BS EN 12102:2013

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Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling — Measurement of airborne noise — Determination of the sound power level

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National foreword

This British Standard is the UK implementation of EN 12102:2013. It supersedes BS EN 12102:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/17, Testing of air conditioning units.

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

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

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Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling - Measurement of airborne noise - Determination of the sound power level

Climatiseurs, groupes refroidisseurs de liquide, pompes à chaleur et déshumidificateurs avec compresseur entraîné par moteur électrique pour le chauffage et la réfrigération - Mesure de bruit aérien émis - Détermination du niveau de puissance acoustique

Klimageräte, Flüssigkeitskühlsätze, Wärmepumpen und Entfeuchter mit elektrisch angetriebenen Verdichtern zur Raumbeheizung und -kühlung - Messung der Luftschallemissionen - Bestimmung des Schallleistungspegels

This European Standard was approved by CEN on 30 May 2013.

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Foreword

This document (EN 12102:2013) has been prepared by Technical Committee CEN/TC 113 “Heat pumps and air conditioning units”, the secretariat of which is held by AENOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2014 and conflicting national standards shall be withdrawn at the latest by January 2014.

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

This document supersedes EN 12102:2008.

The main changes with respect to the previous edition are listed below:

a) the addition of a table containing the sound power levels to be recorded in the test report;

b) the addition of an Annex ZA relating to the Commission Regulation (EC) n°206/2012.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard establishes requirements for determining, in accordance with a standardized procedure, the sound power level emitted into the surrounding air by air conditioners, heat pumps, liquid chilling packages with electrically driven compressors when used for space heating and/or cooling, including water cooled multisplit systems, as described in EN 14511 and dehumidifiers as described in EN 810.

This European Standard also covers the measurement of the sound power level of evaporatively-cooled condenser air conditioners, as defined in EN 15218. However, the measurement should be done without external water feeding and these units will thus be considered as the other air conditioners covered by EN 14511.

It is emphasised that this measurement standard only refers to airborne noise.

This European Standard offers ways to determine the sound power level of units. Some of them are specifically adapted to provide results with low uncertainties, by using laboratory class acoustic methods and highly controlled working conditions. Those measurements are suitable for certification, labelling and marking purposes.

In some cases, the target and/or the environment of the measurements do not allow such precision-class methods. This European Standard also offers ways to assess sound power levels with acceptable accuracy even though acoustic methods and/or working conditions are not laboratory-type, e.g. *in situ* or quality control measurements.

This European Standard gives two classes of measurements and results, according to the test environment:

— Class A measurements correspond to controlled working conditions (standard or application rating conditions). It is defined by the respect to the tolerances of Table 2 and should be used for the conformity to requirements of the Commission Regulation (EC) No 206/2012 of 6 March 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air conditioners

— Class B measurements correspond to the case where the range defined by the tolerances of Table 2 cannot be fulfilled.

In both classes, precision or engineering class acoustic methods should be applied. The choice of the acoustic measurement method is done in accordance with EN ISO 3740 and EN ISO 9614 depending on the type of surrounding acoustic fields (diffuse or free field, enclosed or open space), and the available instrumentation. Whatever the current working conditions, the reference of acoustic standard should be reported, with explicit mention of its accuracy class.

The use of EN ISO 3746 and EN ISO 3747 as survey grade methods are not recommended due to the high level of uncertainties. Their use is only allowed for non controlled environments.

Three methods for determining the sound power levels are specified in order to avoid unduly restricting existing facilities and experience:

— the first methodology is based on reverberation room measurement (see EN ISO 3741, EN ISO 3743 and EN ISO 3747 in some favourable cases when the engineering grade can be fulfilled);

— the second method is based on measurements in an essentially free field over a reflecting plane (see EN ISO 3744 and EN ISO 3745);

— the third method is based on sound intensity measurement (see EN ISO 9614) in preferably free field environment.

The references in this European Standard to EN ISO 3743 should be understood as EN ISO 3743-1 or EN ISO 3743-2 as well.

The necessity to regulate the test conditions obviously leads to recommend test methods implemented in acoustically designed (enclosed) spaces, such as EN ISO 3741, EN ISO 3743, EN ISO 3745 and also EN ISO 9614 when implemented in an enclosed space.

The open spaces should be covered only in specific cases, e.g. when the size or the power of the unit under test cannot be managed by standard test rooms. Suitable test methods are EN ISO 3744 and EN ISO 9614.

NOTE Intensity measurement methods are quite robust and are well suited for tests to be done in environments without or with a light acoustic treatment (the better the acoustic treatment, the easier the implementation).

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.

EN 15218:2013, *Air conditioners and liquid chilling packages with evaporatively cooled condenser and with electrically driven compressors for space cooling - Terms, definitions, test conditions, test methods and requirements*

EN 810:1997, *Dehumidifiers with electrically driven compressors — Rating tests, marking, operational requirements and technical data sheet*

EN 14511-1:2013, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 1: Terms, definitions and classification*

EN 14511-2:2013, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 2: Test conditions*

EN 14511-3:2013, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 3: Test methods*

EN 14511-4:2013, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 4: Operating requirements, marking and instructions*

EN ISO 3740, *Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards (ISO 3740)*

EN ISO 3741, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms (ISO 3741)*

EN ISO 3743-1, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for small, movable sources in reverberant fields — Part 1: Comparison method for hard-walled test rooms (ISO 3743-1)*

EN ISO 3743-2, *Acoustics — Determination of sound power levels of noise sources using sound pressure - Engineering methods for small, movable sources in reverberant fields — Part 2: Methods for special reverberation test rooms (ISO 3743-2)*

EN ISO 3744, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane (ISO 3744)*

EN ISO 3747, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering/survey methods for use in situ in a reverberant environment (ISO 3747)*

EN ISO 9614-1, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points (ISO 9614-1)*

EN ISO 9614-2, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning (ISO 9614-2)*

EN ISO 9614-3, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 3: Precision method for measurement by scanning (ISO 9614-3)*

3 Terms, definitions and symbols

3.1 General

Terms, definitions and symbols of EN 14511:2013, EN 15218:2013 and EN 810:1997 apply.

The terms, definitions and symbols of the acoustic standards referred in Clause 2 apply.

The required value, sound power level, expressed in dB, is denoted by L_W, defined by:

$$Lw = 10 \cdot \log_{10}\left(W / W_o\right) \quad (1)$$

where W is the sound power and W_0 is the reference sound power = 1 pW (10^{-12} W)

3.2 Symbols

3.2.1 Non ducted units

The suffix "*i*" denotes the indoor side of units and "*o*" the outdoor ones.

L_{Wi} : sound power level radiated by the indoor side.

L_{Wo} : sound power level radiated by the outdoor side.

3.2.2 Ducted units

For ducted unit, the attended value is the sound power level travelling into the duct. It is assessed from the sound power level radiated by the air outlet opening of the duct, corrected by the "duct end correction" factor *E* (vori 6.2.2). The suffix "d" denotes the "in duct" sound power level.

L_{Wd} = sound power level travelling into the (discharge or suction) duct.

For the case of a ducted indoor side of a split unit:

L_{Wdi} = sound power level travelling into the (discharge or suction) duct of indoor unit.

For the case of a ducted unit on the outdoor side:

L_{Wdo} = sound power travelling into the (discharge or suction) duct of outdoor unit.

The sound radiated by the casing does not require any specific suffix. Use the same symbols as in 3.2.1 to specify which unit is concerned, indoor or outdoor side.

3.3 Standard operating conditions

The "standard operating conditions" shall be defined as the conditions for the operating points of the unit in accordance with the relevant parts of EN 14511 and EN 810. The definitions given in these European Standards also apply.

4 Measuring instruments

The instruments used for measuring and evaluation shall comply with the requirements of the standards appropriate to the test method used, from acoustic and capacity points of view.

To respect Class A measurements, the instruments necessary to control the working conditions shall fulfil the requirements of Table 1.

Table 1 — Uncertainties of measurement for indicated values

Measured quantity	Unit	Uncertainty of measurement
Liquid		
- temperature inlet/outlet	°C	± 0,3 K
- volume flow	m3/s	± 3 %
Air		
- dry bulb temperature	°C	± 0,5 K
- wet bulb temperature	°C	± 0,8 K
- static pressure difference	Pa	± 8 Pa ($\Delta p \leq 100$ Pa) ± 8 % ($\Delta p > 100$ Pa)
- volume flow	m³/s	± 10 %
Refrigerant		
- pressure at compressor outlet	kPa	± 3 %
- temperature	°C	± 1 K
Concentration		
- heat transfer medium	%	± 6 %
Electrical quantities		
- voltage	V	± 1 %
Rotation speed	min-1	± 1 %

Wet bulb temperature measurement involves the generation of air flow around a wet thermometer which may generate unwanted noise in the sound power measurement. It is then recommended to preferably determine relative humidity or dew point instead.

Suitable windshields are recommended to be fitted on microphones if they have to be affected by air velocity (above about 2 m/s) which may be produced by the appliance to be tested or by the laboratory facilities. Adjustment should be made to the measured sound pressure levels to compensate for any alteration in the sensitivity of shielded microphones. Above 10 m/s, windshields are usually not efficient enough and care shall

be taken to reduce the air velocity (by changing the location of microphones) or to change the type of windshields.

It is recommended to fit the intensity probes with windshields if they have to be affected by air velocity because they are much more sensitive to that parameter. For instance, the maximum air velocity admitted by EN ISO 9614-1 is 2 m/s.

5 Operation of the unit

NOTE The case of inverter devices is treated in Annex A.

As a general rule, the sound power level is dependent on the operating conditions of the unit. Sound measurements shall be carried out at the standard operating rating conditions.

The unit shall be installed and connected for the test as recommended by the manufacturer in its installation and operation manual according to EN 14511. The accessories provided by option (for example heating element) shall not be included in the test.

Steady state conditions of operation of the appliance are considered obtained and maintained when all the measured quantities remain constant, with respect of the tolerances given in Table 2.

The noise measurement shall be started no sooner than 30 min of operation under steady state conditions of the appliance.

These steady state conditions shall be maintained during the sound pressure (or intensity) measurements that may require from 30 s (multichannel analyzer) to sometimes several hours (free fieldmethods). This requires the continuous recording of the meaningful data.

The uncertainties of each measurement shall not exceed the values specified in Table 1.

Table 2 — Permissible deviations from set values

Measured quantity	Permissible deviation of the arithmetic mean values from set values	Permissible deviations of individual measured values from set values
Liquid		
- inlet temperature	± 1 K	± 1,5 K
- Δ T	± 1 K	± 1,5 K
- volume flow	± 5 %	± 10 %
Air		
-inlet temperature (dry bulb or wet bulb)	± 2 K [a]	± 3 K
- HR	± 10 %	± 15 %
- rpm of fan	± 3 %	± 6 %
Airflow		
- Static pressure difference	-	± 8 Pa for $\Delta P \leq 100$ Pa ± 10 % otherwise
- Airflow [b]	± 5 %	± 10 %
Refrigerant		
- Liquid temperature	± 3 K	± 5 K
- Saturated vapour/bubble point temperature	± 1,5 K	± 2,5 K
Voltage	± 4 %	± 4 %

[a] Care shall be taken with controlled outdoor fan speed units. Unless a specific procedure for fixing the frequency of the compressor's side fan is specified in the manufacturer's manuals bundled with the unit, the test shall be performed at maximum fan speed obtained with the unit running within the standard rating temperature conditions plus tolerances

[b] If the rating flow has been measured during a previous test, for instance, during a capacity measurement.

For units tested in enclosed space, care should be taken to the airflow of the unit (m³/h) which would preferably not exceed 60 times the volume of the room (m³). This upper limit indicates the microphones can be submitted to excessive air velocity. In addition, it is recommended to check the air speed through the microphone path(s) or at the different microphone positions to ensure negligible influence of air speed over the microphone(s).

The humidity needs not to be controlled during the sound measurement.

In the case of heat pumps with air as the heat transfer medium, the evaporator shall be free of ice during the measurement. However, sound measurements are sometimes not possible due to coil frosting and stationary time running requirement.

6 Installation

6.1 General points

The unit should be installed and connected up for the test as recommended by the manufacturer in its installation and operation instruction manual. In case of split or ducted units, care shall be taken to ensure that transmission of structure-borne sound via ducts and piping systems is minimised.

The test shall be performed with anti-vibratory pads if supplied by the manufacturer, otherwise make the unit level using small wooden wedges.

6.2 Ducted units

6.2.1 Installation

For units which are to be connected with ducts, it is recommended to use straight ducts, without bend. The length of the ducts will depend on the dimensions of the unit, but should be as short as possible.

If a bend cannot be avoided, only one soft bend without guide vanes is permissible in each duct.

The ducts shall not radiate noise capable of disturbing the measurements. In some cases (e.g. discharge or suction noise), the use of standard metal duct is sufficient to avoid a parasite radiation. However, in case of measurements of radiated noise of the casing for a ducted unit (e.g. in reverberation room), the radiation of duct should be as low as possible to avoid perturbation of the sound pressure under measurement. In that case, the ducts may be made of materials ensuring a good insulation against airborne transmission and having an acoustically reflecting outer layer.

It is permitted to change the shape of the duct, e.g. a rectangular outlet followed by a circular duct. In that case, the areas should be the same at ± 10 % and the change of shape should be as smooth as possible. This can be helpful because the circular ducts present a better sound insulation in the low frequency range than the rectangular ones.

Any soundproofing lining inside the ducts is prohibited. An external lining can be installed to limit the radiation. The best device is an additional uncoupled lagging.

The shape of the duct should fit the shape of inlet/outlet of the unit, and only one duct is allowed by inlet/outlet. It is recommended to insert a weak connection between the duct and the unit.

As no in-duct measurement is allowed, the measurement shall be carried out at the duct opening (inlet/outlet sound level), which should be preferably mounted flush to the wall (or to the reflecting plane).

The final sound power level results shall be given taking into account the corrections explained in 6.2.2.

6.2.2 Duct end correction

The acoustic energy travelling into the duct is not fully transferred to the surrounding space at the outlet (or inlet), because of the sudden change of acoustical impedance. For the low frequency range (large wavelength), a part of energy is reflected due to the change of section. To get the in-duct sound power level, it is then necessary to add a duct end correction factor E (dB) to the sound power level measured at the outlet (or inlet) of the duct. This correction depends on the equivalent diameter of the duct and on the frequency.

The equivalent diameter *D* (m) of any cross-sectional area A (m²) is the diameter corresponding to the cross-sectional area of a circular duct.

$$D = \sqrt{\frac{4 \cdot A}{\pi}} \tag{2}$$

The speed of sound in air (m/s), c_o, is defined by:

$$c_o = 20.5\sqrt{T + 273} \tag{3}$$

where T is the dry bulb temperature (°C) at the discharge or the suction of the duct.

For a duct terminating flush or at a distance less than D from the wall and radiating over 2 π, the duct end correction factor *E* is:

$$E = 10\lg\left(1 + \left(\frac{0.8\,c_0}{\pi\,f\,D}\right)^{1.88}\right) \tag{4}$$

where f is the centre frequency band (Hz).

NOTE For a duct penetrating into the free space, and radiating over 4 π, the duct end correction becomes:

$$E = 10\lg\left(1 + \left(\frac{c_0}{\pi\,f\,D}\right)^{1.88}\right) \tag{5}$$

The sound power level after correction corresponds to the sound power level travelling into the duct: the "in-duct" sound power level, L_{Wd}.

The sound power measured in the acoustic room is the sound power level radiated by the air outlet (inlet) opening.

L_{Wd} in-duct = L_W in the room + E (6)

In case of several ducts of same diameter (discharge or suction), the sound power level travelling in one duct can be determined by measuring the sound power level radiated by all the openings:

L_{Wd} one duct = L_W in the room + E – 10 lg (number of ducts) (7)

6.2.3 Bend correction

If the installation of a bend cannot be avoided, the sound level radiated by the air outlet (inlet) should be corrected. The bend tends to reflect part of the acoustic energy to the source; a part of energy is consequently not transferred outside. The correction B (dB) takes into account this phenomenon.

L_p without bend = L_p with bend – B (8)

Table 3, except from ASHRAE Applications Handbooks, gives the correction B for two types of bends, square and round bends (without turning vanes). The correction depends on the frequency and on the width of the duct.

Table 3 — Insertion loss of unlined elbows

Fw[a]	***B*** **= Insertion Loss, dB**	
	Square bends without turning vanes	Round bends
$fw < 48$	0	0
$48 \leq fw < 96$	1	1
$96 \leq fw < 190$	5	2
$190 \leq fw < 380$	8	3
$380 \leq fw < 760$	4	3
$fw > 760$	3	3
[a] ***fW*** **=** ***f*** (centre frequency considered (kHz)) * ***W*** (greater size width (mm))		

The test report should clearly mention the presence of that bend and its characteristics.

6.2.4 Pressure and airflow measurements

6.2.4.1 General

The working condition of a ducted unit requires getting data about the airflow rate. This European Standard recommends to measure simultaneously the available static pressure measurement and the rotation speed of the fan(s).

When the test is carried out in an enclosed space, the pressure measurement can be done using the difference of the static pressure between the two rooms used for the test. When testing in an open space, normalised duct lengths should be used. Minimum duct length and probe points for measuring pressure difference are defined in EN 14511-3:2013, B.2.1.

In case of in-situ measurement, the static pressure can be measured into the duct by following the requirements of EN ISO 5802**.**

If necessary, the airflow can be measured before the acoustic test; the aerodynamic working condition is then assessed by measuring a reference (available static pressure) in both cases. Airflow measurement should also be done according to EN ISO 5801.

Whatever the measurement method used, the report should mention the test method to determine airflow, static pressure and rotation speed values.

6.2.4.2 Wet Coils

When testing indoor units in cooling mode, the coil wets after a while and changes the airflow of the running unit. This is important for ducted indoor units (when tested in cooling mode) where the airflow is related to the available static pressure.

For ducted units, a minimum delay of 40 min with the unit running in nominal test conditions is usually required for the coil to wet.

Dry coil available pressure immediately after starting the unit will normally differ from final wet coil available pressure after a while with the unit’s fan running in specific test conditions.

Both wet coil and dry coil available pressure shall be registered and shall appear in the final report.

6.2.5 Casing radiated test

In the case of units, ducted on both inlet and outlet air sides, the sound power level of the noise radiated by the casing would be determined. Both openings shall be ducted with high insulation ducts (it may be necessary to lag the ducts with insulation devices). Care shall be taken to avoid all coupling between the duct and the lagging.

6.3 Wall mounted

The units intended to be mounted on a wall shall be mounted on a rigid tubular frame, without any area which could radiate unwanted noise.

NOTE Although this set-up is not exactly representative of real mounting, it avoids the radiation of the (light) plate usually used in these cases, and which is excited by the vibration of the unit.

For the free-field, hemi-anechoic room or intensity method, the unit shall be considered as a package unit, radiating in all the directions over a 4 π solid angle.

6.4 Ceiling mounted

The indoor units intended to be mounted in the ceiling, shall be suspended to a rigid tubular frame (avoiding radiating areas), the lowest part of the units being at least at 1,5 m above the floor.

No plane is required to simulate the ceiling.

6.5 Window-type

For window air conditioner, the unit shall be installed in an aperture in the separating wall of two rooms, following the requirements of the manufacturer. The outdoor side should be supported by a light structure with an uncoupling device to avoid parasite vibrations and sound radiation.

6.6 Multisplits

For multisplit air conditioners, the outdoor unit should be tested in a separate room, connected to all the necessary indoor units.

Whenever different indoor unit models may appear for a specific configuration, independent measurements shall be performed over each indoor unit model.

For multisplit systems running with only one indoor unit model, all identical indoor units can be measured at the same time and final sound power level for a single unit can be deduced from the following formula:

L_W of a single indoor unit = L_W of all identical indoor units – 10 lg (number of indoor units running at the same time). (9)

The outdoor unit sound power level shall be measured with all indoor units running at the same time.

6.7 Single ducts

6.7.1 Noise radiated by the casing

Single ducts are to be installed at 0,5 m from the nearest wall.

The flexible duct bundled with each unit shall be used for the set up of the unit. Any other fittings provided to be installed at the duct outlet as an option, shall not be installed.

If the bundled duct is not long enough, the length after extending the bundled duct to the maximum shall be enlarged using a duct with a casing capable of avoiding any unwanted noise coming from the add on.

It is recommended to use stiff iron, steel or high density plastic tubes for the insulation add on duct when needed.

A 0 Pa pressure difference should be ensured between the test room and the room in which open the outlet ducts.

6.7.2 Ducted outlet

Due to the high sound absorption coefficient of the normally bundled flexible ducts, the meaningful parameter to be determined is the sound power level of duct outlet.

In this case the installation of the unit shall be made according to the manufacturer's installation instructions and the duct length shall be of 0,5 m. Whenever the duct length is not long enough to reach 0,5 m, the procedure described in 6.7.1 shall be applied.

A 0 Pa pressure difference should be ensured between the test room and the room where the unit is installed.

The results for the ducted outlet shall not be corrected.

NOTE The duct end correction of 6.2.2 is not intended to be used here.

7 Acoustic measurement methods

7.1 Frequency range

The frequency range of interest is (100 – 10 000) Hz for one-third octave bands and (125 – 8 000) Hz for octave bands analysis.

For intensity method, the technology of the method limits the frequency range to (100 – 6 300) Hz.

NOTE With rare exceptions, 8 000 Hz and 10 000 Hz frequency bands usually do not have an impact on the overall dB(A) sound power level.

7.2 To choose a method

7.2.1 General

The choice of a method depends on:

— the target of the measurement (and the use of results);

— the available test facilities.

EN ISO 3740 is helpful to determine the method to preferably use according to the facilities and the environment.

7.2.2 Available test facilities

In acoustic rooms where air temperatures are controlled, precision or engineering methods can be used, such as EN ISO 3741, EN ISO 3743, EN ISO 3745 or EN ISO 9614-1 and -3.

In non-acoustic rooms where air temperatures are controlled, only engineering methods are likely to be applied, such as EN ISO 9614 or EN ISO 3743 (or EN ISO 3747 with engineering grade).

In open spaces where air temperatures are not controlled, only engineering (or survey) methods can be applied, such as EN ISO 3744, EN ISO 9614 or EN ISO 3746.

7.2.3 Target of measurement

For marking, certification or application of Directive (see Annex A) purposes, Class A measurements are required.

Precision acoustic methods such as EN ISO 3741, EN ISO 3745, EN ISO 9614-1 (with precision class criterions) and EN ISO 9614-3 are recommended as they lead to the smallest uncertainties. Measurements using engineering methods (EN ISO 3743, EN ISO 9614-1 and EN ISO 9614-2) are also allowed, even if their uncertainty is higher, as those present an interesting ratio level of accuracy/measurement costs.

When only open space is available, the operating conditions can usually not be fulfilled: Class B measurements. The result cannot be considered as standardized (even if acoustic precision method could be used). In that case, the results are considered as specific for an operating condition. The test report shall mention "*non standard condition*" and give the values of actual working conditions.

7.3 Reverberation room methods

7.3.1 General

The installation and the room design shall comply with EN ISO 3741 or EN ISO 3743.

NOTE The size and the shape of the room are decisive factors for an effective reverberation room, and particularly the non-parallel walls and their ratio of dimensions.

7.3.2 Non ducted units

To determine the sound power level L_W of a compact unit without ducts, the unit shall be installed inside the reverberation room with a minimum distance of at least 1,5 m from the nearest wall (see Figure 1).

NOTE It is often beneficial (and cautious) to position the unit into the room with no lateral side parallel to the wall (e.g. with an angle of 20º-25°) to avoid additional stationary waves.

Dimensions in metres

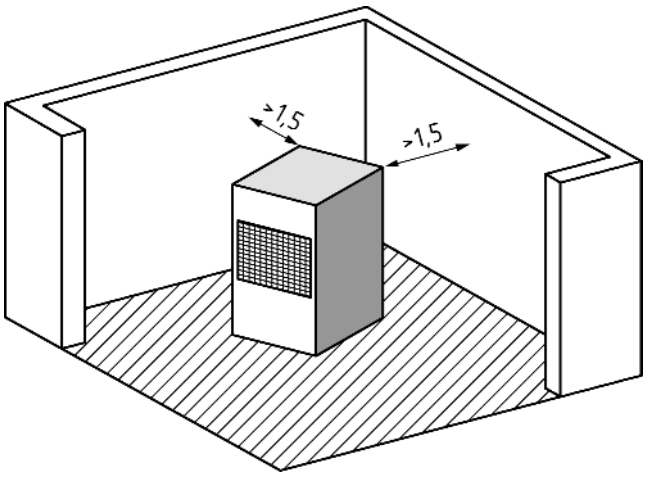


Figure 1 — Measurement of L_W in reverberation room

7.3.3 Ducted units

To determine the sound power radiated by the casing, the unit shall be installed into the room, with ducts connected to the outside through the wall. Care shall be taken to avoid parasite radiation of ducts.

To determine the sound power level L_{Wd}, the unit shall be installed outside the measuring room. The duct(s) shall be led into the reverberation room. The arrangement, construction, and setting of the length of the ducts shall be as described above. The duct(s) shall come onto the wall according to Figure 2.

The minimum distance of 1,5 m applies whenever the walls conforming the nearest corners to the duct end form an angle close to 90º. Irregular perimeter walls could be closer with negligible influence over the sound power radiated by the duct end.

Dimensions in metres

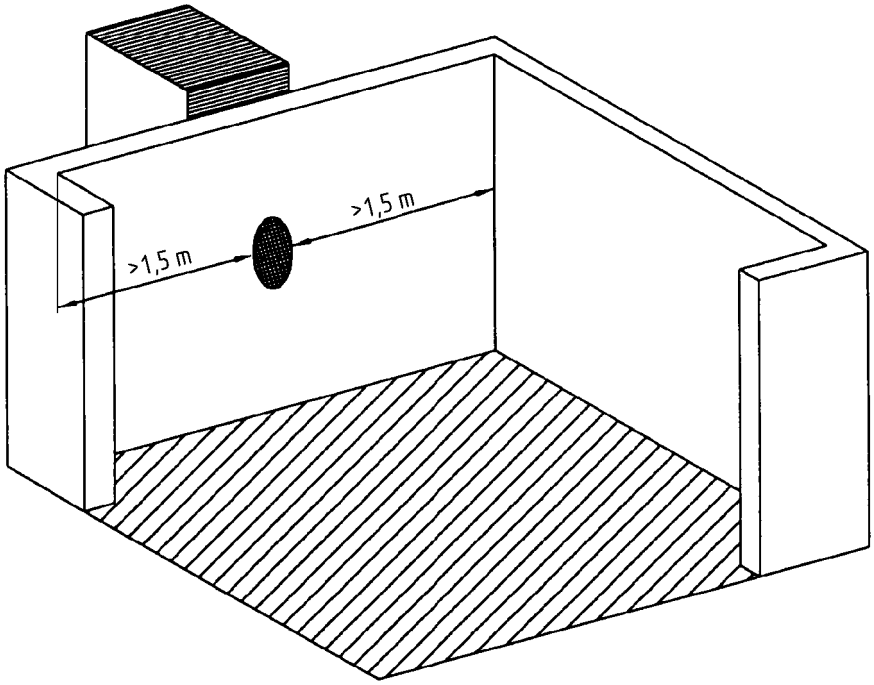


Figure 2 — Measurement of L_{Wd}, with flush terminating duct

7.4 Installation of the free field over a reflecting plane method

7.4.1 General

The environment of measurement shall be in accordance with EN ISO 3744 (all kinds of surface shape are allowed, but it is recommended to use the hemispherical measurement surface method, which leads to reduced level of uncertainty) and EN ISO 3745.

7.4.2 Reference surface

Two kinds of units are to be considered:

— units without ducts: the reference surface is specified in EN ISO 3744;

— units with ducts: the reference surface shall include the bend(s) of the ducts and parts of them.

For measuring L_{Wd} the reference surface shall be a flat reference area designed as shown in Figure 5.

7.4.3 Measuring surface

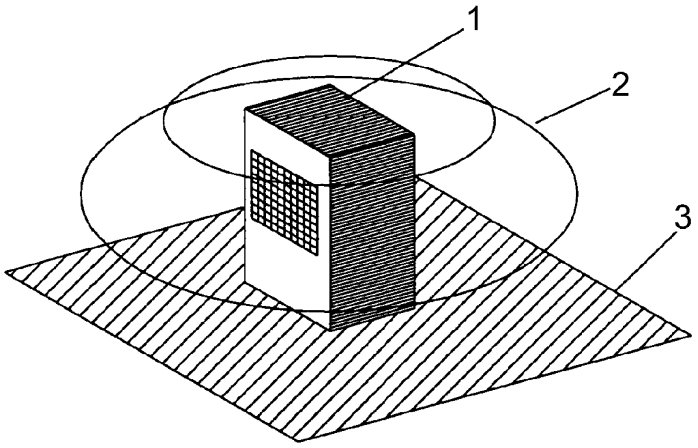
7.4.3.1 General

For the measuring surface and measuring points, two kinds of units are to be considered: units without or with ducts. In all cases, the reflecting planes shall extend in all directions at least half a wavelength of the lowest frequency of interest away from the measuring surface.

7.4.3.2 Units without ducts

For measuring L_W the unit shall be positioned on a horizontal reflecting plane as shown in Figure 3.

Around the reference surface, a hemispherical measurement surface shall be specified, ending on the plane.



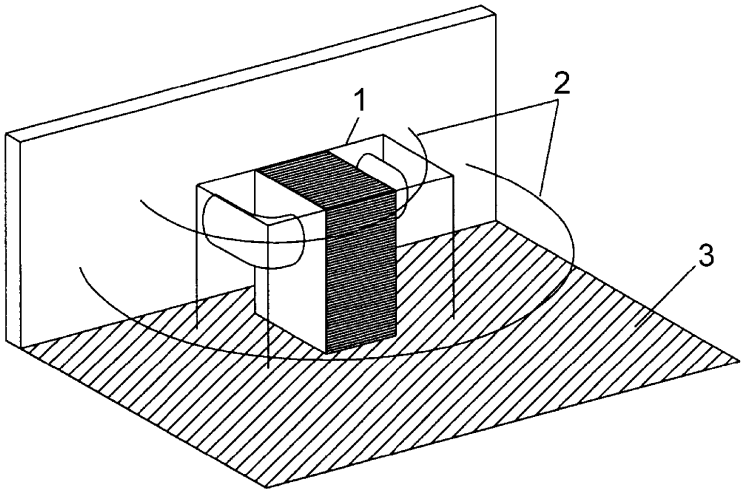
Key

1 reference surface
2 measurement surface
3 reflecting

Figure 3 — Measurement of L_W using the free field over a reflecting plane method

7.4.3.3 Units with ducts

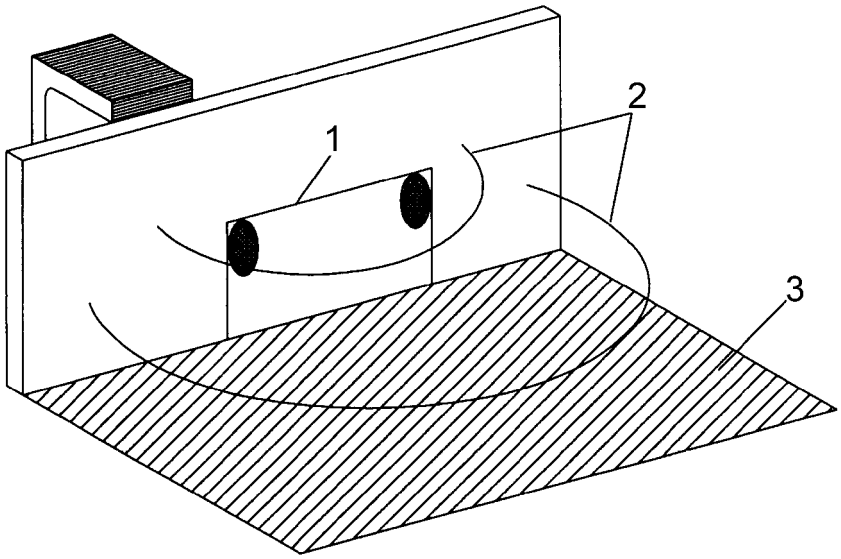
For measuring L_{Wio} a vertical reflecting plane has to be added. The weight of the vertical reflecting plane shall be at least 15 kg/m^2 and its coefficient of absorption shall be smaller than 0,1 in the considered range of frequencies. The unit shall be positioned against the vertical reflecting plane as shown in Figure 4.



Key

1 reference surface
2 measurement surface
3 reflecting surface

Figure 4 — Measurement of L_W using the free field over a reflecting plane method



Key

1 reference surface
2 measurement surface
3 reflecting surface

Figure 5 — Measurement of L_{Wd} using the free field over a reflecting plane method (e.g. of a double discharge or inlet – duct end correction to be applied)

The measuring surface for measuring L_{Wio} and L_{Wd} is shown in Figure 4 and Figure 5. The centre of the quarter spherical surface is situated at the junction of the two reflecting planes (in the dihedron).

Component units which are not being tested shall be installed in such a way that they have no significant effect on the measurement of the sound power level. This can be achieved by installing them inside a suitable acoustic enclosure.

8 Uncertainty of measurement results

As specified in the acoustic measurement standard, EN ISO 3740 series and EN ISO 9614 series.

It is highly recommended to use the Guide for Uncertainty of Measurement (GUM) to determine the uncertainty of measurement. Due to its analytical approach, it gives very interesting information about the components of uncertainty, thus ways to improve the measurement quality.

9 Test report

9.1 General

The test report shall give the designation of the method used, and the details specified in 9.2 to 9.5.

9.2 Unit specification

— type of unit;

— manufacturer's serial number;

— dimensions;

— manufacturer;

— year of manufacture.

9.3 Operating conditions, installation and environmental conditions

This part should state the class of working conditions, Class A if the working conditions correspond to the tolerances of Table 2, for standard or application rating conditions, done in a controlled environment and respecting the uncertainties from Table 1; otherwise Class B.

It should also mention the acoustical environment (free-field, reverberation room, hemi-anechoic room, etc.) and the class of measurement: precision or engineering.

All data regarding the installation of the unit (duct length, bends, mountings, feet, rubber pads, etc.) should be explicitly mentioned in this part.

9.4 Measurement instruments

— measuring equipment used, including details of name, type if necessary and manufacturer;

— serial number shall be kept by the laboratory in its registers;

— method of calibration used;

— a statement as to whether a windshield was used on the microphone. If used, the type shall be named.

9.5 Measured values and results

The report shall give the following information:

— acoustic power spectrum in octave bands (normative) or in one-third octave bands (optional), resolution 1/10 th dB, according to the range defined in 7.1;

— overall A-weighted sound power level (resolution 1/10th dB);

— date of measurement.

Furthermore, the following information shall be registered:

— the average set values measured during the stationary conditions required for the acoustic measurements, and according to the acoustic method;

— reverberation room method: position and alignment of mobile or fixed microphones path or microphone array (if necessary, a drawing can be attached);

— free field over a reflecting plane method: distance of measurement and shape of measurement surface;

— sound intensity method: table of criteria (see EN ISO 9614);

— if relevant, the test method used to measure airflow, static pressure and rotation speed.

Table 4 gives a template for the sound power levels results to be reported for air conditioners and heat pumps.

Table 4 — Sound power levels to be reported

	L_{WA} (outoor/indoor) in dB(A)
Standard rating conditions, indoor air dry bulb (wet bulb) temperature in cooling (or heating) mode	
Standard rating conditions, outdoor air dry bulb (wet bulb) temperature in cooling (or heating) mode	
Single-duct air conditioner or heat pump	L_{Wdo} / L_{Wi}
Double duct air conditioner or heat pump	L_{Wdo} / L_{Wi}
Air conditioners except single duct and double duct units (outdoor side / indoor side)	
- Non ducted / non ducted	L_{Wo} / L_{Wi}
- Ducted / non ducted	L_{Wdo} / L_{Wi}
- Non ducted / ducted	L_{Wo} / L_{Wdi}
- Ducted / ducted	L_{Wdo} / L_{Wdi}

Annex A
(normative)

Specific measurement for variable speed units

A.1 General requirements

The general requirements for non inverter units whichever the unit type (split, ducted or not, etc.) apply.

A.2 Test mode

The test mode is a specific running mode of the unit, only used for test purpose, with settings defined by the manufacturer, for which fan(s) and compressor(s) work at fixed frequencies.

The test mode shall set the frequencies of the fan(s) and compressor(s) that give the rating capacity as measured according to EN 14511-3, in order to assess the sound power level in the same operating conditions.

A.3 Measurements process

Whenever the unit is bundled with specific instructions for setting up the test mode of the unit, these instructions are to be followed so the unit starts running at a fixed frequency.

Such instructions shall be included in the installation or user's manual. This procedure is required in the manuals because the announced capacities for a certain unit are only achieved when using the start up procedure and when the unit is running at standard rating conditions.

Whenever no specific start up procedure is indicated for testing purposes, the unit shall be tested as a non inverter unit type but care should be taken to ensure that the unit was running in steady state compressor and fan frequency by at least measuring the power input to the unit during test time.

Once the setting of the unit is obtained, the sound power level determination test is performed as for a non inverter unit type.

Annex ZA
(informative)

Relationship between this European Standard and the requirements of Commission Regulation (EC) No 206/2012

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to requirements of *Commission Regulation (EC) No 206/2012 of 6 March 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air conditioners*.

Once this standard is cited in the Official Journal of the European Union under that Commission Regulation, compliance with the clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding requirements of that and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] ENV 13005:1999, *Guide to the expression of uncertainty in measurement*

[2] EN ISO 3745, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for anechoic and hemi-anechoic rooms (ISO 3745)*

[3] EN ISO 3746, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane (ISO 3746)*

[4] EN ISO 5801, *Industrial fans — Performance testing using standardized airways (ISO 5801:2007 including Cor 1:2008)*

[5] EN ISO 5802:2008, *Industrial fans — Performance testing in situ (ISO 5802:2001)*

[6] "Investigations of the sound power of aerodynamic sources as a function of static pressure", Gerhard HÜBNER, Volker WITTSTOCK, Inter-Noise 2001, The Hague, The Netherlands, 2001 August 27-30

[7] "How to estimate the sound level of *inverter*-type air-conditioner units", François BESSAC, Inter-Noise 2004, Prague, The Czech Republic, 2004 August 23-25

[8] "Assessment of reproducibility uncertainties for use in international standards on the determination of sound power", PAYNE R ; SIMMONS D., NPL Reports

[9] ASHRAE Applications Handbook SI – 2003 Chapter 47: Sound & Vibration Control Tables 13 and 14 (pages 47.16)

[10] GUM: Guide to the Expression of Uncertainty in Measurement

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