are equal to those obtained in a special reverberant test room.

It should be emphasized that this code is concerned with airborne noise only. In some cases, structure-borne noise, for example transmitted to the adjoining room, may be of importance.

1. Scope and object

1.1 Scope

This standard applies to electric appliances (including their accessories or components) for household and similar use, supplied from mains or from batteries.

By similar use is understood the use in similar conditions as in households, for example in inns, coffee-houses, tea-rooms, hotels, barber or hairdresser shops, launderettes, etc., if not otherwise specified in Part 2.

This standard does not apply to:

- appliances, equipment or machines designed exclusively for industrial or professional purposes;
- appliances which are integrated parts of a building or its installations such as equipment for air conditioning, heating and ventilating (except household fans, cooker hoods and free standing heating appliances), oil burners for central heating, pumps for water supply and for sewage systems;
- separate motors or generators;
- appliances for outdoor use.

1.2 Object

This standard is concerned with objective methods of engineering accuracy (engineering method, grade 2 according to ISO 2204) for determining sound power levels L_w , expressed in decibels (dB) with reference to a sound power of 1 picowatt (1 pW), of airborne acoustical noise within the specified frequency range of interest, including the octave bands between 125 and 8 000 hertz (Hz) (this interval being, for practical reasons, narrower than the frequency range of audible sound), and for prescribed operating conditions of the appliance to be measured.

The following sound power levels are used:

- A-weighted sound power level, L_{wA} , and
- octave band sound power levels, L_{wOct} .

In general, the described methods are specified for appliances operated with no operator present. Only for the (rare) cases where an appliance can only be operated by an operator, or must be fed by an operator, shall a standard test operator be present, as specified in the relevant Part 2.

The uncertainties of measurements according to this standard tend to result, for A-weighted sound power levels, in standard deviations generally not exceeding approximately 2 dB, provided that the noise spectrum does not contain pronounced discrete frequencies; if it does, the magnitude of the uncertainties will be larger. The mentioned standard deviations reflect the cumulative effects of all causes of measurement uncertainties, excluding variations in the noise level of the appliance from test to test.

The noise values obtained under the described conditions of this standard will not necessarily correspond with the noise experienced under the operational conditions of practical use (see Sub-clause 6.4.1).

For quality control during production, etc., simplified methods may be appropriate. For noise control purposes (for example, development of quieter appliances, insulation of equipment, etc.) other measurement methods employing, for example, narrow-band frequency analysis will usually have to be applied. These methods are not covered by this standard.

Not included in this standard are methods for determining sound power levels with precision accuracy (precision method, grade 1 according to ISO 2204) specified for example in ISO Standards 3741, 3742 and 3745; they may, however, be applied if the appropriate instrumentation and test environment is available.

2. References

- ISO 2204-1979: Acoustics — Guide to international standards on the measurement of airborne acoustical noise and evaluation of its effects on human beings.
- ISO 3741-1975: Acoustics — Determination of sound power levels of noise sources — Precision methods for broad-band sources in reverberation rooms.
- ISO 3742-1975: Acoustics — Determination of sound power levels of noise sources — Precision methods for discrete-frequency and narrow-band sources in reverberation rooms.
- ISO 3743-1976: Acoustics — Determination of sound power levels of noise sources — Engineering methods for special reverberation test rooms.
- ISO 3744-1981: Acoustics — Determination of sound power levels of noise sources — Engineering methods for free-field conditions over a reflecting plane.
- ISO 3745-1977: Acoustics — Determination of sound power levels of noise sources — Precision methods for anechoic and semi-anechoic rooms.
- ISO 6926 (in preparation): Acoustics — Characteristics and methods of calibration of reference sound sources.
- IEC Publication 50(08): International Electrotechnical Vocabulary — Electro-acoustics.
- IEC Publication 225: Octave, Half-octave and Third-octave Band filters Intended for the analysis of Sounds and Vibrations.
- IEC Publication 651: Sound Level Meters.

3. Terms and definitions

3.1 *Terms and definitions pertinent to determination of sound power levels*

These may be found in ISO Standards 3743 and 3744.

3.2 *Direct method*

Method in which the sound power level is calculated from the measured sound pressure levels produced by the source to be tested, as follows:

- in free-field conditions: the sound pressure levels are averaged on the measurement surface and in time, the sound power level is calculated from the area of the measurement surface;
- in reverberant field conditions: the sound pressure levels are averaged in space and time, the sound power level is calculated from the volume and the reverberation time or the total absorption of the test room.

3.3 *Comparison method*

Method in which the sound power level is calculated by comparing the measured sound pressure levels produced by the source to be tested, with the sound pressure levels produced by a reference sound source in the same test environment and, as far as possible, in the same location and position.

3.4 *Period of observation*

The time interval during which acoustical data are obtained. The period of observation is specified depending upon the characteristics of the noise being measured, upon the required accuracy of the measurements and upon the characteristics of the instrumentation.

3.5 *Period*

A time interval during which a specified process is accomplished by the appliance to be tested, for example, washing, rinsing or drying in a dishwasher.

3.6 *Operational cycle*

A sequence of periods occurring in the appliance during normal use.

3.7 *Time history*

A continuous recording of the sound pressure level (for a distinct microphone position) as a function of time as obtained during one or more periods of an operational cycle.

3.8 *Standard test operator*

A person necessary for operating or feeding the source (appliance) to be tested, not wearing abnormally sound absorptive clothing which might influence sound measurements.

Additional details are given, if necessary, in Part 2.

3.9 *Centre of location or position of a source*

The term used for describing the location or position of the source (appliance) to be tested within the test environment and with respect to the co-ordinate system of microphone positions.

The centre of location is such that the centre of the appliance coincides with the centre of a parallelepiped drawn around the main part of hand-held, suspended or stand-type appliances.

The centre of location is such that the centre of the appliance coincides with the centre of a rectangle drawn around the projection of the main part of the appliance on the floor for floor-supported appliances and on the wall for wall-mounted appliances.

4. Measurement methods and acoustical environments

4.1 General information

The sound power of a noise source is the total sound energy radiated per second by the source, unit: watt. The sound power of a source is usually expressed as sound power level equal to ten times the logarithm to the base of 10 of the ratio of the sound power of the source to the reference sound power 1 pW ($= 10^{-12}$ W). Unit: decibel (dB).

The concept of sound power level has been chosen for expressing the noise emission of appliances for household (and similar purposes) mainly because:

1. For most purposes, it gives an adequate description of the noise emission of the appliance.
2. It can be determined with known accuracy from relatively simple acoustic measurements made under a variety of specified acoustic conditions.

According to this standard, there exist two principal methods, the direct method or the comparison method as described in Sub-clauses 4.2 and 4.3 below. These two methods can be used alternatively.

For each method, two types of environment, as described in Sub-clause 4.4, may be used. A Part 2 may, if necessary, exclude one or several combinations among the four thus available.

4.2 Direct method

- 4.2.1 The direct method can be used only for measurements in qualified test environments according to ISO Standard 3744 for free-field conditions over a reflecting plane and according to ISO Standard 3743 for special reverberation rooms.

With this method the sound power level is determined:

- in free-field conditions, from the time-averaged sound pressure levels, measured on the measurement surface and from the area of the measurement surface;
- in reverberant field conditions, from the space and time-averaged sound pressure levels and the equivalent sound absorption of the test room (or from the reverberation time and the volume of the test room).

This method yields results expressed in A-weighted sound power levels (and sound power levels in octave bands, if required) which are calculated directly from measured sound pressure levels.

4.3 Comparison method

The comparison method for measurements in a special reverberation test room is explicitly described in ISO Standard 3743, Sub-clause 8.3. The term “comparison method” is not explicitly given in ISO Standard 3744 for measurements in free-field conditions but when applying the “absolute comparisons tests” for the determination of the environmental correction given in Clause A.3 of ISO Standard 3744, by using a reference sound source, the procedure is, in fact, a comparison method.

With this method, the sound power level (A-weighted, and octave bands, if required) is determined by comparing the mean-square band sound pressure levels produced by the appliance under test with the mean-square band sound pressure levels produced in the same acoustical environment by a stable, thoroughly calibrated reference sound source (RSS) of known sound power output, complying with the requirements of ISO Standard 6926.

The accuracy depends essentially on the calibration of the reference sound source (RSS) which shall be performed in an appropriately equipped laboratory.

To check whether there is a systematic difference between results obtained in different environments, the use of the comparison method is recommended.

4.4 *Acoustical environments*

4.4.1 *Free-field conditions over reflecting plane(s)*

General requirements are given in Clause 4 of ISO Standard 3744.

For measurements to be carried out according to the direct method, and for measurements according to the comparison method if the A-weighted sound power level is to be determined directly from A-weighted sound pressure levels, the test environment shall be qualified by the procedure specified in Annex A of ISO Standard 3744.

Guidelines for the design of simple test rooms with free-field conditions are given in Appendix A of this standard.

4.4.2 *Special reverberation rooms*

The test room requirements are given in Clause 4 of ISO Standard 3743.

Guidelines for the design of a suitable test room are given in Appendix A of ISO Standard 3743.

5. **Instrumentation**

5.1 *Instrumentation for measuring acoustical data*

Requirements are given in Clause 5 of ISO Standards 3743 and 3744.

If for the measurements, sound level meters are applied, they shall comply with the requirements for type 1 of IEC Publication 651 and shall be used with the frequency-weighting A and the time-weighting S.

For measurements in free-field conditions, the microphone(s) shall be oriented with respect to the source in accordance with the angle of incidence as specified by the manufacturer for calibration. (The angle of incidence is the angle between the direction of propagation of sound waves and the longitudinal axis of the microphone.)

For measurements in reverberant-field conditions, the microphone(s) shall be designed and calibrated for randomly incident sound.

If the microphone(s) may be influenced (especially at low frequencies) by a moving air stream (with velocities exceeding approximately 2 m/s) generated, for example, by the appliance under test (fan heater, etc.), suitable wind-screens shall be applied for the microphone(s) and necessary corrections for changes in microphone sensitivity shall be added to the observed sound pressure levels.

Reference sound sources (RSS) shall have characteristics and shall be calibrated as specified in ISO Standard 6926.

5.2 *Instrumentation for measuring climatic conditions*

- 5.2.1 The temperature is determined with instruments having an accuracy of $\pm 1^\circ\text{C}$.
- 5.2.2 The relative humidity is determined with instruments having an absolute accuracy of $\pm 2\%$.

5.3 *Instrumentation for measuring operating conditions*

- 5.3.1 The voltage at the plug of the cable or cord of mains powered appliances is measured with voltmeters having an accuracy of Class 1 instruments if the tolerance for the voltage is specified with $\pm 2\%$, and is measured with voltmeters having an accuracy of Class 0.5 instruments if the tolerance for the supply voltage is specified with $\pm 1\%$.
- 5.3.2 The voltage at the battery terminals of battery powered appliances is measured with voltmeters having an accuracy of Class 1 instruments;
- 5.3.3 The rotational speed of motors, attachments, etc. is measured, if necessary, with speed indicators having an accuracy of $\pm 1\%$ of full scale.

6. **Operation and location of appliances under test**

6.1 *Equipping and pre-conditioning of appliances*

- 6.1.1 The appliance is equipped with attachments, accessories, etc. as delivered or specified by the manufacturer for the intended use or function.
- 6.1.2 Care shall be taken to ensure that any auxiliary equipment, for example, electrical conduits or cables, piping for water supply or drainage, air ducts, etc., necessary for the operation of the appliance, do not radiate significant amounts of sound energy into the test environment or change the sound output of the appliance.
- 6.1.3 Prior to noise measurements, the appliance equipped as for the intended use, shall have been in operation, as indicated in Part 2, for a total period of at least 2 h for running-in at the highest speed setting, if any, and without load.
- 6.1.4 Immediately before each series of noise measurements, the appliance, equipped as for the intended use, is operated 10 min for stabilizing at the highest speed setting, if any, without load.

Care should be taken to avoid possible overheating of appliances for short-time or intermittent use. Rated operating times have to be taken into account.

6.2 *Supply of electric energy and of water or gas*

- 6.2.1 Appliances with mains powered electric motor(s) are supplied at rated voltage with a tolerance of $\pm 2\%$, except for commutator motors, for which the tolerance is $\pm 1\%$, and, if applicable, at rated frequency. Appliances designed for d.c. only are supplied with d.c. Appliances not marked with rated frequency are supplied either with 50 Hz or with 60 Hz, as common in the country of use.

Appliances designed for a voltage range are supplied with the mean voltage of the range and the same tolerances as specified before, if the difference between the limits of the range does not exceed 10% of the mean voltage of the range. If the difference exceeds 10%, the appliance is supplied with the highest voltage of the range and the same tolerances as specified before.