

**E C M A**

**EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION**

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**STANDARD ECMA-74**

**MEASUREMENT OF AIRBORNE NOISE  
EMITTED BY COMPUTER  
AND BUSINESS EQUIPMENT**

**3rd Edition - December 1992**

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## Brief History

ECMA-74 specifies methods for the measurement of airborne noise emitted by computer and business equipment. Hitherto, a wide variety of methods has been applied by individual manufacturers and users to satisfy particular equipment or application needs. These diverse practices have, in many cases, made comparison of noise emission difficult. This Standard simplifies such comparisons and is the basis for declaration of the noise emission level of computer and business equipment.

In order to ensure accuracy, validity and acceptability, this Standard is based on the basic International Standards for determining the sound power level and the sound pressure level at the operator position(s). Furthermore, implementation is simplified by conformance to these International Standards.

In many cases free-field conditions over a reflecting plane are realized by semi-anechoic rooms. These rooms may be particularly useful during product design to locate and to improve individual contributing noise sources. Reverberation rooms may be more economical for production control and for obtaining sound power levels for noise emission declaration purposes.

The method for measuring the sound pressure level at the operator or bystander positions (ISO 6081 superseded by ISO 11201) is specified in a separate clause, as this level is not considered to be primary noise emission declaration information. The measurements can, however, be carried out at the same time as those for sound power determination in a free field over a reflecting plane.

For comparison of similar equipment it is essential that the installation conditions and mode of operation are the same. In annex C these parameters are standardized for many categories of equipment.

The first edition of this Standard was issued in September 1981. It was contributed to ISO TC43 and formed the base for ISO 7779. The second edition was issued in December 1987. The differences between the third and the second edition are indicated in annex G.



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## **1 General**

### **1.1 Scope**

ECMA-74 specifies procedures for measuring and reporting the noise emission of computer and business equipment. It is based on the measurement procedures specified in International Standards ISO 3740, ISO 3741, ISO 3742, ISO 3744 and ISO 3745. The basic emission quantity is the A-weighted sound power level which may be used for comparing equipment of the same type but from different manufacturers, or for comparing different equipment.

The A-weighted sound power level is supplemented by the A-weighted sound pressure level measured at the operator position(s) or the bystander positions. This sound pressure level is not a worker's immission rating level, but it may assist in identifying any potential problems that could cause annoyance, activity interference, or hearing damage to operators and bystanders.

Two methods for determining the sound power levels are specified in this Standard in order to avoid undue restriction on existing facilities and experience. The first method is based on reverberation room measurements (ISO 3741 and ISO 3742); the second is based on measurements in an essentially free field over a reflecting plane (ISO 3744, and ISO 3745). Either method may be used in accordance with this Standard. An alternative method for determining the A-weighted sound power level using sound intensity techniques is given in ECMA-160. The three methods are comparable in accuracy and yield the same A-weighted sound power level within the tolerance range of the methods specified in this Standard.

Methods for determining on whether the noise emission includes prominent discrete tones or is impulsive in character are given in annexes D and E respectively.

### **1.2 Field of Application**

This Standard is suitable for type tests and provides methods for manufacturers and testing laboratories to obtain comparable results.

The methods specified in this Standard allow the determination of noise emission levels for a unit tested individually.

The procedures in this Standard may be applied to equipment which emits broad-band noise, narrow-band noise and noise which contains discrete-frequency components, or impulsive noise.

The sound power and the sound pressure levels obtained may serve noise emission declaration and comparison purposes (see ECMA-109). They are not to be considered as installation noise immission levels; however they may be used for installation planning (see ECMA TR/27).

If sound power levels obtained are determined for several units of the same production series, they can be used to determine a statistical value for that production series.

## **2 Conformance**

Measurements are in conformance with this Standard if they meet the following requirements.

- The measurement procedure, the installation and the operating conditions specified by this Standard are taken fully into account.
- For the determination of sound power levels, the method specified in clause 5 or the method specified in clause 6 is used.
- For the measurement of sound pressure level at the operator or bystander positions, the method specified in clause 7 is used.

### 3 References

ECMA-108	Measurement of High Frequency Noise Emitted by Computer and Business Equipment (1989)
ECMA-109	Declared Noise Emission Values of Computer and Business Equipment (1992)
ECMA-160	Determination of Sound Power Levels of Computer and Business Equipment using Sound Intensity Measurements; Scanning Method in Controlled Rooms (1992)
ECMA TR/27	Method for the Prediction of Installation Noise Levels (1985)
ISO 266:1975	Preferred frequencies for measurements
ISO 3740:1980	Guidelines for the use of basic International Standards and for the preparation of noise test codes
ISO 3741:1988	Precision methods for broad-band sources in reverberation rooms
ISO 3742:1988	Precision methods for discrete-frequency and narrow-band sources in reverberation rooms
ISO 3743:1988	Engineering methods for special reverberation rooms
ISO 3744:1981	Engineering methods for free-field conditions over a reflecting plane
ISO 3745:1977	Precision methods for anechoic and semi-anechoic rooms
ISO 6081:1986	Guidelines for the preparation of test codes of engineering grade requiring noise measurements at the operator's or bystander's position
ISO 6926:1990	Characterization and calibration of reference sound sources
ISO 7779:1988	Measurement of airborne noise emitted by computer and business equipment
ISO 9295:1988	Measurement of high-frequency noise emitted by computer and business equipment
ISO 9296:1988	Declared noise emission values of computer and business equipment
ISO 11160:1993	Information technology - Minimum information to be included in specification sheets - Printing machines
ISO DIS 11201:1992	Acoustics - Noise emitted by machinery and equipment - Engineering method for the measurement of emission sound pressure levels at the work station and at other specified positions
ISO/IEC 10561:1991	Information technology - Method for measuring printer throughput
IEC 225:1982	Octave, half-octave and third-octave band filters intended for the analysis of sound and vibrations
IEC 651:1979	Sound level meters
IEC 804:1985	Integrating - averaging sound level meters

### 4 Definitions

For the purpose of this Standard the following definitions apply.

#### 4.1 A-weighted impulse sound pressure Level, $L_{pAI}$ in dB

The A-weighted sound pressure level determined with a sound level meter set for the I-time weighting characteristic (impulse).



**4.2 Bystander**

An individual who is not the operator of the equipment but whose position lies within the sound field produced by the equipment, either occasionally or continuously.

**4.3 Bystander position**

A measurement position at a typical location occupied by a bystander.

**4.4 C-weighted peak sound pressure level,  $L_{pCpeak}$  in dB**

The highest instantaneous value of the C-weighted sound pressure level determined over an operational cycle.

**4.5 Computer and business equipment**

Equipment and components thereof which are primarily used in offices or office-like environments and in computer installations.

**4.6 Floor-standing equipment**

A functional unit which is intended to be installed on the floor with or without its own stand.

**4.7 Frequency range of interest**

This range normally extends from the 100 Hz one-third octave band to the 10 000 Hz one-third octave band. The 16 kHz octave band shall be included if a preliminary investigation indicates that it may affect the A-weighted sound pressure or sound power levels. If the noise in the 16 kHz octave band contains discrete tones, then the 16 kHz octave band shall not be included in the determination of the A-weighted levels. The range and centre frequencies of the octave bands are specified in ISO 266. See table 7 for additional information.

*NOTE 1*

*If the 16 kHz octave band is included in the measurements, the procedures of this Standard may yield measurement uncertainties greater than those stated.*

*NOTE 2*

*For equipment which emits sound only in the 16 kHz octave band, the procedures specified in ECMA-108 (ISO 9295) should be used.*

**4.8 Functional unit**

An entity of physical equipment, which has been allocated an identification number, capable of accomplishing a specified task. A functional unit may be supported by a frame or frames and may be self-enclosed or designed to be attached to another device.

**4.9 Idle mode**

A condition in which the equipment being tested, after any necessary warm-up period, is energized but is not operating.

**4.10 Level of background noise**

The sound pressure level at specified locations when the equipment being tested is neither operating nor idling.

**4.11 Measurement surface**

A hypothetical surface of area  $S$  enveloping the equipment being tested on which the measuring points are located.

**4.12 Operating mode**

A condition in which the equipment being tested is performing its intended function(s).

**4.13 Operator**

An individual who operates a piece of equipment from a position in the immediate vicinity of the equipment.

**4.14 Operator position**

A measurement position at the assigned work station of the operator.

**4.15 Rack-mounted equipment**

One or more sub-assemblies installed in an end-use enclosure.

**4.16 Reference box**

A hypothetical reference surface which is the smallest rectangular parallelepiped that just encloses the equipment being tested and terminates on the reflecting plane.

**4.17 Reference sound source**

A device which is intended for use as a stable source of sound, which has a known, calibrated broad-band sound power spectrum over the frequency range of interest and which conforms to ISO 6926.

**4.18 Sound power level,  $L_W$  in dB**

Ten times the logarithm to the base 10 of the ratio of a given sound power to the reference sound power. The weighting network (A-weighting) or the width of the frequency band used shall be indicated. The reference sound power is 1 pW.

*NOTE 3*

*For the purpose of this Standard, the sound power is the time-average value of the sound power during the measurement duration.*

**4.19 Sound pressure level,  $L_p$  in dB**

Ten times the logarithm to the base 10 of the ratio of the time-mean-square sound pressure to the square of the reference sound pressure. The weighting network (A-weighting) or the width of the frequency band used shall be indicated. The reference sound pressure is 20  $\mu$ Pa.

*NOTE 4*

*For the purpose of this Standard the sound pressure is the square root of the time-average value of the squared sound pressure during the measurement duration.*

**4.20 Test table**

A rigid table having a top surface of at least 0,5 m<sup>2</sup> (length of the top plane  $\geq$  700 mm). A suitable design for the test table is shown in annex A.

**4.21 Sub-assembly**

A functional unit intended to be installed in another unit or assembled with other units in a single enclosure. The unit may or may not have its own enclosure and identification number.

**4.22 Surface-average sound pressure level,  $L_{pt}$  in dB**

Space/time-average sound pressure level average over a measurement surface, corrected for the environment.

**4.23 Table-top equipment**

A functional unit that has a complete enclosure and is intended to be installed or used on a table, desk or separate stand.



**4.24 Time-average sound pressure level,  $\overline{L}_{pT}$  in dB**

The equivalent continuous sound pressure level during time T, in decibels: Ten times the logarithm to the base 10 of the ratio of a time-mean-square value of instantaneous band-limited sound pressure, during a stated time interval, to the square of the standard reference sound pressure.

**4.25 Wall-mounted equipment**

A functional unit which is normally mounted against or in a wall and does not have a stand of its own.

**5 Method for determining sound power levels of equipment in reverberation rooms**

**5.1 General**

The method specified in this clause provides a comparison procedure for determining the sound power levels produced by computer and business equipment using a reverberation room. It applies to equipment which radiates broad-band noise, or narrow-band noise, or noise which contains discrete-frequency components or impulsive noise.

The measurements shall be carried out in a qualified reverberation room. The volume of the equipment being tested should preferably be not greater than 1 % of the volume of the reverberation room.

*NOTE 5*

*Measurements on equipment which has a volume of less than 1 m<sup>3</sup> and emits broad-band noise may be carried out in a special reverberation test room (see ISO 3743).*

**5.2 Measurement uncertainty**

Measurements carried out in accordance with this method yield standard deviations which are equal to, or less than, those given in table 1.

**Table 1 - Uncertainty in determining sound power levels in a reverberation room**

Octave band centre frequencies Hz	One-third octave band centre frequencies Hz	Standard deviation dB
125	100 to 160	3,0
250	200 to 315	2,0
500 to 4 000	400 to 5 000	1,5
8 000	6 300 to 10 000	3,0

*NOTE 6*

*For most computer and business equipment, the A-weighted sound power level is determined by the sound power levels in the 250 Hz to 4 000 Hz octave bands. The A-weighted sound power level is determined with a standard deviation of approximately 1,5 dB. A larger standard deviation may result when the sound power levels in other bands determine the A-weighted level.*

*NOTE 7*

*The standard deviations given in table 1, reflect the cumulative effects of all causes of measurement uncertainty, including variations from laboratory to laboratory, but excluding variations in the sound power level from equipment to equipment or from test to test which may be caused, for example, by changes in the installation or operating conditions of the equipment. The reproducibility and repeatability of the test results for the same piece of equipment and the same measurement conditions may be*



considerably better (i.e. smaller standard deviations) than the uncertainties given in table 1 would indicate.

**NOTE 8**

*If the method specified in this clause is used to compare the sound power levels of similar equipment that are omnidirectional and radiate broad-band noise, the uncertainty in this comparison yields a standard deviation which is less than that given in table 1, provided that the measurements are carried out in the same environment.*

**5.3 Test environment**

**5.3.1 General**

Guidelines specified in ISO 3741 and ISO 3742 for the design of the reverberation room shall be used. Criteria for room absorption and the procedure for room qualifications given in these same International Standards shall be used.

**5.3.2 Test room volume**

The minimum test room volume shall be as stated in table 2. If frequencies above 3 000 Hz are included in the frequency range of interest, the volume of the test room shall not exceed 300 m<sup>3</sup>. The ratio of the maximum dimension of the test room to its minimum dimension shall not exceed 3:1.

**Table 2 - Minimum room volume as a function of the lowest frequency band of interest**

Lowest frequency band of interest Hz	Minimum room volume m <sup>3</sup>
125 Hz octave or 100 Hz third-octave	200
125 Hz third-octave	150
160 Hz third-octave	100
250 Hz octave or 200 Hz third-octave and higher	70

**5.3.3 Level of background noise**

The level of the background noise, including any noise due to motion of the microphone and/or rotating diffusers, shall be at least 6 dB, and preferably more than 15 dB, below the sound pressure level to be measured in each frequency band within the frequency range of interest. See also 6.7.3.

**5.3.4 Temperature and relative humidity**

The air absorption in the reverberation room varies with temperature and humidity, particularly at frequencies above 1000 Hz. The temperature  $\theta$  in °C and the relative humidity (rh), expressed as a percentage, shall be controlled during the sound pressure level measurements. The product

$$rh \times (\theta + 5)$$

shall not vary by more than  $\pm 10$  % during the measurements specified in 5.6, 5.7 and 5.8. For equipment the sound pressure level of which varies with temperature, the room temperature during the measurement shall be  $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ .

The following conditions are recommended:

- Barometric pressure : 86 kPa to 106 kPa
- Temperature : 15 °C to 30 °C
- Relative humidity : 40 % to 70 %

## **5.4 Instrumentation**

### **5.4.1 General**

The instrumentation shall be designed to measure the time-average sound pressure level in octave and/or one-third octave bands. The space/time-average sound pressure level is the level of the squared sound pressure averaged over time and space. Alternatively, the space/time-average sound pressure level may be calculated in accordance with 5.9.

The instrument used may perform the required averaging in one of two different ways:

- i) By integrating the squared signal over a fixed time interval and dividing by the time interval. This integration may be performed by either digital or analogue means. Digital integration is the preferred method (see IEC Publication 804).
- ii) By continuous averaging of the square of the signal using RC-smoothing with a time constant of at least 1 s ("slow" - meter characteristic). Such continuous averaging provides only an approximation of the true average and it places restrictions on the settling time and observation time (see 5.7.2).

### **5.4.2 The microphone and its associated cable**

The microphone used shall comply with the requirements regarding accuracy, stability and frequency response for a type 1 instrument specified either in IEC Publication 651 or in IEC Publication 804 and shall have been calibrated for its random incidence response.

The microphone and its associated cable shall be chosen so that their sensitivity does not change by more than 0,2 dB over the temperature range encountered during measurement. If the microphone is moved, care shall be exercised to avoid introducing acoustical or electrical noise (e.g. from gears, flexing cables, or sliding contacts) that could interfere with the measurements.

### **5.4.3 Frequency response of the instrumentation system**

The frequency response of the entire instrumentation system shall be flat over the frequency range of interest within the tolerances given either in IEC Publication 651 or, preferably, in IEC Publication 804, for type 1 instruments.

### **5.4.4 Reference sound source**

The reference sound source shall meet the requirements specified in ISO 6926 over the frequency range of interest.

### **5.4.5 Filter characteristics**

An octave-band or one-third octave-band filter set complying with the requirements specified in IEC Publication 225 shall be used. The centre frequencies of the bands shall correspond to those specified in ISO 266.

### **5.4.6 Calibration**

During each series of measurements, an acoustical calibrator with an accuracy of  $\pm 0,5$  dB shall be applied to the microphone to check the calibration of the entire measuring system at one or more frequencies over the frequency range of interest. The calibrator shall be checked at least once a year to verify that its output has not changed. In addition, an acoustical and an electrical calibration of the instrumentation system over the entire frequency range shall be carried out at least every two years. The reference sound source shall be checked annually to verify that its output sound level has not changed.



## 5.5 Installation and operation of equipment - General requirements

### 5.5.1 Equipment installation

The equipment shall be installed according to its intended use. Installation conditions for many different categories of computer and business equipment are specified in annex C; these shall be followed when declaration information is to be obtained. If the normal installation is unknown or if several possibilities exist, a representative condition shall be chosen and reported.

- a) Floor-standing equipment shall be located at least 1,5 m from any wall of the room and no major surfaces shall be parallel to a wall of the reverberation room.

If the equipment being tested consists of several frames bolted together in an installation or is too large for testing purposes, the frames may be measured separately. In such circumstances, additional covers may be required for the frames during the acoustical evaluation. These additional covers shall be acoustically comparable with the other covers on the equipment. If a unit is mechanically or acoustically coupled to another unit so that the noise levels of one are significantly influenced by the other, the equipment being tested shall, where practicable, include all units coupled together in this way.

- b) Floor-standing equipment which is to be installed only in front of a wall shall be placed on a hard floor in front of a hard wall (see note 17 in 6.3.1). The distance from the wall shall be in accordance with the manufacturer's instructions or as specified in annex C. If such information is not available, the distance shall be 0,1 m.
- c) Table-top equipment shall be placed on the floor at least 1,5 m from any wall of the room unless a table or stand is required for operation according to annex C, e.g. printers which take paper from or stack paper on the floor. Such equipment shall be placed in the centre of the top plane of the standard test table (see annex A).
- d) Wall-mounted equipment shall be mounted on a wall of the reverberation room at least 1,5 m from any other reflecting surface, unless otherwise specified. Alternatively, if operation permits, the equipment may be laid with its mounting surface on the floor at least 1,5 m from any wall of the room.
- e) Rack-mounted equipment shall be placed in an enclosure which complies with the installation specifications for the equipment. The location of all units within the enclosure shall be described. The enclosure shall be tested as floor-standing or table-top equipment. Rack-mounted equipment which does not include, but requires the use of, air-moving equipment (i.e. cooling-fan assemblies) when in operation shall be tested with such equipment, as supplied or recommended by the manufacturer.

Rack-mounted equipment with more than one end-use enclosure may be tested and reported either as individual functional units or as a complete system.

- f) If the equipment is usually installed by being recessed into a wall or other structure, a representative structure shall be used for mounting during the measurements and described in the test report.
- g) Hand-held equipment shall be supported 0,1 m above the reflecting plane by vibration-isolating elements. The supports shall not interfere with the propagation of airborne sound.
- h) A sub-assembly shall be supported 0,25 m above the reflecting plane by vibration-isolating elements. The supports shall not interfere with the propagation of airborne sound.



**NOTE 9**

*If the equipment is mounted near one or more reflecting planes, the sound power radiated by the equipment may depend upon its position and orientation. It may be of interest to determine the radiated sound power either for one particular equipment position and orientation or from the average value for several positions and orientations.*

Care shall be taken to ensure that any electrical conduits, piping, air ducts or other auxiliary equipment connected to the equipment being tested do not radiate significant amounts of sound energy into the test room. If practicable, all auxiliary equipment necessary for the operation of the equipment shall be located outside the test room and the test room shall be cleared of all objects which may interfere with the measurements.

**5.5.2 Input voltage and frequency**

The equipment shall be operated at its nominal rated voltage and the rated power line frequency.

Phase-to-phase voltage variations shall not exceed 5 %.

**5.5.3 Equipment operation**

During the acoustical measurements the equipment shall be operated in a manner typical of normal use. Annex C specifies installation and operating conditions for many different categories of equipment. The equipment shall be operated a sufficient period of time before proceeding with the acoustical test to allow temperature and other pertinent conditions to stabilize.

The noise shall be measured with the equipment in both the idle and the operating modes. If the equipment is designed for performing different functions, such as manually typing and automatic printing of stored information, or for printing in different print qualities, unless otherwise specified in annex C, the noise of each individual mode shall be determined and recorded. For equipment which, in normal functional operation, performs several operating modes, such as document insertion, reading, encoding, printing and document eject, and for which a typical operation cycle has not been defined in annex C, such a typical cycle shall be defined for the measurements and described in the test report.

In the case of rack-mounted or other equipment in which the operation of several functional units is possible, the unit producing the highest A-weighted sound power level shall be operated together with those other units required for its operation. All other units shall be in the idle mode. However, if the operation of the noisiest unit occurs only once and less than 5 % of the time during a typical eight-hour workday, the unit producing the next highest A-weighted sound power level shall be operated together with those other units required for its operation; all other units shall be in the idle mode. If none of the operations occur for more than 5 % of the time of a typical eight-hour workday, then the aforementioned conditions with the unit with the highest A-weighted sound power level shall apply.

Some equipment does not operate continuously because of its mechanical design or its mode of operation under program control. Long periods may occur during which the equipment is idle. The operating mode measurements shall not include these idling periods. If it is not possible to operate the equipment continuously during the acoustical evaluation, the time interval during which measurements have to be made shall be described in the test plan, equipment specifications or other documentation.

Some equipment has operational cycles that are too short to allow reliable determination of the noise emissions. In such cases, a typical cycle shall be repeated several times.

If the equipment being tested produces attention signals, such as tones or bells, such intermittent sound shall not be included in an operating mode. During the acoustical evaluation in the operating mode(s), such attention signals shall be inoperative, or if not possible, be set to a minimum.

**NOTE 10**

*For certain applications, e.g. in ergonomics, such signals as well as the maximum response of feedback signals of keyboards may be of interest. In such cases, special measurements may be made which are not part of this Standard.*

**5.6 Microphone positions and source locations**

The major cause of uncertainty in determining sound power level in a reverberation room is the spatial irregularity of the sound field. The extent of this irregularity and, hence, the effort required to determine the average sound pressure level accurately is greater for discrete-frequency sound than for broad-band sound.

The procedure specified in 5.6 shall be used to determine the minimum number of microphone positions and equipment locations, which depend upon the presence or absence of significant discrete-frequency components or narrow bands of noise in the sound emitted by the source, and to determine the microphone locations. It is strongly recommended that the room be qualified in accordance with ISO 3742, annex A because the number of microphone and equipment positions calculated in accordance with the following procedure is usually large.

**5.6.1 Identification of the significance of discrete-frequency components and narrow bands of noise**

**5.6.1.1 General**

If a discrete-frequency component is present in the spectrum of a source, the spatial variations in the sound pressure level usually exhibit maxima separated by minima having an average spacing of approximately  $0,8 \lambda$ , where  $\lambda$  is the wavelength corresponding to the frequency of the sound.

**5.6.1.2 Qualitative procedure**

The presence of a significant discrete-frequency component can often be detected by a simple listening test or by narrow-band analysis (e.g. by means of a fast Fourier transform analyser). If such a component is audible or if narrow-band analysis clearly indicates the presence of a discrete-frequency component, the measurements described in 5.6.1.3 may be omitted. In this case, either the provisions of the bottom row of table 3 shall be applied or, alternatively, the test set-up shall be qualified as described in ISO 3742, annex A.

Discrete-frequency components may be present in the spectrum even if these components are not audible or if narrow-band analysis does not clearly indicate the presence of a discrete-frequency component. A conclusion that no discrete-frequency components are present can only be reached by performing the test described in 5.6.1.3.

**5.6.1.3 Estimate of standard deviation**

**5.6.1.3.1** Obtain an estimate of the standard deviation of the sound pressure levels produced by the source under test in the room by following the procedure described in 5.6.1.3.2 and 5.6.1.3.3.

**5.6.1.3.2** Select an array of six fixed microphones (or six microphone positions) spaced at least  $\lambda/2$  apart, where  $\lambda$  is the wavelength of the sound corresponding to the lowest frequency of the frequency band of interest. Locate the source at a single position in the test room in accordance with ISO 3741.

Obtain the time-average sound pressure level,  $L_i$ , at each microphone position according to the techniques described in ISO 3741. Instead of a fixed array, a single microphone may be sequentially positioned at six points equally spaced along a path the length of which is calculated from equation (2) with  $N_m = 6$ .

Determine the time-average sound pressure level at each point.



- 5.6.1.3.3** For each one-third octave or octave band within the frequency range of interest, calculate the standard deviation,  $s$ , of the space/time-average sound pressure levels in the room,  $L_i$ , in decibels from the following equation:

$$s = (n - 1)^{-1/2} \left[ \sum_{i=1}^n (L_i - L_m)^2 \right]^{1/2} \quad (1)$$

where

$L_i$  = the time average sound pressure level at the  $i$ -th microphone positions, in dB

$L_m$  = the arithmetic mean value of the sound pressure levels  $L_1$  to  $L_6$ , in dB

$n$  = 6.

The magnitude of  $s$  depends upon the properties of the sound field in the test room. These properties are influenced by the characteristics of the room as well as the characteristics of the source (i.e. directivity and spectrum of emitted sound). In theory, a standard deviation of 5,56 dB corresponds to a spectral component of zero bandwidth, i.e. a discrete tone.

## **5.6.2 Number of microphone positions and source locations**

### **5.6.2.1 General**

Because equation (1) only gives an estimate of the true standard deviation, this Standard uses three broad ranges of values for  $s$  to determine the number of microphone positions (or path length) and the number of source locations required to achieve the estimated accuracy. Detailed knowledge of the spectrum of the source is not necessary for carrying out the measurements. Irregularities in the sound field are taken into account in so far as they influence the estimate of the standard deviation,  $s$ .

### **5.6.2.2 Calculation**

The value of  $s$  calculated according to 5.6.1.3.3 is used with tables 3 and 4 to determine the recommended microphone path length and the number of source locations. The number of microphone positions is determined from table 4. If a continuous microphone traverse is used, the length of the traverse,  $I$ , should be at least

$$I = N_m (\lambda / 2) \quad (2)$$

where

$\lambda$  = as defined in 5.6.1.3.2

$N_m$  = the number of microphone positions.



**Table 3 - Procedures to be followed for measuring discrete-frequency**

Standard deviation $s$ dB	Procedure	Number of microphone positions, $N_m$ (or microphone path length, 1)	Number of equipment locations $N_s$
$s \leq 1,5$	Broad-band procedure adequate	$N_m = 3$ or 1 computed from equation (2) for a continuous path	$N_s = 1$
$1,5 < s \leq 3$	Assume that a narrow band of noise is present	$N_m$ determined from table 4 or 1 computed from equation (2) for a continuous path	Use half the number of equipment locations computer from equation (4)
$s > 3$	Assume that a discrete tone is present	$N_m$ determined from table 4 or 1 computed from equation (2) for a continuous path	Compute $N_s$ from equation (4)

**Table 4 - Number of microphone positions required and constant K for determining number of equipment locations**

Octave band (and one-third octave band) centre frequencies	Number of microphone positions ( $N_m$ ) if $1,5 < s \leq 3$ dB	Number of microphone positions ( $N_m$ ) if $s > 3$ dB	Constant K for determining number of equipment locations
125 (100, 125, 160)	3	6	5
250 (200, 250, 315)	6	12	10
500 (400, 500, 630)	12	24	20
1 000 (800, 1 000, 1 250) and above	15	30	25

### 5.6.3 Microphone arrangement

#### 5.6.3.1 Microphone traverse or array

The microphone traverse or array shall not lie in any plane within  $10^\circ$  of a room surface. No point on the traverse or array shall be closer than  $\lambda/2$  or 1 m, whichever is the smaller, to any room surface of the reverberation room, where  $\lambda$  is the wavelength of sound corresponding to the centre frequency of the lowest frequency band of interest. All microphones shall be at least  $\lambda/4$  or 0,5 m, whichever is the smaller, from the nearest surface of the rotating diffuser (if any).

The location of the microphone traverse or array shall be within that portion of the test room where the reverberant sound field dominates. The criterion to ensure that the microphone traverse or array is within the reverberant field is given in 5.6.3.2.

The microphone traverse or array shall avoid areas of air discharge (if any) or sound beaming from the equipment being tested.

### 5.6.3.2 Minimum distance

The minimum distance,  $d$ , in metres, between the nearest microphone position and the equipment being tested shall be

$$d \geq 0,8 \times 10^{0,05(L_{Wr} - L_{pr})} \quad (3)$$

where

$L_{Wr}$  is the calibrated sound power level, in decibels, of the reference source;

$L_{pr}$  is the space/time-average sound pressure level, in decibels, produced in the room by the reference sound source.

#### NOTE 11

1. It is highly desirable that, whenever possible, all microphone positions be more than the minimum distance,  $d$ , from the equipment so as to minimize contributions from the direct sound field.

2. The microphone traverse or array should avoid areas of air discharge (if any) or sound beaming from the equipment being tested.

### 5.6.3.3 Repetition rate

The repetition rate of the microphone traverse (or the scanning rate for an array of fixed microphones) shall meet the following criteria:

- a) There shall be a whole number of microphone traverses or array scans during the observation period (see 5.7.2).
- b) If integration over a fixed time interval is used, there shall be a whole number of microphone traverses or array scans during the integrating time of the indicating device.
- c) If continuous averaging is used, the traverse or scanning period shall be less than twice the time constant of the indicating device.

### 5.6.4 Number of equipment locations

The required number of equipment locations at which the equipment being tested shall be placed successively depends on the room absorption and on the frequency. If discrete-frequency tones are present, the required number of equipment locations,  $N_s$ , shall be computed from the following formula:

$$N_s \geq K \left[ 0,032 \times 10^{0,1(L_{pr} - L_{Wr})} \times \left( \frac{1000}{f} \right)^2 + \frac{1}{N_m} \right] \quad (4)$$

where

$L_{pr}$  is the space/time-average sound pressure level, in decibels, produced in the room by the reference sound source;

$L_{Wr}$  is the calibrated sound power level, in decibels, of the reference source;

$f$  is the frequency, in hertz, of the discrete tone or the centre frequency of the band in which a discrete frequency or narrow-band noise component is found;

$K$  is a constant given in table 4;

$N_m$  is the number of microphone positions for the narrow-band or discrete frequency tone (see table 4).



The value of  $N_s$  shall be rounded to the nearest higher integer.

The minimum distance between any two equipment locations shall be  $r_{\min} = \lambda/2$ . The source positions should not be symmetrical with respect to the axes of the test room.

## 5.7 Measurement of sound pressure level

### 5.7.1 General

Measurement of the sound pressure level along the microphone path (or at the individual microphone positions) shall be carried out for each frequency band within the frequency range of interest. The following data shall be obtained:

- the band sound pressure levels for the specified modes of operation of the equipment;
- the band sound pressure levels produced by the background noise (including noise from the support equipment, the motion of the microphone and diffuser (if any), and internal electrical noise in the measuring instrumentation);
- the band sound pressure levels during operation of the reference sound source (see 5.8)

The microphone traverse or array shall be the same for each set of readings and shall meet the requirements of 5.6. The sound diffuser(s), if any, shall be operated in exactly the same way for each set of readings. No observers or operators shall be present in the test room during the measurements, unless necessary for operating the equipment being tested. If their presence is necessary, they should also be present during the reference sound source measurement.

### 5.7.2 Measurement duration

The measurement duration shall be adjusted to the operation of the equipment. For all idle or operating modes the measurement duration shall be at least

- 30 s for the frequency bands centred on or below 160 Hz;
- 10 s for the frequency bands centred on or above 200 Hz.

For equipment which performs repetitive operation cycles (e.g. enveloping machines), the measurement duration shall include at least three operation cycles. For equipment which performs a sequence of varying operation cycles, the measurement duration shall include the total sequence. Annex C specifies additional requirements for many types of equipment.

If the measuring instruments use continuous time-averaging (RC-smoothing), no observation shall be made after any microphone or filter switching (including transfer of the microphone to a new position) until a settling time of five times the time constant of the instrumentation has elapsed. The observation time shall have at least the same duration as the settling time.

### 5.7.3 Corrections for background noise

If the level of the background noise is at least 15 dB below the sound pressure level at each measurement point in each frequency band, no corrections for background noise are required. If the level of the background noise is less than 15 dB but more than 6 dB below the sound pressure level at each measurement point and in each frequency band, the measured sound pressure levels shall be corrected for the influence of background noise using the following formula:

$$K_1 = L_c - 10 \log(10^{0,1L_c} - 10^{0,1L_b}) \quad (5)$$

where

$K_1$  = the correction, in dB, to be subtracted from the sound pressure level measured with the sound source operating to obtain the sound pressure level due to the sound source alone;



$L_c$  = the measured sound pressure level, in dB, with the sound source operating;

$L_b$  = the level of background noise alone, in dB.

If the level of the background noise is less than 6 dB below the sound pressure level at any measurement point in any given frequency band, the accuracy of the measurements is reduced and no correction shall be applied for that measurement point in that band. The results may, however, be reported and may be useful in determining an upper limit to the sound power level of the equipment being tested. If such data are reported, it shall be clearly stated that the background noise requirements of this Standard have not been satisfied for that frequency band.

## 5.8 Measurement of the sound pressure level of the reference sound source

For the purposes of calculating the sound power level of the equipment, this Standard uses the comparison method of ISO 3741. This method has the advantage that it is not necessary to measure the reverberation time of the test room. The comparison method requires the use of a reference sound source with characteristics and calibration in accordance with ISO 6926. The reference sound source shall be operated, as described in its calibration chart, in the presence of the equipment being tested and in the presence of the operator, if required to operate the equipment.

The reference sound source shall be mounted on the floor of the reverberation room at least 1,5 m away from any other sound-reflecting surface, such as a wall or the equipment being tested. The distance from the source to the microphone traverse or array shall be in accordance with 5.6.3. The number of microphone positions or the equivalent path length shall be the same as specified for the sound pressure level measurements on the equipment. One source position for the reference sound source will suffice.

The sound pressure levels in each octave band or one-third octave band within the frequency range of interest shall be measured in accordance with 5.7.

## 5.9 Calculation of space/time-average band sound pressure level

If a continuous path or automatic scan is used together with analogue or digital integration, the sound pressure levels measured in accordance with 5.7 (corrected according to 5.7.3, if applicable) in each frequency band of interest constitute the space/time-average band sound pressure levels. If more than one continuous path or more than one automatic scan is used, then the averaging shall be performed by using the following equation:

$$\overline{L_p} = 10 \log \left[ \frac{1}{N} \sum_{i=1}^N 10^{0,1 \overline{L_{pi}}} \right] \quad (6)$$

where

$\overline{L_p}$  = the space/time-average band sound pressure level, in dB.

$\overline{L_{pi}}$  = the time-average band sound pressure level resulting from  $i$ -th measurement, in dB.

$N$  = the total number of measurements in the band.

## 5.10 Calculation of sound power level

### 5.10.1 Calculation of band sound power levels

The sound power level of the equipment in each octave band or one-third octave band within the frequency range of interest is obtained as follows. The space/time-average band sound pressure level produced by the reference sound source (corrected for background noise according to 5.7.3) is subtracted

from the known sound power level of the reference sound source. The difference is added to the band sound pressure level of the equipment being tested (corrected for background noise in accordance with 5.7.3). Hence

$$L_w = \overline{L_p} + (L_{wr} - \overline{L_{pr}}) \quad (7)$$

where

$L_w$  = the band sound power level of the equipment being tested, in dB.

$\overline{L_p}$  = the space/time-average band sound pressure level of the equipment being tested, in dB.

$L_{wr}$  = the calibrated band power level of the reference sound source, in dB.

$\overline{L_{pr}}$  = the space/time-average band sound pressure level of the reference sound source, in dB.

#### 5.10.2 Calculation of A-weighted sound power level

The A-weighted sound power level ( $L_{WA}$ ) in dB, shall be calculated from the following equation:

$$L_{WA} = 10 \log \sum_{j=1}^{j_{\max}} 10^{0,1[L_{Wj} + A_j]} \quad (8)$$

where

$L_{Wj}$  = the level in the  $j$ -th octave or third-octave band.

For computations with octave-band data,  $j_{\max} = 7$  and  $A_j$  is given in table 5.

Table 5 - Values of A-weighting,  $A_j$

$j$	Octave band centre frequency (Hz)	$A_j$ (dB)
1	125	- 16,1
2	250	- 8,6
3	500	- 3,2
4	1 000	0,0
5	2 000	1,2
6	4 000	1,0
7	8 000	- 1,1
8	16 000	- 6,6

For computations with third-octave band data,  $j_{\max} = 21$  and  $A_j$  is given in table 6.

Table 6 - Values of A-weighting,  $A_j$

$j$	One third octave band centre frequency (Hz)	$A_j$ (dB)
1	100	- 19,1
2	125	- 16,1
3	160	- 13,4
4	200	- 10,9
5	250	- 8,6
6	315	- 6,6
7	400	- 4,8
8	500	- 3,2
9	630	- 1,9
10	800	- 0,8
11	1 000	0,0
12	1 250	0,6
13	1 600	1,0
14	2 000	1,2
15	2 500	1,3
16	3 150	1,2
17	4 000	1,0
18	5 000	0,5
19	6 300	- 0,1
20	8 000	- 1,1
21	10 000	- 2,5
22	12 500	- 4,3
23	16 000	- 6,6
24	20 000	- 9,3

If the noise from the 16 kHz octave band is broad-band in character, the A-weighted levels shall be calculated from one-third octave band measurements which include the 16 kHz octave band. If the noise in the 16 kHz octave band contains discrete tone(s), then the 16 kHz octave band shall not be included in the determination of the A-weighted levels.

For equipment which emits noise in the 16 kHz octave band, the procedures specified in ECMA-108 for reporting sound power levels shall be used (see table 7).



**Table 7 - Type of noise and determination of sound power levels**

Type of noise in the frequency range of the octave bands centred at		Sound power level to be determined
125 Hz to 8 kHz	16 kHz	
Broad-band or narrow-band noise	Broad-band noise	Combined A-weighted level (125 Hz to 16 kHz) according to ECMA-74
Broad-band or narrow-band noise	Discrete tone	A-weighted level (125 Hz to 8 kHz) according to ECMA-74 and the level and frequency of the discrete tone according to ECMA-108
	Multiple tones	A-weighted level (125 Hz to 8 kHz) according to ECMA-74 and the levels and frequencies of all tones in the 16 kHz band that are within 10 dB of the highest tone level in the band according to ECMA-108
No significant noise	Discrete tone	Level and frequency of the discrete tone in the 16 kHz octave band according to ECMA-108
	Multiple tones	Level and frequencies of all tones in the 16 kHz band that are within 10 dB of the highest tone level in the band according to ECMA-108

#### 5.11 Information to be recorded

The information, when applicable, specified in 5.11.1. to 5.11.4, shall be recorded.

##### 5.11.1 Equipment under test

The following information shall be recorded:

- a description of the equipment under test (including main dimensions; name, model and serial number of each unit; name, model and serial number of noise producing components and sub-assemblies in the unit under test);
- a complete description of the idle and operating modes, including operating speed, data medium used and the test programme in terms that are meaningful for the type of equipment being tested;
- a complete description of the installation and mounting conditions;
- the location of the equipment in the test environment;
- the location and functions of an operator, if present;
- the nominal power line frequency, in Hz (e.g. 50 Hz), and the measured power line voltage, in volts.

##### 5.11.2 Acoustical environment

The following information shall be recorded:

- a description of the test room, including dimensions, shape, surface treatment of the walls, ceiling and floor;
- a description of diffusers, or rotating vanes, if any;
- results of qualification of the reverberation room in accordance with ISO 3741, annex A, or ISO 3742;
- the air temperature, in °C, relative humidity, as a percentage, and barometric pressure, in kPa.

### 5.11.3 Instrumentation

The following information shall be recorded:

- a) equipment used for the measurements, including name, type, serial number and manufacturer;
- b) bandwidth of frequency analyser;
- c) frequency response of the instrumentation system;
- d) method used for checking the calibration of the microphones and other system components, the date and the place of calibration shall be given;
- e) method used for determining the band space/time-average sound pressure level;
- f) type and calibration of reference sound source.

### 5.11.4 Acoustical data

The following information shall be recorded:

- a) location and orientation of the microphone traverse (path) or array;
- b) the corrections, if any, in dB, applied in each frequency band for the frequency response of the microphone, frequency response of the filter in the passband, background noise, etc;
- c) the values for the difference ( $L_{Wf} - L_{pr}$ ), in dB, as a function of frequency;
- d) the band sound pressure level readings, in dB, to at least the nearest 0,1 dB preferred (0,5 dB, required) for the calculations in 5.9;
- e) the sound power levels, in dB (reference 1 pW) in octave and/or one-third octave bands, tabulated or plotted to the nearest 0,1 dB preferred (0,5 dB required);
- f) The A-weighted sound power level in dB, Reference 1 pW, rounded to the nearest 0,1 dB preferred (0,5 dB required).
- g) The date, time and place where the measurements were carried out, and the name of the person who carried out the measurements.

### 5.12 Test report

The test report shall contain the statement that the sound power levels have been obtained in full conformity with the procedures specified in clause 5 of this Standard. The test report shall state that these sound power levels are given in dB to the nearest 0,1 dB preferred (0,5 dB required).

#### NOTE 12

*For the determination of declared noise emission values for computer and business equipment in accordance with ECMA-109, the numerical value of the sound power level, divided by ten, given to the nearest 0,01 B preferred (0,05 B required) is used.*

The test report shall contain at least the following information:

- the name(s) and model number(s) of the equipment under test;
- the A-weighted sound power level,  $L_{WA}$ , in dB (reference: 1 pW), for the idle mode and the operating mode(s);
- the sound power levels,  $L_W$ , in dB (reference: 1 pW), in octave or one-third octave bands, if required, for the idle mode and the operating mode(s) - the bandwidth used shall be stated;
- a detailed description of operating conditions of the equipment being tested with reference to annex C, if applicable.



## 6 Method for determining sound power levels of equipment under essentially free-field conditions over a reflecting plane

### 6.1 General

The method specified in this clause provides a direct procedure for determining the sound power levels produced by computer and business equipment using essentially free-field conditions over a reflecting plane. It applies to equipment which radiates broad-band noise, narrow-band noise, noise which contains discrete frequency components or impulsive noise.

The measurements shall be carried out in a qualified environment.

### 6.2 Measurement uncertainty

Measurements carried out in accordance with this method yield standard deviations which are equal to, or less than, those given in table 8.

**Table 8 - Uncertainty in determining sound power levels in a free field over a reflecting plane**

Octave band centre frequencies Hz	One-third octave band centre frequencies Hz	Standard deviation dB
125	100 to 160	3,0
250 to 500	200 to 630	2,0
1 000 to 4 000	800 to 5 000	1,5
8 000	6 300 to 10 000	2,5

#### NOTE 13

*For most computer and business equipment, the A-weighted sound power level will be determined by the sound power levels in the 250 Hz to 4 000 Hz octave bands. The A-weighted sound power level is determined with a standard deviation of approximately 1,5 dB. A larger standard deviation may result when the sound power levels in other bands determine the A-weighted level.*

#### NOTE 14

*The standard deviations given in table 8 reflect the cumulative effects of all causes of measurement uncertainty, including variations from laboratory to laboratory, but excluding variations in the sound power level from equipment to equipment or from test to test which may be caused, for example, by changes in the installation or operating conditions of the equipment. The reproducibility and repeatability of the test results for the same piece of equipment and the same measurement conditions may be considerably better (i.e. smaller standard deviations) than the uncertainties given in table 8 would indicate.*

#### NOTE 15

*If the method specified in this clause is used to compare the sound power levels of similar equipment that are omnidirectional and radiate broad-band noise, the uncertainty in this comparison yields a standard deviation which is less than that given in table 8, provided that the measurements are performed in the same environment with the same shape of measurement surface.*

### 6.3 Test environment

#### 6.3.1 General

The test environment shall provide a free field over a reflecting plane. Suitable test environments are defined in ISO 3744 and ISO 3745. Those environments include:



- a) a semi-anechoic room qualified in accordance with ISO 3745;
- b) a flat outdoor area that meets the requirement of 6.3.2;
- c) a room in which the contribution of the reverberant field to the sound pressure levels on the measurement surface are small compared with those of the direct field of the equipment.

**NOTE 16**

*Conditions described under iii) above are met in very large rooms as well as in smaller rooms with sufficient sound-absorptive materials on their walls and ceiling and a reflecting (hard) floor.*

**NOTE 17**

*A plane (floor, wall) is considered to be reflecting (hard) if its absorption coefficient  $\alpha < 0,06$  over the frequency range of interest (e.g. concrete floor:  $\alpha < 0,01$ , plastered wall:  $\alpha \approx 0,04$ , tiled wall:  $\alpha \approx 0,01$ ).*

### **6.3.2 Adequacy of the test environment**

The test environment should be free from reflecting objects other than a reflecting plane so that the equipment radiates into a free-field over a reflecting plane.

If the test environment does not meet the requirements of 6.3.1.a then the procedure for  $K_2$  in annex A of ISO 3744 shall be used to determine the magnitude of the environmental corrections to take account of departures (if any) of the test environment from the ideal condition. The correction in any frequency band shall not exceed 2 dB.

### **6.3.3 Level of background noise**

At the microphone positions, the levels of the background noise shall be at least 6 dB, and preferably more than 15 dB, below either the sound pressure level to be measured in each frequency band within the frequency range of interest or the A-weighted sound pressure level. See also 6.7.3.

### **6.3.4 Temperature and relative humidity**

The following conditions are recommended:

- Barometric pressure : 86 kPa to 106 kPa
- Temperature : 15 °C to 30 °C
- Relative humidity : 40 % to 70 %

For equipment the sound pressure of which varies with temperature, the room temperature during the measurement shall be 23 °C  $\pm$  2 °C.

## **6.4 Instrumentation**

### **6.4.1 General**

The instrumentation shall be designed to measure the space/time averaged sound pressure level; the space/time-average sound pressure level is the level of the squared sound pressure averaged over time and the measurement surface. Surface averaging is performed over a fixed number of microphone positions (see 6.6) and by computing the average value in accordance with 6.9.1, except as described in clause B.3.

The instruments used may perform the required time and space-averaging in one of two different ways:

- a) By integrating the square of the signal over a fixed time interval and dividing by the time interval. This integration may be performed by either digital or analogue means; digital integration is the preferred method. (See IEC Publication 804).

- b) By continuous averaging of the square of the signal using RC-smoothing with a time constant of at least one second ("slow" meter characteristic). Such continuous averaging provides only an approximation of the true time average and it places restrictions on the settling time and observation time.

#### **6.4.2 Microphone and its associated cable**

The microphone used shall comply with the requirements regarding the accuracy, stability and frequency response for a type 1 instrument as specified either in IEC Publication 651 or in IEC Publication 804 for the angle of incidence specified by the manufacturer.

The microphone and its associated cable shall be chosen such that their sensitivity does not change by more than 0,2 dB over the temperature range encountered during measurement. If the microphone is moved, care shall be exercised to avoid introducing acoustical or electrical noise (e.g. from wind, gears, flexing cables or sliding contacts) that could interfere with the measurements.

#### **6.4.3 Frequency response of the instrumentation system**

The frequency response of the entire instrumentation system shall be flat over the frequency range of interest within the tolerances given in either IEC Publication 651 or, preferably, in IEC Publication 804, for type 1 instruments.

#### **6.4.4 Weighting network and filter characteristics**

Weighting network complying with the tolerances specified either in IEC Publication 651 or in IEC Publication 804 for type 1 instruments and an octave band or one-third octave band filter set complying with the requirements specified in IEC Publication 225 shall be used. The centre frequencies of the frequency bands shall correspond to those of ISO 266.

#### **6.4.5 Calibration**

During each series of measurements, an acoustical calibrator with an accuracy of  $\pm 0,5$  dB shall be applied to the microphone to check the calibration of the entire measuring system at one or more frequencies over the frequency range of interest. The calibrator shall be checked at least once a year to verify that its output has not changed. In addition, an acoustical and an electrical calibration of the instrumentation system over the entire frequency range shall be carried out at least every two years.

If a reference sound source is used it shall be checked annually to verify that its output sound power level has not changed.

### **6.5 Installation and operation of equipment - General requirements**

#### **6.5.1 Equipment installation**

The equipment shall be installed according to its intended use. Installation conditions for many different categories of computer and business equipment are specified in annex C; these shall be followed when declaration information is to be obtained. If the normal installation is unknown or if several possibilities exist, a representative condition shall be chosen and reported.

The equipment shall be installed in a way which allows access to all sides except the reflecting plane(s). The dimensions of the reflecting plane(s) shall extend beyond the test object by at least the measurement distance. The requirements for reflection are given in note 17 to 6.3.1. The plane(s) shall not contribute to the sound radiation due to their own vibrations.

- a) Floor-standing equipment shall be installed on the reflecting (hard) floor at a sufficient distance (more than 2 m, if possible) from the walls, unless otherwise specified in annex C.

If the equipment being tested consists of several frames bolted together in an installation or is too large for testing purposes, the frames may be measured separately. In such circumstances, additional covers may be required for the frames during the acoustical evaluation. These



additional covers shall be acoustically comparable with the other covers on the equipment. If a unit is mechanically or acoustically coupled to another unit so that the noise levels of one are significantly influenced by the other the equipment being tested shall, where practicable, include all units coupled together in this way.

- b) Floor-standing equipment which is to be installed only in front of a wall shall be placed on a hard floor in front of a hard wall. The distance from the wall shall be in accordance with the manufacturer's instructions or as specified in annex C. If such information is not available, the distance shall be 0,1 m.
- c) Table-top equipment shall be placed on the floor unless a table or stand is required for operation according to annex C; e.g. printers which take paper from or stack paper on the floor. Such equipment shall be placed in the centre of the top plane of the standard test table (see annex A). In any case the measurement surface defined in 6.6 terminates on the floor.
- d) Wall-mounted equipment shall be mounted on a reflecting (hard) wall at least 1,5 m away from any other reflecting plane, unless otherwise specified. Alternatively, if operation permits, the equipment may be laid on its side and attached to the reflecting floor at a sufficient distance from the walls (more than 2 m, if possible).
- e) Rack-mounted equipment shall be placed in an enclosure which complies with the installation specifications for the equipment. The location of all units within the enclosure shall be described. The enclosure shall be tested as floor-standing or table-top equipment. Rack-mounted equipment which does not include, but requires the use of, air-moving equipment (i.e. cooling-fan assemblies) when in operation shall be tested with such equipment, as supplied or recommended by the manufacturer (see 5.5.1).
- f) If the equipment is usually installed by being recessed into a wall or other structure, a representative structure shall be used for mounting during the measurements.
- g) Hand-held equipment shall be supported 0,1 m above the reflecting plane by vibration-isolating elements. The supports shall not interfere with the propagation of airborne sound.
- h) A sub-assembly shall be supported 0,25 m above the reflecting plane by vibration-isolating elements. The supports shall not interfere with the propagation of airborne sound.

Care shall be taken to ensure that any electrical conduits, piping, air ducts or other auxiliary equipment connected to the equipment being tested do not radiate significant amounts of sound energy into the test room. If practicable, all auxiliary equipment necessary for the operation of the equipment being tested shall be located outside the test room and the test room shall be cleared of all objects which may interfere with the measurements.

#### **6.5.2 Input voltage and frequency**

The equipment shall be operated at its nominal rated voltage and the rated power line frequency.

Phase-to-phase voltage variations shall not exceed 5 %.

#### **6.5.3 Equipment operation**

During the acoustical measurements the equipment shall be operated in a manner typical of normal use. Annex C specifies installation and operating conditions for many different categories of equipment. The equipment shall be operated a sufficient period of time before proceeding with the acoustical test to allow the temperature and other pertinent conditions to stabilize.

The noise shall be measured with the equipment in both the idling and the operating modes. If the equipment is designed for performing different functions, such as manually typing and automatic printing of stored information, or for printing in different print qualities, unless otherwise specified in



annex C, the noise of each individual mode shall be determined and recorded. For equipment which, in normal functional operation, performs several operating modes, such as document insertion, reading, encoding, printing and document eject, and for which a typical operation cycle has not been defined in annex C, such a typical cycle shall be defined for the measurements and described in the test report.

In the case of rack-mounted or other equipment in which the operation of several functional units is possible, the unit producing the highest A-weighted sound power level shall be operated together with those other units required for its operation. All other units shall be in the idling mode. However, if the operation of the noisiest unit occurs only once and less than 5 % of the time during a typical eight-hour workday, the unit producing the next highest A-weighted sound power level shall be operated together with those other units required for its operation; all other units shall be in the idle mode. If none of the operations occur for more than 5 % of the time of a typical eight-hour workday, then the aforementioned conditions with the unit with the highest A-weighted sound power level shall apply.

Some equipment does not operate continuously because of its mechanical design or its mode of operation under program control. Long periods may occur during which the equipment is idle. The operating mode measurements shall not include these idling periods. If it is not possible to operate the equipment continuously during the acoustical evaluation, the time interval during which measurements have to be made shall be described in the test plan, equipment specifications or other documentation.

Some equipment has operational cycles that are too short to allow reliable determination of the noise emissions. In such cases a typical cycle shall be repeated several times.

If the equipment being tested produces attention signals, such as tones or bells, such intermittent sound shall not be included in an operating mode. During the acoustical evaluation in the operating mode(s), such attention signals shall be inoperative.

#### NOTE 18

*For certain applications, such signals as well as the maximum response of feed-back signals of keyboards may be of interest. In such cases, special measurements may be made which are not part of this Standard.*

## 6.6 Measurement surface and microphone positions

### 6.6.1 General

In order to facilitate the location of the microphone positions, a hypothetical reference surface is defined. This reference surface is the smallest possible rectangular box, i.e. rectangular parallelepiped, that just encloses the equipment and terminates on the reflecting plane(s). It has length  $l_1$ , width  $l_2$  and height  $l_3$ . Elements protruding from the equipment being tested which are unlikely to contribute to the noise emission may be disregarded. The microphone positions lie on the measurement surface, a hypothetical surface of area  $S$  which envelops the equipment as well as the reference box and terminates on the reflecting plane.

For computer and business equipment the preferred measurement surface is the parallelepiped the sides of which are parallel to those of the reference box at the preferred measurement distance  $d$ , where  $d = 1$  m.

In some cases, mainly for small equipment, a hemisphere or a quarter-sphere of radius  $r$  may be chosen as the measurement surface, if the condition  $r > 2d_0$  is met, where  $d_0$  is the distance to the corners of the reference box from the origin of the co-ordinates. The co-ordinates for those measurements surfaces are given in annex B, arrangements B3 and B4.

Co-axial circular paths in parallel planes for microphone traverses in a free field over a reflecting plane may be used. Either the microphones may be traversed around the equipment under test, or a fixed



microphone array may be used and the equipment rotated. The co-ordinates are given in annex B.5, arrangement B.5.

The location of the equipment being tested, the measurement surface and the microphone positions are defined by a co-ordinate system with horizontal axes  $x$  and  $y$  in the ground plane parallel to the length and width of the reference box and with the vertical axis  $z$  passing through the geometric centre of the reference box. The  $x$  axis points towards the front of the equipment. The position of the origin for the co-ordinates of the microphone positions is given as follows:

- a) for floor-standing equipment: on the floor in the centre of the plane of the reference box which is coplanar with the room floor;
- b) for table-top equipment on a table with extension tables: on the extended table-top plane in the centre of the base plane of the reference box;
- c) for table-top equipment on a table without extension tables or on the floor: same conditions as for floor-standing equipment described above in i);
- d) for wall-mounted equipment: in the centre of that plane of the reference box which is coplanar with the mounting surface;
- e) for rack-mounted equipment: same conditions as for floor-standing equipment described above in i);
- f) for hand-held equipment: same conditions as for floor-standing equipment described above in i);
- g) for sub-assemblies: same conditions as for floor-standing equipment described above in i);

The number and location of the microphone positions is as specified in 6.6.2 and in annex B.

**NOTE 19**

*Either a single microphone may be moved from one position to the next sequentially or a number of fixed microphones may be used and their outputs sampled sequentially (see note 25).*

Near air exhausts the microphone position shall be selected in such a way that the microphone is not exposed to the air stream, otherwise a windscreen shall be used.

The microphones shall be oriented in such a way that the angle of sound incidence is the same as the angle for which the microphone has the most uniform frequency response as specified by the manufacturer. For most practical cases this will be an orientation towards the approximate geometric centre of the equipment.

## **6.6.2 Microphone positions on the measurement surface**

### **6.6.2.1 Arrangement B.1: Measurement surface for floor-standing equipment**

The key microphone positions are given in figure B.1 and table 9. The area  $S$  of the measurement surface is given by the formula

$$S = 4(ab + bc + ca)$$

where

$$a = 0,5 l_1 + d$$

$$b = 0,5 l_2 + d$$

$$c = l_3 + d$$

$l_1$ ,  $l_2$  and  $l_3$  are the length, width and height of the reference box.

$d$  is the measurement distance, normally 1 m.

**Table 9 - Coordinates of key microphone positions for arrangement B.1**

Position No.	$x$	$y$	$z$
1	$a$	0	$c/2$
2	0	$b$	$c/2$
3	$-a$	0	$c/2$
4	0	$-b$	$c/2$
5	$a$	$b$	$c$
6	$-a$	$b$	$c$
7	$-a$	$-b$	$c$
8	$a$	$-b$	$c$
9	0	0	$c$

**6.6.2.2 Arrangement B.2: Measurement surface for floor-standing equipment in front of or mounted on a wall**

The key microphone positions are given in figure B.2 and table 10. The area  $S$  of the measurement surface is given by the formula

$$S = 2(2ab + 2ac + bc)$$

where

$$a = 0,5(l_1 + d)$$

$$b = 0,5 l_2 + d$$

$$c = l_3 + d$$

$l_1$ ,  $l_2$  and  $l_3$  are the length, width and height of the reference box.

$d$  is the measurement distance, normally 1 m.

**Table 10 - Coordinates of key microphone positions for arrangement B.2**

Position No.	$x$	$y$	$z$
1	$2a$	0	$c/2$
2	$a$	$b$	$c/2$
3	$a$	$-b$	$c/2$
4	$2a$	$b$	$c$
5	$2a$	$-b$	$c$
6	$a$	0	$c$

**NOTE 20**

*If large equipment is to be measured in small rooms providing free-field conditions over a reflecting plane, it may be easier to place the equipment not in the centre of the room but closer to a corner and to arrange the microphone positions in the free field of the room. The equipment should be turned around so that noise radiation from the different sides of the machine can be determined sequentially.*

**NOTE 21**

*For comparison of equipment of the same kind and size, e.g. for quality control tests during series production, a reduced number of representative microphone positions may be adequate (see 6.6.4).*

**6.6.3 Additional microphone positions on the measurement surface**

Sound pressure measurements are required at additional microphone positions if one or more of the following conditions exist:

- a) the range of sound pressure values measured at the microphone positions (i.e. the difference, in decibels, between the highest and the lowest sound pressure levels) exceeds the number of basic measurement positions,
- b) any of the dimensions of the reference parallelepiped is larger than 2 d,
- c) the equipment radiates noise with a high directivity,
- d) the noise from a large equipment is radiated only from a small portion of the equipment, for example, the openings of an otherwise enclosed machine.

If conditions a) and/or b) exist, additional microphone positions as shown in figure B.1 in annex B shall be used.

If conditions c) or d) exist, a detailed investigation is necessary of the sound pressure levels over a restricted portion of the measurement surface. The purpose of this detailed investigation is to determine the highest and lowest values of the sound pressure level in the frequency bands of interest. The additional microphone positions will usually not be associated with equal areas on the measurement surface. In this case, the calculation procedure specified in ISO 3745, sub-clause 7.7.1.2 (unequal areas), for the determination of  $L_W$  shall be used.

**6.6.4 Reduction in the number of microphone positions**

When testing a series of units which are of the same type and which produce a symmetrical radiation pattern, it may be permissible to use a reduced number of microphone positions. The first unit shall be tested using both the full number of microphone positions defined over the entire measurement surface and a reduced number of microphone positions defined over only a portion of the measurement surface. If the surface sound pressure levels for the two cases, determined in accordance with the calculation procedures specified in 6.9, do not differ by more than 0,5 dB, the reduced number of positions may be used for subsequent units in the series.

**6.7 Measurement of sound pressure levels**

**6.7.1 General**

Measurements of the sound pressure level shall be carried out at the microphone positions specified in 6.6 with A-weighting and/or for each frequency band within the frequency range of interest, if required. The following data shall be obtained:

- the A-weighted sound pressure levels and/or the band sound pressure levels, for the specified modes of operation of the equipment;
- the A-weighted sound pressure levels and/or the band sound pressure levels of the background noise (including noise from support equipment).

If environmental corrections  $K_2$  are required per 6.3.2, band sound pressure levels shall be used to determine the A-weighted levels per 6.10.



**NOTE 22**

*When using a sound level meter, the person reading the meter should not disturb the sound field at the microphone.*

**NOTE 23**

*Should spatial fluctuations occur, due to interferences or standing waves, it is recommended that the microphone be moved by approximately 0,1 d in a vertical plane around the nominal measurement position, and the mean value of the sound pressure level be recorded.*

**NOTE 24**

*If the equipment emits short-duration high-amplitude (i.e., impulsive) noise, a sound level meter that has 1 000 ms (or "SLOW") exponential time average may be overloaded and may not provide an accurate measurement of the time-average sound pressure level. If such noise is found to be present, measurements should be made with instruments conforming to the requirements of IEC Publication 804 for Type 1 integrating-averaging sound level meters.*

**6.7.2 Measurement duration**

The measurement duration shall be adjusted to the operation of the equipment. For all idle or operating modes the measurement duration shall be at least 8 s for each measurement position.

For equipment which performs repetitive operation cycles (e.g. enveloping machines), the measurement duration shall include at least three operation cycles. For equipment which performs a sequence of varying operation cycles, the measurement duration shall include the total sequence. Annex C specifies additional requirements for many types of equipment.

**NOTE 25**

*When the measurement duration over the total sequence of operation cycles exceeds 40 s, time and spatial averaging may be performed in combination by sampling all microphones in sequence at least ten times and dwelling at each microphone each time for at least 4 s. This may be accomplished, for example, with nine microphones, a multiplexer and an integrating analyser or integrating-averaging sound level meter. Sampling for a period longer than 4 s should be carried out, as required, to ensure that 4 s of data at that microphone position are actually acquired and that any settling period (due to exponential averaging, for example) is excluded. Dwell duration and number of samples shall be the same for all microphones.*

If the measuring instruments use continuous time-averaging (RC-smoothing), no observation shall be made after any microphone or filter switching (including transfer of the microphone to a new position) until a settling time of five times the time constant of the instrumentation has elapsed. The observation time shall have at least the same duration as the settling time.

**6.7.3 Corrections for background noise**

If the level of the background noise is at least 15 dB below the sound pressure level at each measurement point and in each frequency band, no corrections for background noise are required. If the level of the background noise is less than 15 dB but more than 6 dB below the sound pressure level at each measurement point and in each frequency band, the measured sound pressure levels shall be corrected for the influence of background noise using the following formula:

$$K_1 = L_c - 10 \log(10^{0,1L_c} - 10^{0,1L_b}) \quad (9)$$

where

$K_1$  = the correction, in dB, to be subtracted from the sound pressure level measured with the sound source operating to obtain the sound pressure level due to the sound source alone;

$L_c$  = the measured sound pressure level, in dB, with the sound source operating;

$L_b$  = the level of background noise alone, in dB.

If the level of the background noise is less than 6 dB below the sound pressure level at any measurement point in any given frequency band, the accuracy of the measurement is reduced and no correction shall be applied for that measurement point in that frequency band. The results may, however, be reported and may be useful in determining an upper limit to the sound power level of the equipment being tested. If such data are reported, it shall be clearly stated that the background noise requirements of this Standard have not been satisfied for that frequency band.

## 6.8 Corrections for unwanted reflections

If a room as defined in 6.3.1 c) is used, band sound pressure levels shall be corrected for the unwanted reflections present in the test environment. The environmental correction,  $K_2$ , accounts for the influence of a non-ideal environment.

Annex A of ISO 3744 gives the detailed procedure to be followed for determining the magnitude of the environmental correction  $K_2$ , in dB, (the absolute comparison test, clause A.3, shall be used). The maximum allowable range for  $K_2$  is 0 to 2 dB. It shall be subtracted from the measured sound pressure levels (equation (11)). For laboratory-quality semi-anechoic rooms, the qualification procedure of ISO 3745 may be used.

### NOTE 26

*If the environmental correction varies from microphone position to microphone position within the maximum allowable range, a mean value should be determined and subtracted from the measured sound pressure level.*

## 6.9 Calculation of surface-average sound pressure level

### 6.9.1 Calculation of sound pressure level averaged over the measurement surface, $\overline{L_{pm}}$

If automatic spatial movement of an individual microphone is used together with analogue or digital integration, the sound pressure levels measured in accordance with 6.7 (corrected in accordance with 6.7.3, if applicable) constitute the A-weighted sound pressure levels and/or band sound pressure levels averaged over time and over the measurement surface. If individual microphone positions are used or if the sound pressure levels fluctuate during the period of observation, the averaging shall be performed by using the following equation:

$$\overline{L_{pm}} = 10 \log \left[ \frac{1}{N} \sum_{i=1}^N 10^{0,1 L_{pi}} \right] \quad (10)$$

where

$\overline{L_{pm}}$  = the band sound pressure level averaged over the measurement surface in dB. Reference: 20  $\mu$ Pa.

$L_{pi}$  = the band sound pressure level resulting from the  $i$ -th measurement in dB. Reference: 20  $\mu$ Pa.



$N$  = the total number of measurements.

For A-weighted sound pressure level the symbols  $\overline{L}_{pm}$  and  $L_{pi}$  should be replaced by  $\overline{L}_{pAm}$  and  $L_{pAi}$ .

### 6.9.2 Calculation of surface-average sound pressure level, $\overline{L}_{pf}$ and $\overline{L}_{pAf}$

The band surface-average sound pressure levels  $\overline{L}_{pf}$ , are obtained by correcting the values of  $L_{pm}$  for reflected sound to approximate the sound pressure level which would be obtained under ideal free-field conditions (or free-field conditions over a reflecting plane) by the equation:

$$\overline{L}_{pf} = \overline{L}_{pm} - K_2 \quad (11)$$

where

$\overline{L}_{pf}$  = the surface-average band sound pressure level, under ideal free-field conditions, in dB.

Reference: 20  $\mu$ Pa.

$\overline{L}_{pm}$  = the band sound pressure level calculated from measurements, in dB, from equation 10.

Reference: 20  $\mu$ Pa.

$K_2$  = the mean value in dB of the environmental correction over the measurement surface to account for the influence of reflected sound (6.8).

For semi-anechoic rooms qualified in accordance with ISO 3745 and for which A-weighted sound pressure levels have been measured,  $\overline{L}_{pAf} = \overline{L}_{pAm}$ .

### 6.10 Calculation of sound power level

The sound power level of the equipment shall be calculated from the following equations:

For semi-anechoic rooms qualified per ISO 3745 and for which A-weighted sound pressure levels have been measured,  $L_{WA}$  shall be determined from equation 12:

$$L_{WA} = \overline{L}_{pAf} + 10 \log \frac{S}{S_0} \quad (12)$$

Band sound power levels,  $L_W$  shall be determined from equation 13:

$$L_W = \overline{L}_{pf} + 10 \log \frac{S}{S_0} \quad (13)$$

where

$L_{WA}$  = the A-weighted sound power level of the equipment in dB. Reference: 1 pW.

$L_W$  = the band sound power level of the equipment in dB. Reference: 1 pW.

$\overline{L}_{pAf}$  = the A-weighted surface-average sound pressure level determined in accordance with 6.9.2 in dB.  
Reference: 20  $\mu$ Pa.

$\bar{L}_{pf}$  = the surface-average band sound pressure level determined in accordance with 6.9.2 in dB.  
Reference: 20  $\mu$ Pa.

$S$  = the area of the measurement surface, in  $m^2$ .

$S_0$  = 1  $m^2$

**NOTE 27**

*The effect of variations in temperature and barometric pressure is not included in the calculation of equations (12) and (13) because of the relatively large uncertainty in the sound power using this method. If the effect is of interest, a precision method of measurement should be used.*

For determination of A-weighted sound power levels  $L_{WA}$  from band levels, the procedure of 5.10.2 shall be used with the value of  $L_W$  from equation 13.

**6.11 Information to be recorded**

The information, when applicable, specified in 6.11.1 to 6.11.4 shall be recorded.

**6.11.1 Equipment under test**

The following information shall be recorded:

- a) a description of the equipment under test (including main dimensions; name, model and serial number of each unit; name, model and serial number of noise producing components and sub-assemblies in the unit under test);
- b) a complete description of the idle and operating modes, including operating speed, data medium used and the test programme in terms that are meaningful for the type of equipment being tested;
- c) a complete description of the installation and mounting conditions;
- d) the location of the equipment in the test environment;
- e) the location and functions of an operator, if present;
- f) the nominal power line frequency, in Hz (e.g. 50 Hz), and the measured power line voltage, in volts.

**6.11.2 Acoustical environment**

The following information shall be recorded:

- a) a description of the acoustical environment, if indoors, the size and acoustic characteristics of the room, including absorptive properties of the walls, ceiling and floor;
- b) environmental correction  $K_2$  resulting from the acoustical qualification of test environment in accordance with ISO 3744, annex A;
- c) the air temperature in  $^{\circ}C$ , relative humidity in %, and barometric pressure in kPa.

**6.11.3 Instrumentation**

The following information shall be recorded:

- a) equipment used for the measurements, including name, type, serial number and manufacturer;
- b) bandwidth of frequency analyser;
- c) frequency response of the instrumentation system;



- d) method used for checking the calibration of the microphones and other system components; the date and place of calibration shall be given;
- e) method used for determining the surface-average sound pressure level;
- f) type and calibration of reference sound source.

#### 6.11.4 Acoustical data

The following information shall be recorded:

- a) the shape of the measurement surface, the measurement distance, the location and orientation of microphone positions or paths;
- b) the area,  $S$ , of the measurement surface;
- c) the corrections, if any, in dB, applied in each frequency band for the frequency response of the microphone, and frequency response of the filter in the passband;
- d) the correction  $K_1$ , if any, for background noise;
- e) the correction  $K_2$ , if any, for unwanted reflections;
- f) the A-weighted surface-average sound pressure level  $L_{pAf}$  and the band surface-average sound pressure level  $L_{pf}$ , for each frequency band of interest, rounded to at least the nearest 0,1 dB preferred (0,5 dB required);
- g) the A-weighted sound power level  $L_{WA}$ , and the band sound power level  $L_W$ , for each frequency band of interest, rounded to the nearest 0,1 dB preferred (0,5 dB required);
- h) the date, time and place where the measurements were carried out, and the name of the person who carried out the measurements.

#### 6.12 Test report

The test report shall contain the statement that the sound power levels have been obtained in full conformity with the procedures specified in clause 6 of this Standard. The test report shall state that these sound power levels are given in dB (reference: 1 pW) to the nearest 0,1 dB preferred (0,5 dB required).

##### NOTE 28

*For the determination of declared noise emission values for computer and business equipment in accordance with ECMA-109, the numerical value of the sound power level, divided by ten, given to the nearest 0,01 B preferred (0,05 B required) is used.*

The test report shall contain at least the following information:

- The name(s) and model number(s) of the equipment under test.
- The A-weighted sound power level,  $L_{WA}$ , in dB, for the idle mode and the operating mode(s). Reference: 1 pW.
- The sound power levels,  $L_W$ , in dB, in octave or one-third octave bands, if required, for the idle mode and the operating mode(s) - the bandwidth used shall be stated. Reference: 1 pW.
- Detailed description of operating conditions of the equipment being tested with reference to annex C, if applicable.

## 7 Method for measuring sound pressure levels at the operator and bystander positions

### 7.1 General

This method specified in this clause lays down the conditions of measurement of noise at the operator and bystander positions. The method applies to equipment which radiates broad-band noise, narrow-band noise, noise which contains discrete frequency components, or impulsive noise. This method of measurement does not apply to sub-assemblies.

#### NOTE 29

*The methods for determining whether the noise at the operator position or at the bystander positions contains discrete tones and/or is impulsive in character are given in annex D and annex E, respectively.*

The measurements shall be carried out in a free field over a reflecting plane. For convenience, the measurements may be carried out in conjunction with those performed in accordance with clause 6.

### 7.2 Measurement uncertainty

Measurements carried out in accordance with this method yield standard deviations which are equal to, or less than, those given in table 11.

**Table 11 - Uncertainty in determining time-average sound pressure level at the operator and bystander positions over a reflecting plane**

Octave band centre frequencies Hz	One-third octave band centre frequencies Hz	Standard deviation dB
125	100 to 160	3,0
250 to 500	200 to 630	2,0
1 000 to 4 000	800 to 5 000	1,5
8 000	6 300 to 10 000	2,5

#### NOTE 30

*For most computer and business equipment, the A-weighted sound pressure level is determined by the sound pressure levels in the 250 to 4 000 Hz octave bands. The A-weighted sound pressure level is determined with a standard deviation of approximately 1,5 dB. A larger standard deviation may result when the sound pressure levels in other bands determine the A-weighted sound pressure level.*

#### NOTE 31

*In free-field conditions over a reflecting plane, the standard deviations given in table 11 reflect the cumulative effects of all causes of measurement uncertainty, including variations from laboratory to laboratory, but excluding variations in the sound pressure level from equipment to equipment or from test to test which may be caused, for example, by changes in the installation or operating conditions of the equipment.*

### 7.3 Test environment

#### 7.3.1 General

These measurements shall be carried out in a free field over a reflecting plane. Suitable environments are specified in 6.3.1.

#### 7.3.2 Adequacy of the test environment

The test environment should be free from reflecting objects other than a reflecting plane so that the equipment radiates into a free field over a reflecting plane.



**NOTE 32**

*Any deviations from these conditions may result in an increased sound pressure level and therefore in standard deviations greater than those given in table 11.*

Standard deviations greater than those given in table 11 shall be reported. No environmental correction shall be made to compensate for an unfavourable test environment.

**7.3.3 Level of background noise**

At the microphone positions, the levels of the background noise shall be at least 6 dB, and preferably more than 15 dB, below either the sound pressure level to be measured in each frequency band within the frequency range of interest or the A-weighted sound pressure level. See also 7.7.3.

**7.3.4 Temperature and relative humidity**

The environmental conditions shall be as specified in 6.3.4.

**7.4 Instrumentation**

Instrumentation shall be designed in accordance with either 5.4 or 6.4 with the following provisos:

- a) the microphone shall meet the requirement of 6.4.2;
- b) there is no requirement for spatial averaging of sound pressure level;
- c) the microphone shall be stationary during the measurement except when standing waves or interference requires otherwise (see note 35).

**7.5 Installation and operation of equipment**

Equipment shall be installed and operated in accordance with the requirements of 6.5 except that table-top equipment shall always be installed centrally on a standard test table without extension tables.

**7.6 Microphone positions**

**7.6.1 At the operator position(s)**

One or more operator positions shall be specified for equipment which requires operator attention while in the operating mode.

For equipment which is operated from a standing position, the microphone shall be located 1,50 m  $\pm$  0,03 m above the floor (see figure 1, position P1).

For equipment which is operated from a seated position, the microphone shall be located 1,20 m  $\pm$  0,03 m above the floor (see figure 1, position P2 or P3).

The horizontal distance from the reference box shall be 0,25 m  $\pm$  0,03 m unless this distance is not representative of the operator position; in which case the representative operator position shall be described and shall be used.

For equipment which normally has a detachable keyboard and which is not tested with the keyboard (e.g. a personal computer or a video display unit that is tested without a keyboard), the distance from the front end of the reference box, for purposes of determining the operator position, shall be 0,50 m in front of such equipment.

**NOTE 33**

*During this measurement the operator should be absent, if possible, or move aside, so that he can still operate the equipment but not significantly disturb the sound field around the microphone.*

### 7.6.2 At the bystander positions

For equipment which does not require operator attention while in the operating mode, an operator position need not be specified. In this case, at least four bystander positions shall be selected and specified.

The bystander positions shall be  $1,00\text{ m} \pm 0,03\text{ m}$  away from the projection of the reference box on the horizontal plane and  $1,50\text{ m} \pm 0,03\text{ m}$  above the floor. The four preferred bystander positions are centred at the front, rear, right and left sides of the equipment. If the length of any side of the reference box exceeds  $2,0\text{ m}$ , additional bystander positions at  $1,0\text{ m}$  intervals should be used. For wall-mounted equipment or for equipment placed against the wall, the three preferred bystander positions are centred at the front, right and left sides of the measurement surfaces.

### 7.6.3 Microphone orientation

The microphones shall be oriented in such a way that the angle of sound incidence is the same as the angle for which the microphone has the most uniform frequency response. For most practical cases, the primary sound source is assumed to be  $30^\circ$  below horizontal (see figure 1).

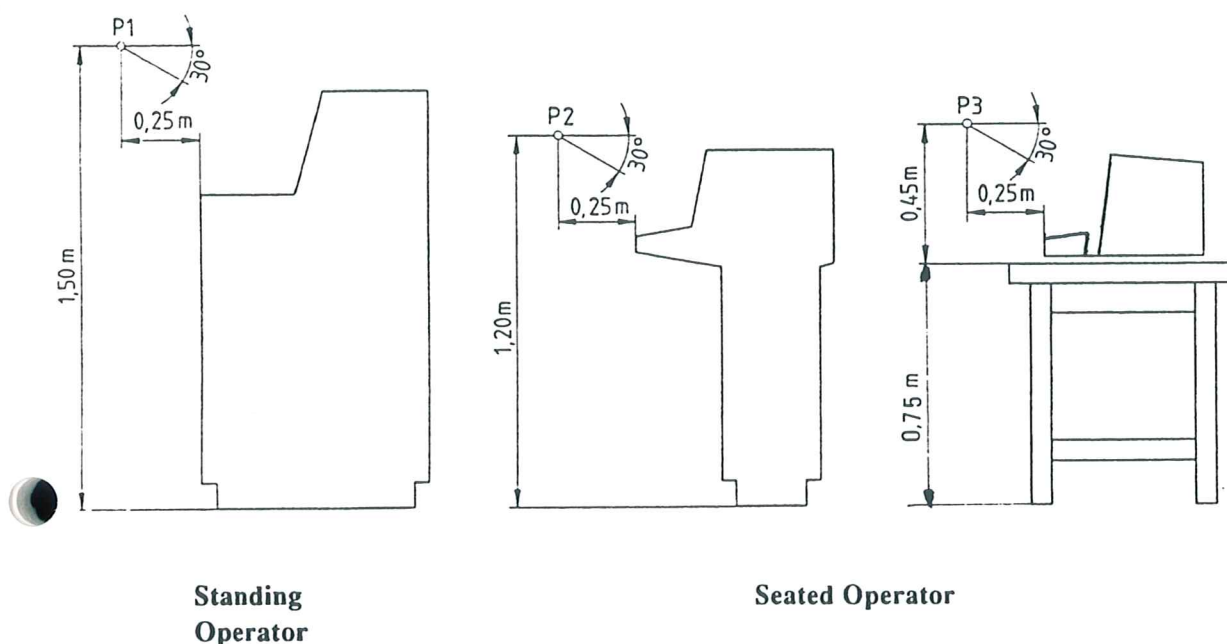


Figure 1 - Examples of the microphone positions for standing and seated operators

## 7.7 Measurement of sound pressure levels

### 7.7.1 General

Measurements of the sound pressure level required by this clause shall be carried out at the microphone positions specified in 7.6 with A-weighting and/or for each frequency band within the frequency range of interest. The following data shall be obtained:

- the A-weighted sound pressure levels and/or the band sound pressure levels, for the specified modes of operation of the equipment;
- the A-weighted sound pressure levels and/or the band sound pressure levels of the background noise (including noise from support equipment).



**NOTE 34**

*When using a sound level meter, the person reading the meter should not disturb the sound field at the microphone.*

**NOTE 35**

*Should spatial fluctuations occur, due to interferences or standing waves, it is recommended that the microphone be moved by approximately 0,1 m in a vertical plane around the nominal measurement position, and the mean value of the sound pressure level be recorded.*

**NOTE 36**

*The methods for determining whether the noise at the operator position or at the bystander positions contains discrete tones and/or is impulsive in character are given in annex D and annex E, respectively.*

Measurements of the C-weighted peak sound pressure level  $L_{pCpeak}$  shall be carried out at the microphone positions specified in 7.6 if any of the  $L_{pCpeak}$  levels at the specified positions exceeds 120 dB.

**NOTE 37**

*Contemporary computer and business equipment is unlikely to emit  $L_{pCpeak}$  values greater than 120 dB.*

**7.7.2 Measurement duration**

The measurement duration shall be as specified in 6.7.2.

**7.7.3 Corrections for background noise**

If the level of background noise is at least 15 dB below the sound pressure level at each measurement point and in each frequency band, no corrections for background noise are required. If the level of the background noise is less than 15 dB but more than 6 dB below the sound pressure level at each measurement point and in each frequency band, the measured sound pressure levels shall be corrected for the influence of background noise using the following formula:

$$K_1 = L_c - 10 \log(10^{0,1L_c} - 10^{0,1L_b}) \quad (14)$$

where

$K_1$  = the correction, in dB, to be subtracted from the sound pressure level measured with the sound source operating to obtain the sound pressure level due to the sound source alone;

$L_c$  = the measured sound pressure level, in dB, with the sound source operating;

$L_b$  = the level of background noise alone, in dB.

If the level of the background noise is less than 6 dB below the sound pressure level at any measurement point in any given frequency band, the accuracy of the measurement is reduced and no correction shall be applied for that measurement point in that band. The results may, however, be reported and may be useful in determining an upper limit to the sound power level of the equipment being tested. If such data are reported, it shall be clearly stated that the background noise requirements of this Standard have not been satisfied for that frequency band.

**7.7.4 Corrections for unwanted reflections**

No corrections are permitted.

### 7.7.5 Calculation of A-weighted sound pressure levels from band levels

A-weighted sound pressure levels  $L_{pA}$  may be measured directly or determined from the following equation:

$$L_{pA} = 10 \log \sum_{j=1}^{j_{\max}} 10^{0,1 [L_{pj} + A_j]} \quad (15)$$

where

$L_{pj}$  = the level in the  $j$ -th octave or third-octave band

$A_j$  = A-weighting from table 5 or 6.

If broad-band noise is present in the 16 kHz octave band, the A-weighted levels shall be calculated from one third band measurements which include the 16 kHz octave band, otherwise the A-weighted levels shall not include the 16 KHz levels.

### 7.8 Calculation of the mean sound pressure level at the bystander position

If bystander positions are defined, the mean A-weighted sound pressure level,  $\overline{L}_{pA}$ , and the mean band sound pressure levels,  $\overline{L}_p$ , if required, at bystander positions defined in 7.6.2, shall be calculated as specified in the following formula:

$$\overline{L}_p = 10 \log \left[ \frac{1}{N} \sum_{i=1}^N 10^{0,1 L_{pi}} \right] \quad (16)$$

where

$\overline{L}_p$  = the band sound pressure level averaged over the bystander positions in dB. Reference: 20  $\mu$ Pa.

$L_{pi}$  = the band sound pressure level resulting from measurement at the  $i$ -th bystander position in dB.  
Reference: 20  $\mu$ Pa.

$N$  = number of bystander positions.

For A-weighted sound pressure level, the symbols  $\overline{L}_p$  and  $L_{pi}$  should be replaced by  $\overline{L}_{pA}$  and  $L_{pAi}$ .

### 7.9 Information to be recorded

The information, when applicable, specified in 7.9.1 to 7.9.4 shall be recorded for all sound pressure level measurements at operator or bystander positions.

#### 7.9.1 Equipment under test

The following information shall be recorded:

- a description of the equipment under test (including main dimensions; name, model and serial number of each unit; name, model and serial number of noise producing components and sub-assemblies in the unit under test);
- a complete description of the idle and operating modes, including operating speed, data medium used and the test programme in terms that are meaningful for the type of equipment being tested;
- a complete description of the installation and mounting conditions;
- the location of the equipment in the test environment;
- the location and functions of an operator, if present;



- f) the nominal power line frequency, in Hz (e.g. 50 Hz), and the measured power line voltage, in volts.

#### 7.9.2 Acoustical environment

The following information shall be recorded:

- a) a description of the acoustical environment, if indoors, the size and acoustic characteristics of the room, including absorptive properties of the walls, ceiling and floor. Acoustical qualification according to 6.3.1 or 6.3.2;
- b) the air temperature in °C, relative humidity in %, and barometric pressure in kPa.

#### 7.9.3 Instrumentation

The following information shall be recorded:

- a) equipment used for the measurements, including name, type, serial number and manufacturer;
- b) bandwidth of frequency analyser;
- c) frequency response of the instrumentation system;
- d) method used for checking the calibration of the microphones and other system components; the date and place of calibration shall be given;
- e) method used for determining the mean value of the sound pressure level and the impulse sound pressure level.

#### 7.9.4 Acoustical data

The following information shall be recorded:

- a) the measurement positions and microphone orientations (preferably including a sketch);
- b) if an operator position is defined according to 7.6.1, the A-weighted sound level  $L_{pA}$ , the band sound pressure levels if required, and the C-weighted peak sound pressure level  $L_{pCpeak}$  if greater than 120 dB, measured at the operator position(s) for both the idle and operating modes, in decibels, rounded to the nearest 0,1 dB preferred (0,5 dB required);
- c) if bystander positions are defined according to 7.6.2, the mean A-weighted sound pressure level  $\overline{L}_{pA}$ , and the mean band sound pressure levels if required, calculated according to 7.8 and the C-weighted peak sound pressure level  $L_{pCpeak}$  if greater than 120 dB at the bystander position with the highest A-weighted sound pressure level for both the idle and operating modes, in decibels rounded to the nearest 0,1 dB preferred (0,5 dB required);
- d) optionally, the impulsive parameter  $\Delta L_1$ , in decibels, if  $\Delta L_1 > 3\text{dB}$ , in accordance with the procedure outlined in annex E;
- e) optionally, the frequency, in Hz, of any prominent discrete tones identified in accordance with the procedure of annex D and the quantity  $(L_1 - L_n)$ , in decibels, associated with that prominent discrete tone;
- f) the correction  $K_1$ , if any, for background noise;
- g) the date, time and place where the measurements were carried out, and the name of the person who carried out the measurements.

#### 7.10 Test report

The test report shall contain the statement that the sound pressure levels have been obtained in full conformity with the procedures specified in clause 7 of this Standard. The test report shall state that these

sound pressure levels are given in dB rounded to the nearest 0,1 dB preferred (0,5 dB required). Reference: 20  $\mu$ Pa. The test report shall contain at least the following information:

- a) The name(s) and model number(s) of the equipment under test.
- b) If an operator position is defined according to 7.6.1, the A-weighted sound pressure level,  $L_{pA}$ , and if required, the band sound pressure levels, in decibels, at the operator position(s) for the idle and operating modes;
- c) If bystander positions are defined according to 7.6.2, the mean A-weighted sound pressure level,  $\overline{L}_{pA}$ , and, if required, the mean band sound pressure levels in decibels, measured at the positions specified in 7.6.2 around the equipment for the idle and operating modes;
- d) Detailed description of the operating conditions of the equipment being tested with reference to annex C, if applicable.

The above information may be supplemented by one of the following statements, which describe the character of the noise as determined in accordance with annexes D and E:

- no impulsive noise, no prominent discrete tones;
- impulsive noise, no prominent discrete tones;
- prominent discrete tones, no impulsive noise;
- impulsive noise and prominent discrete tones.

**NOTE 38**

*Some regulations require the reporting of the C-weighted peak sound pressure level if greater than 130 dB.*

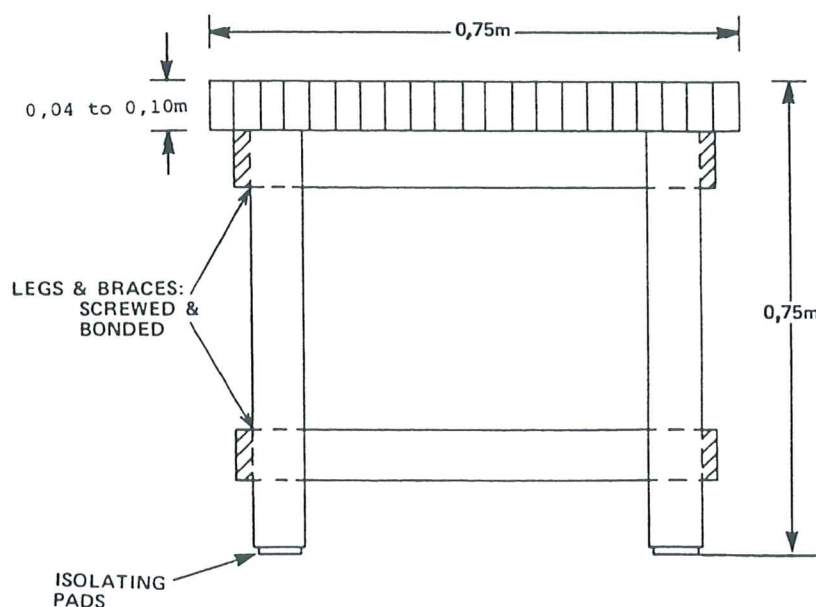




**Annex A**  
**(normative)**  
**Test accessories**

**A.1 Test table**

A suitable design for a test table is shown below. The top of the table shall be of bonded laminated wood 0,04 m to 0,10 m thick, having a minimum area of 0,5 m<sup>2</sup> and a minimum lateral dimension of 0,70 m to 0,75 m. The height of the table shall be 0,75 m. The table may have a slot in its top plate to allow paper to be inserted for printers which feed the paper from underneath their bottom cover.



**Figure A.1**

**A.2 Typing robot**

The typing robot shall be designed to operate a keyboard in the manner specified in this Standard. The robot here described uses 8 solenoids, each being individually adjustable to operate one of the selected keyboard keys.

The requirements for this robot are:

- the noise of the robot shall meet the requirements for background noise of this Standard.
- The stroke of each solenoid plunger shall fully release the key in its upper position and push it completely down to its stop; a total stroke of 6 mm to 7 mm should be sufficient for many types of keyboards including typewriters.
- The electrical input signal shall be a rectangular pulse of 50 ms duration, and of adjustable amplitude.



- The solenoid characteristics shall provide an increasing force during key-down motion, as shown in figure A.2. A suitable design is shown in figure A.3.
- The plunger mass shall be  $20 \text{ g} \pm 1 \text{ g}$ , its end shall be soft (e.g. closed-cell foam, 40 Shore A).

A complete operation of a single key includes the following three steps, which are shown in figure A.4:

1. Home position  $S_a$

The plunger rests under its own weight with its soft end on the key.

2. Key operation

When excited by the solenoid, the plunger pushes the key down until it has reached its stop position  $S_e$ . The adjustment of the solenoid should give a plunger clearance of 1 mm; an appropriate mark at the upper plunger end will facilitate this adjustment.

3. Key return

The plunger is returned only by the key spring. The plunger return stop shall be soft and allow a maximum overshoot of 0,5 mm; the plunger returns to its home position, resting on the key.

NOTE A.1

The specification is based on the design of the robot described in "Geräuschemission von Geräten der Büro- und Informationstechnik" Schriftenreihe der Bundesanstalt für Arbeitsschutz Fb 481 Bd. 1 Wirtschaftsverlag NW, Verlag für neue Wissenschaft GmbH, (Postfach 101110, D-2850 Bremerhaven 1, Germany).

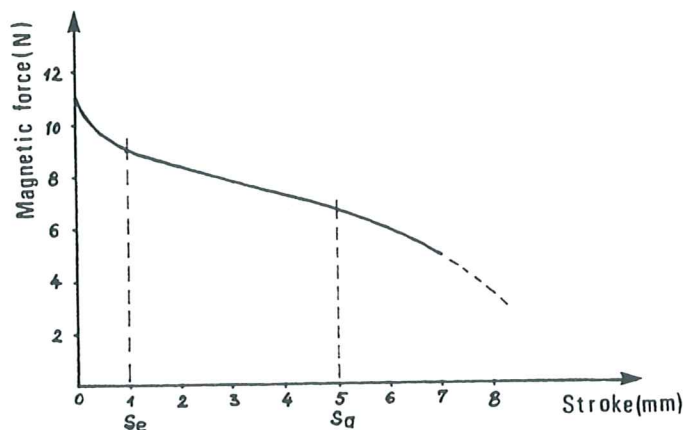


Figure A.2 - Solenoid Characteristics for a plunger stroke of 4 mm

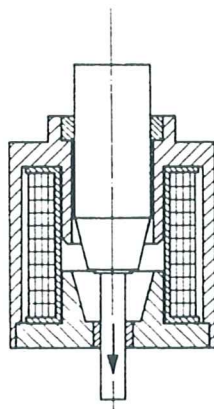
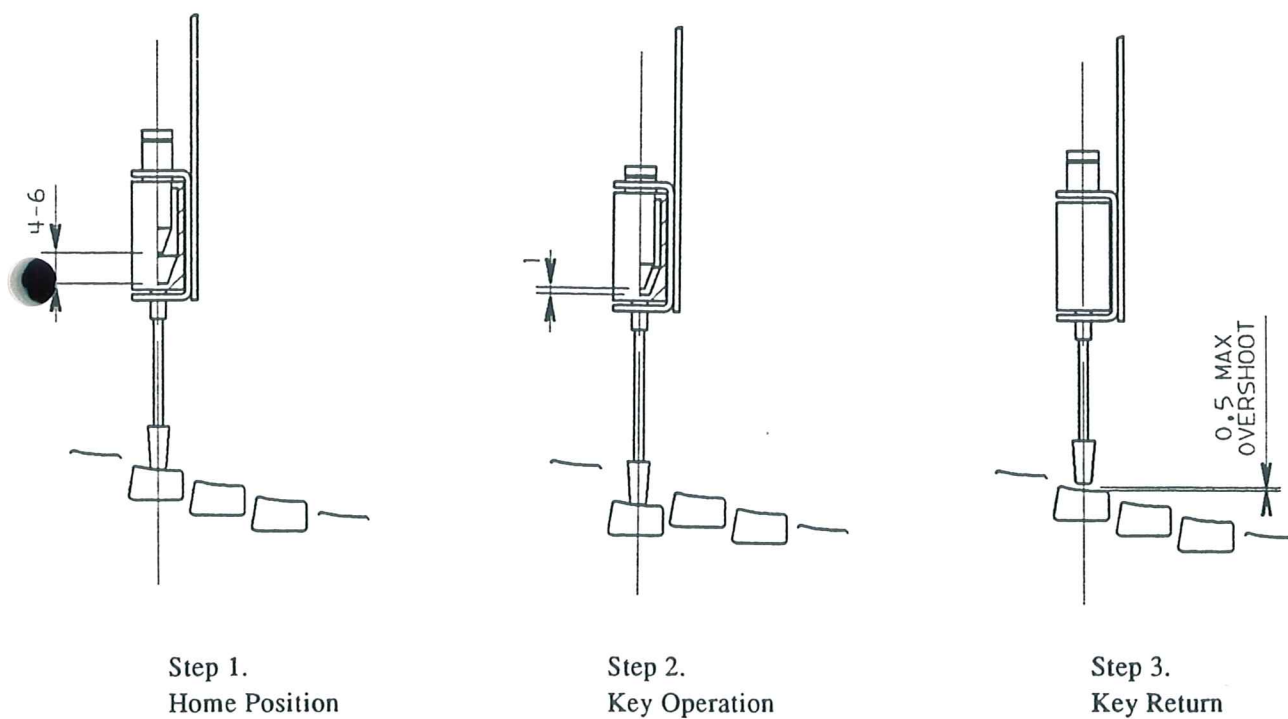


Figure A.3 - Solenoid cross section



Step 1.  
Home Position

Step 2.  
Key Operation

Step 3.  
Key Return

Figure A.4 - Individual steps of the solenoid operation. Dimensions in mm.





**Annex B**  
**(normative)**  
**Measurement surfaces**

For computer and business equipment the preferred measurement surface is the parallelepiped with the surface area  $S$ , the sides of which are parallel to those of the reference box at the measurement distance  $d$ . The preferred value for  $d$  is 1 m, and it shall not be less than 0,25 m. For equipment of the same type, the same measurement distance shall be used.

A hemisphere or a quarter-sphere of radius  $r$  may be chosen as the measurement surface, if the condition  $r > 2d_0$  is met, where  $d_0$  is the distance of the farthest corner of the reference box from the origin of the co-ordinates. The spherical measurement surface shall have a radius of at least 1 m.

Co-axial circular paths in parallel planes for microphone traverses in free field over reflecting plane may be utilized. Either, the microphones may be traversed around the equipment under test, or a fixed microphone array used and the equipment rotated.

**B.1 Arrangement B.1**

**Parallelepipedal Measurement Surfaces**

The number of measurement positions depends on the size of the equipment.

For the conditions :

$$L_1 < 2d$$

$$L_2 < 2d$$

microphone positions No 1 to No 9 shall be used, unless the numerical difference between the maximum and minimum A-weighted sound pressure levels measured at microphone positions No 1 to No 9 exceeds 9 dB; then the number of microphone positions shall be increased to 17.

For the conditions :

$$L_1 > 2d$$

$$L_2 < 2d$$

microphone positions No 1 to No 15 shall be used, unless the numerical difference between the maximum and minimum A-weighted sound pressure levels measured at microphone positions No 1 to No 9 exceeds 9 dB; then the number of microphone positions shall be increased to 17.

For the conditions :

$$L_1 > 2d$$

$$L_2 > 2d$$

microphone positions No 1 to No 17 shall be used.

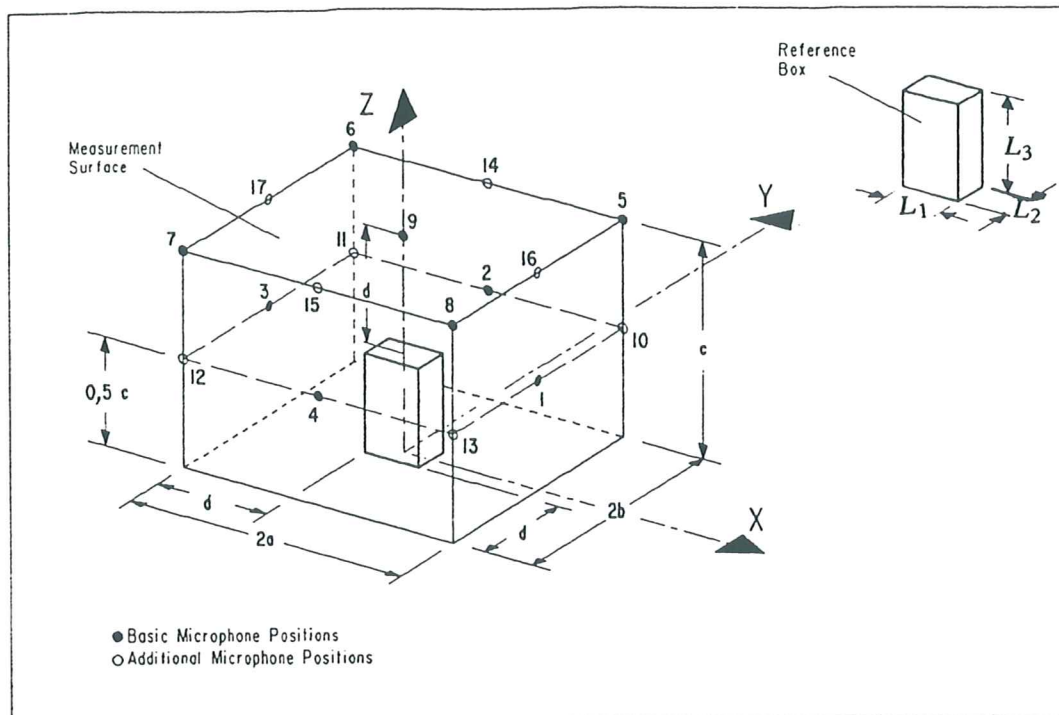


Figure B.1 - Measurement surface



**Table B.1 - Coordinates of the microphone positions**

Position		$x$	$y$	$z$
	1	$a$	0	$c/2$
	2	0	$b$	$c/2$
	3	$-a$	0	$c/2$
	4	0	$-b$	$c/2$
	5	$a$	$b$	$c$
	6	$-a$	$b$	$c$
	7	$-a$	$-b$	$c$
	8	$a$	$-b$	$c$
	9	0	0	$c$
	10	$a$	$b$	$c/2$
	11	$-a$	$b$	$c/2$
	12	$-a$	$-b$	$c/2$
	13	$a$	$-b$	$c/2$
	14	0	$b$	$c$
	15	0	$-b$	$c$
	16	$a$	0	$c$
	17	$-a$	0	$c$

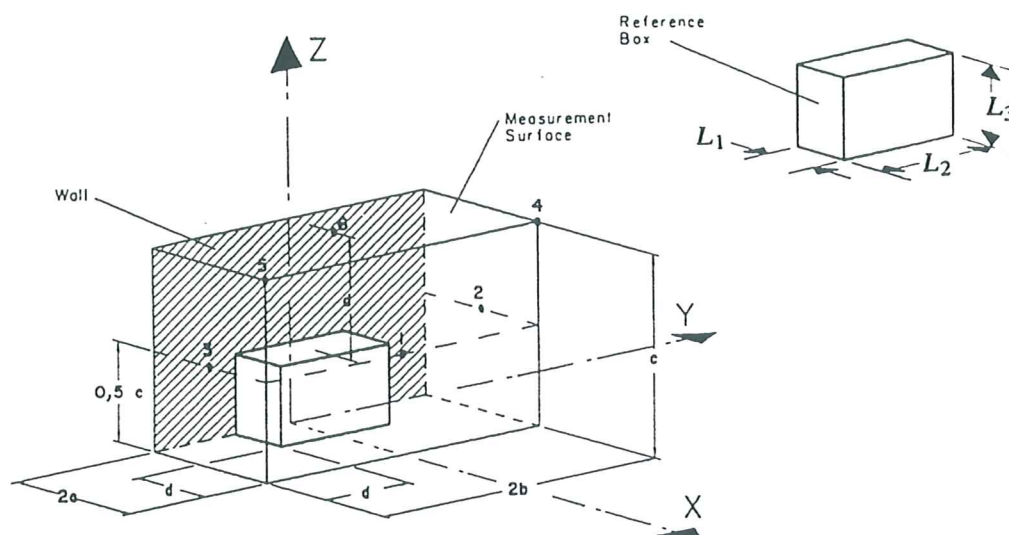
**Area of the measurement surface :**

$$S = 4 \times (ab+bc+ca)$$

## **B.2 Arrangement B.2**

Parallelepipedal measurement surface for equipment in front of a wall

For this arrangement the reference box extends to the wall.



• Microphone positions

Figure B.2 - Measurement surface for equipment in front of a wall

Table B.2 - Coordinates of microphone positions

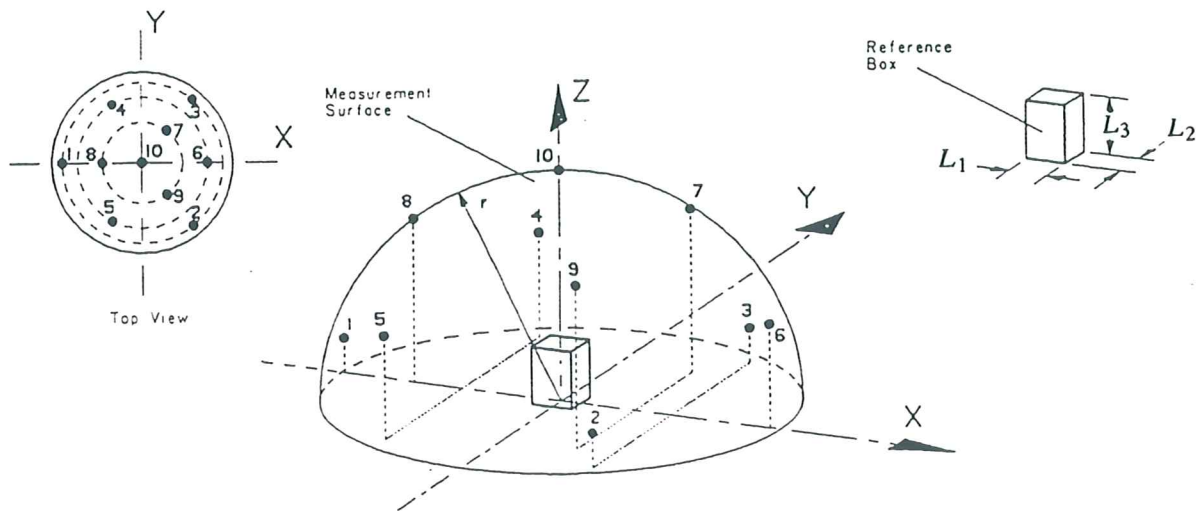
Position	x	y	z
1	2 a	0	1/2 c
2	a	b	1/2 c
3	a	- b	1/2 c
4	2 a	b	c
5	2 a	- b	c
6	a	0	c

Measurement surface area  $S = 2 (2ab+2ac+bc)$

B.3 Arrangement B.3

Hemispherical measurement surface, 10 measurement positions

Measurement surface area  $S = 2\pi r^2$



• Microphone positions

Figure B.3 - Hemispherical measurement surface - 10 measurement positions

Table B.3a - Coordinates of microphone positions for equipment not emitting discrete tones

Position	$x/r$	$y/r$	$z/r$
1	- 0,99	0	0,15
2	0,50	- 0,86	0,15
3	0,50	0,86	0,15
4	- 0,45	0,77	0,45
5	- 0,45	- 0,77	0,45
6	- 0,89	0	0,45
7	- 0,33	0,57	0,75
8	- 0,66	0	0,75
9	0,33	- 0,57	0,75
10	0	0	1,0

If the equipment emits tones, strong interference effects may occur if several microphone positions are placed at the same height above the reflecting plane. In such cases the use of a spiral microphone array with the coordinates given in table B.3b is recommended.



**Table B.3b - Coordinates of microphone positions for equipment emitting discrete tones**

Position	$x/r$	$y/r$	$z/r$
1	0,16	- 0,96	0,22
2	0,78	- 0,60	0,20
3	0,78	0,55	0,31
4	0,16	0,90	0,41
5	- 0,83	0,32	0,45
6	- 0,83	- 0,40	0,38
7	- 0,26	- 0,65	0,71
8	0,74	- 0,07	0,67
9	- 0,26	0,50	0,83
10	0,10	- 0,10	0,99

**B.4 Arrangement B.4**

Quarter-sphere measurement surface, 5 measurement positions

The measurement positions are those numbered 2, 3, 6, 7 and 9 of the arrangement B.3.

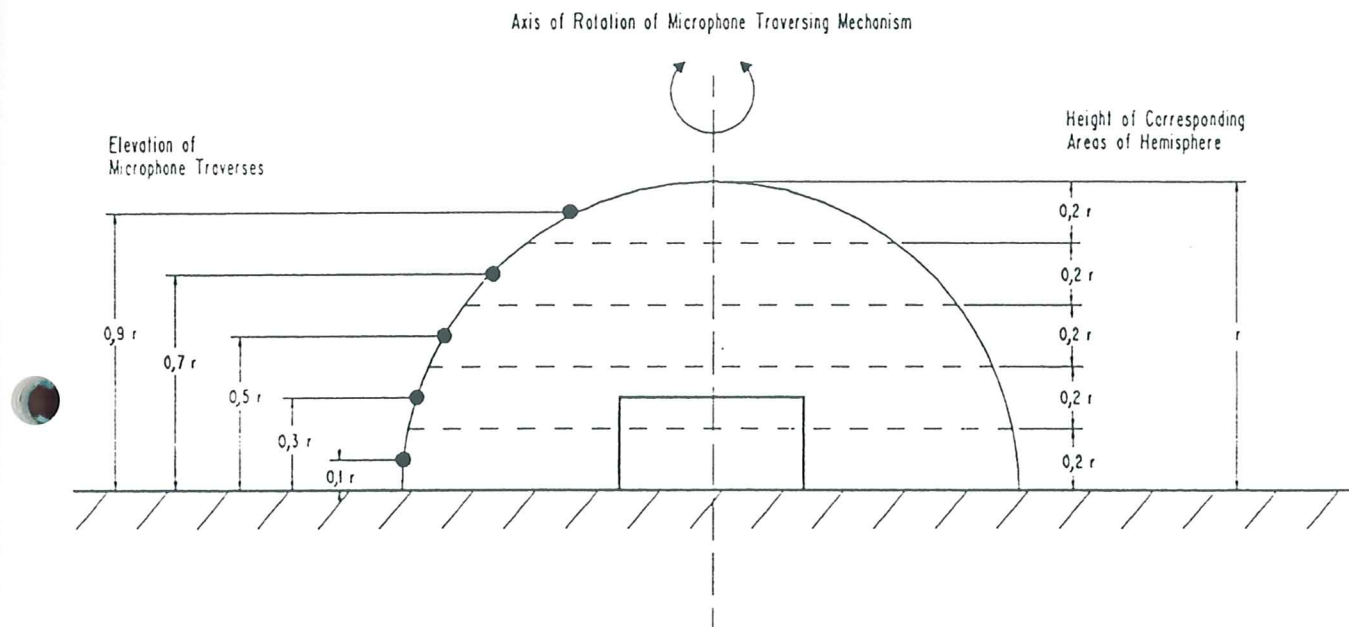
Measurement surface area  $S = \pi r^2$

This arrangement should only be used where small equipment is to be placed against two perpendicular reflecting planes.

**B.5 Arrangement B.5**

Coaxial circular path in parallel planes in a field over a reflecting plane.

In this arrangement either the microphones or the equipment may be rotated. Each path is associated with a zone of the hemisphere. These zones have the same height  $0,2 r$  and thus the same spherical surface area  $2\pi r^2$ .



**Figure B.4 - Hemispherical measurement surface - Circular paths**





**Annex C**  
**(normative)**

**Installation and operating conditions for specific equipment categories**

**C.1 General**

This annex specifies installation and operating conditions for many specific categories of equipment. When testing such equipment, the conditions shall be satisfied in order to comply with this Standard. For categories of equipment not covered in this annex, the actual test conditions used shall be described and justified in the test report.

When possible the conditions specified in this annex are considered to be typical of average end use. They are specified with a view to facilitating the operation of the equipment and to enhancing the reliability of the acoustic measurements.

The following categories of equipment are included:

- C.2 Typewriters
- C.3 Printers
- C.4 Teleprinters
- C.5 Keyboards
- C.6 Duplicators (copiers)
- C.7 Card readers - card punches
- C.8 Magnetic tape units
- C.9 Disk units and storage subsystems
- C.10 Visual Display units
- C.11 Electronic units
- C.12 Microform readers
- C.13 Facsimile machines (Telecopiers) and page scanners
- C.14 Cheque processors
- C.15 Personal computers and workstations
- C.16 Page printers
- C.17 Self-service automatic teller machines
- C.18 Enclosures or rack systems

**C.2 Equipment category - Typewriters**

**C.2.1 Description**

Equipment with a keyboard for manual information entry. The information is either keyed-in and immediately printed on paper character-by-character (manual typing), or keyed-in and stored for word or line editing with following automatic print-out (interactive operations). Typewriters which are equipped

with a full-page storage are considered as typewriters during manual typing and as printers (see C.3) during automatic print-out on a full page.

## C.2.2 Installation

The typewriter shall be placed in the centre of the top plane of the test table. For measurements according to clause 6, the measurement surface terminates on the extended top plane of the test table. Alternatively, the typewriter may be placed on a hard reflecting floor. The condition used shall be reported.

### C.2.2.1 Type font

If the typewriter allows the use of different type fonts or different type elements, a fine line typestyle (e.g. pica, elite) shall be used with a character pitch of 10 characters per 25,4 mm.

### C.2.2.2 Paper

Single sheets of paper weighing 70 g/m<sup>2</sup> to 80 g/m<sup>2</sup> in the ISO A4 or equivalent format shall be used unless the typewriter is designed for special paper having a different weight; in this case, the special paper shall be used. Paper shall be inserted in vertical format with left-hand edge at zero; the leading edge of the paper sheet shall be fed through to approximately 1/3 of the paper length, or 100 mm lower than the trailing edge (see figure C.1). Paper shall have been stored with the material unpacked and exposed to the environmental conditions specified in 6.3.4 for at least 24 hours immediately prior to the test.

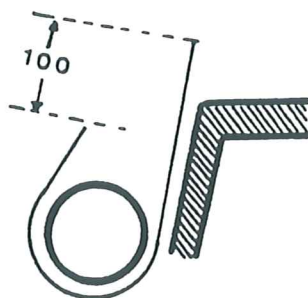


Figure C.1 - Insertion of single sheet paper

## C.2.3 Operation

### C.2.3.1 Idle mode

The power shall be switched on. Paper inserted according to figure C.1.

#### NOTE C.1

*If the typewriter has both standby and ready mode, the idle mode corresponds to the standby mode.*

### C.2.3.2 Operation (Typing mode)

The typing mode consists of keying-in the specified character pattern and printing it on paper. Keying-in should preferably be performed with a suitable robot (see A.2 in annex A) to simulate manual keystrokes. The noise level due to the operation of the robot alone shall be at least 6 dB and preferably more than 10 dB below the level of operation.

Typing shall start when the paper has been inserted, as specified in figure C.1 and shall continue for not more than 100 mm.

#### C.2.3.2.1 Settings

The following settings, when applicable, shall be used:

- a) Impression control: As recommended for a single sheet of paper.

- b) Multi-copy control: Set for a single sheet.
- c) Line spacing: Double line spacing.
- d) Margin: 25 mm from the edges. The end-of-line indicator (bell) shall be disconnected.
- e) Paperbail rollers: The paperbail rollers shall be set 25 mm in from the edges of the paper; others equally spaced between.

**C.2.3.2.2 Character pattern:** the test pattern characters shall be  
etnaiv etnaiv etnaiv etnaiv...

and so on until a full printline of approximately 60 characters has been completed. The single space between each group of six characters is intentional. The carriage return after each line is part of the operation.

*NOTE C.2*

*A maximum of two characters may be replaced by other small letters, if there is a need for adjustment of the robot.*

*NOTE C.3*

*Should small letters not be available, capital letters may be used instead; equivalent conditions may be selected for typewriters with non-Latin character sets.*

**C.2.3.2.3 Operating speed**

- a) For non-interactive operation the operating speed shall be as follows: The typing speed shall be 5 characters per second.
- b) For interactive operations: The specified characters shall be keyed in at a rate of 5 characters/s until the buffer is filled up; a maximum buffer capacity of one printline shall not be exceeded. Immediate printing of the stored information (maximum one line) at rated printing speed is required.

**C.2.4 Measurement duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2 during the following operations:

- a) For non-interactive operation: Measure during continuous typing over at least 3 full lines.
- b) For interactive operations: Measure during keying-in and print-out until at least 3 full lines have been printed.

**C.3 Equipment category - Printers**

**C.3.1 Description**

Electronically controlled equipment which prints stored information on paper and is not normally keyboard-operated, and the noise output of which is dependant on the print pattern. The output may be obtained by means of impact printing (e.g. typebar-, train-, chain- or band-printers, printwheel, type-element or matrix printers) or by non-impact printing (e.g. ink jet, electro-erosion, or thermal printers).

*NOTE C.4*

*For teleprinters, see C.4; for page printers which have noise output independent of the print pattern, see C.16.*



## **C.3.2 Installation**

### **C.3.2.1 General**

Floor-standing printers shall be installed on the hard reflecting floor. Printers which are normally placed on a special stand shall be installed on such a stand on the reflecting floor. Printers which are placed on an office table or desk and which take paper from, or stack paper on, the floor, shall, if possible, be placed in the centre of the top plane of the test table, using the floor to support the paper. For such measurements according to clause 6 the measurement surface terminates on the reflecting floor.

Table-top printers, which do not use the floor for the paper supply or exit stack, shall be placed on the hard reflecting floor for measurements according to clause 5 or 6 and on the test table for measurements according to clause 7.

### **C.3.2.2 Type style**

If the printer allows the use of different type styles or different type elements, a type style typical of normal use (resident standard type style), with a character pitch of 10 characters per 25,4 mm and with a number of 6 lines per 25,4 mm shall be used. If this is not possible an adjustment as close as possible to these values shall be chosen. Condensed or extended characters, shall not be used.

### **C.3.2.3 Paper**

Either single sheets of paper weighing 70 g/m<sup>2</sup> to 80 g/m<sup>2</sup> or continuous, folded or rolled stationery weighing 50 g/m<sup>2</sup> to 60 g/m<sup>2</sup> shall be used, unless the printer is designed for special paper having a different weight; in this case, the special paper shall be used. The quantity of paper available for printing shall be as close as possible to the maximum capacity of the printer. The form width shall be the widest that is commonly available for the printer and shall be described in the test report. For special applications (e.g. passbook or cheque processing) the material shall be typical for customer usage and shall be described in the test report.

Paper storage and unpacking shall be carried out in accordance with the machine manufacturer's instructions. If there are no such instructions, paper shall have been stored with the material unpacked and exposed to the environmental conditions specified in 6.3.4 for at least 24 hours immediately prior to the test.

## **C.3.3 Operation**

### **C.3.3.1 Paper position**

Except when single sheets are being used, the paper shall be loaded and fed through for a length of at least ten times its width. If single sheets are being used, the paper should be inserted in such a way that it can be printed on for at least 60 % of the page length with the printing area centred vertically.

### **C.3.3.2 Idle mode**

The power shall be switched on.

#### *NOTE C.5*

*If the printer has both standby and ready modes, the idle mode corresponds to the standby mode.*

### **C.3.3.3 Operating mode (Print mode)**

Printers with single sheet feeding devices shall be tested in best quality mode. The paper of size A4 or of an equivalent format (portrait) is automatically fed.

Printers with continuous stationery shall be tested in draft mode with maximum paper width.

Printers providing single-sheet feeding devices and continuous stationery shall be tested in both configurations.

The print mode consists of printing a character pattern specified in C.3.3.3.2.

For graphic printers whose print speed is specified per ISO 11160 while printing graphic mode per ISO/IEC 10561, a second operating mode shall be tested and reported: the second mode consists of printing the test pattern in ISO/IEC 10561, annex D.

#### C.3.3.3.1 Settings

The following settings, when applicable, shall be used:

- a) Impression control: As recommended for a single sheet of paper.
- b) Multi-copy control: Set for a single sheet.
- c) Line spacing: Double line spacing and skip 20 mm to 30 mm on each side of the paper fold.
- d) Margin: 25 mm from the edges (excluding the perforation strip) except when the printer characteristics restrict the available line length. In the latter case, typical margin length shall be used and reported.

#### C.3.3.3.2 Character pattern

The full content of a 40-character test pattern is given below. The character pattern shall be arranged in groups of five printed characters followed by five spaces. The position of the pattern should preferably be shifted by five characters on each line, using an end-around shift over the available line length. The printing area shall be left-justified and centred vertically. If the line comprises fewer characters, the left-most ones shall be used.

J1YY7 2DA90 8S8=2 6AI8Q B31AJ 5FTOE PG1TK X6D-4

#### NOTE C.6

*If some of the specified characters are not available, alternative characters of up to 20% of the characters in one line may be substituted. For printers which print only non-Latin characters or numerical information a random set of characters or numbers shall be selected and reported.*

The number of characters to be printed in one line depends on the printer itself and is given in table C.1. Examples of test patterns are shown in Figures C.2 and C.3.

Table C.1 - Number of characters to be used

Available line length in characters	Number of characters to be used
< 40	50 % of max. line length between margins
40 - 59	20 characters
60 - 110	30 characters
> 110	40 characters

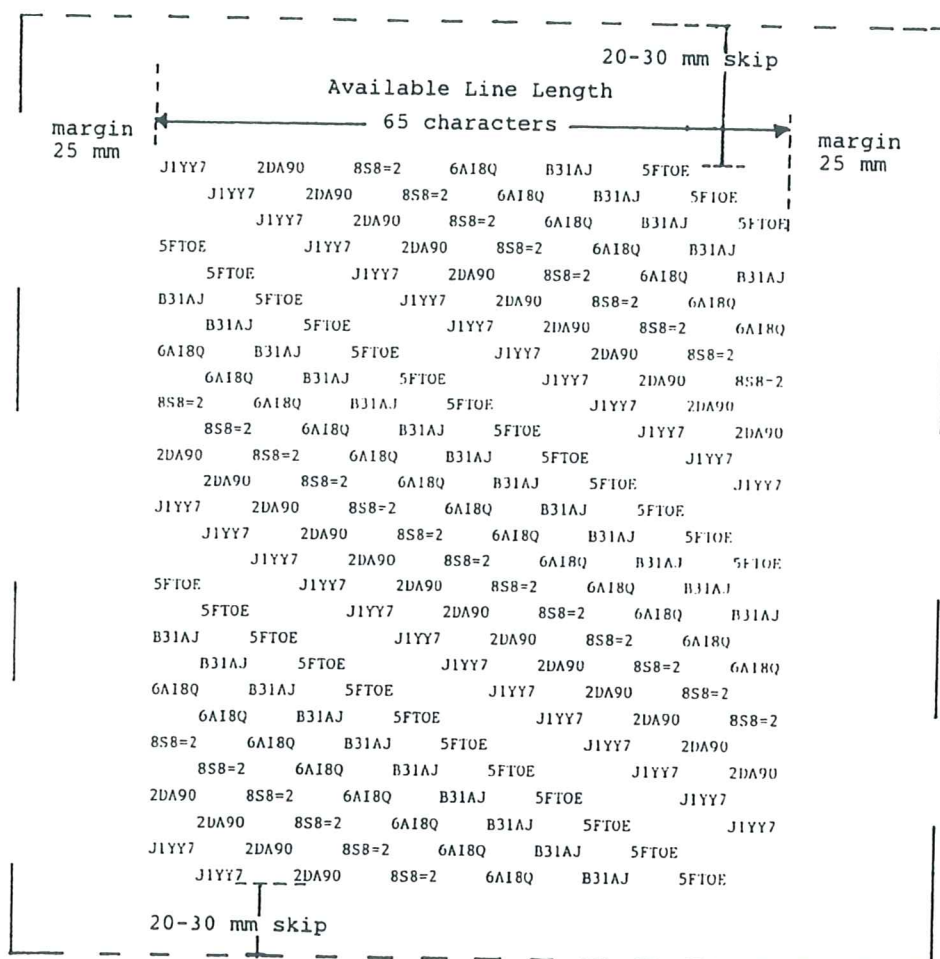


Figure C.2 - Example of the test pattern for a line length of 65 characters



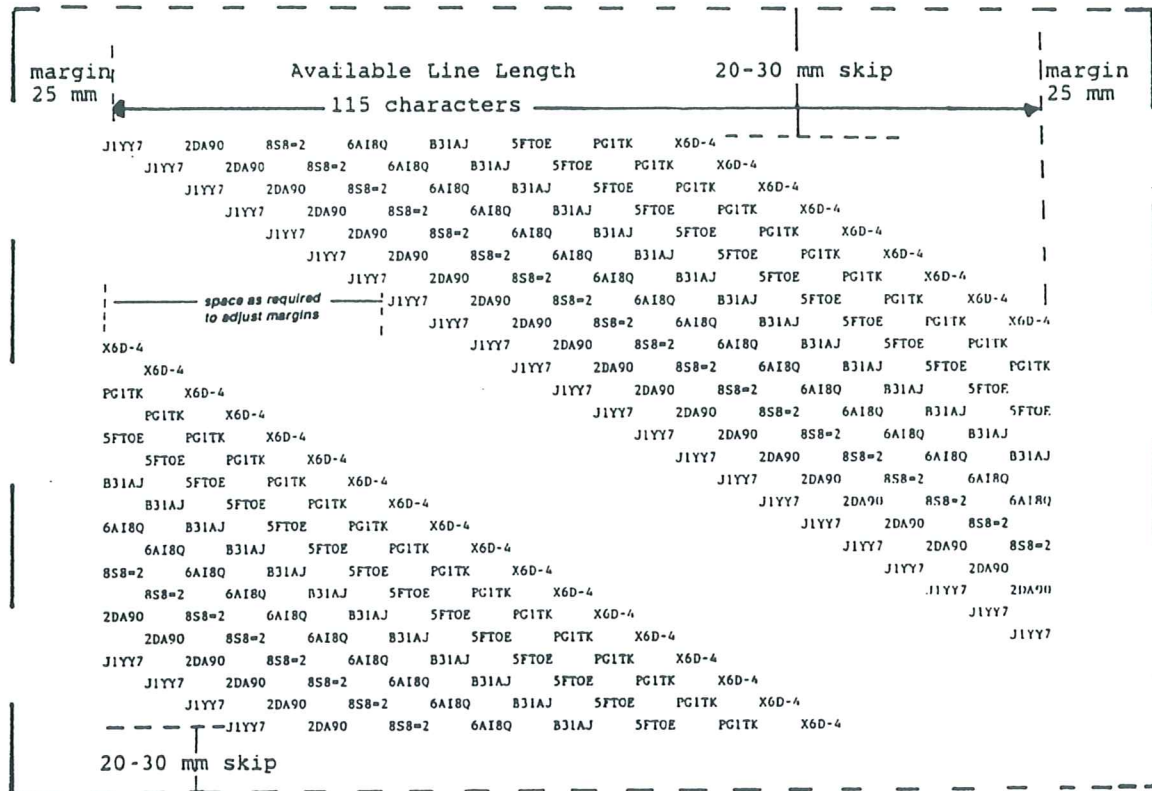


Figure C.3 - Example of the test pattern for a line length greater than 110 characters

#### C.3.3.3.3 Operating speed

The rated speed for which the printer is designed shall be used; if several speeds are provided, the one which is typical for the majority of the uses shall be employed and reported. Additional conditions may be specified for special applications and shall be described in the test report.

#### C.3.4 Measurement duration

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2 during the following operations:

- Single-page form: measure during continuous printing over at least 60 % of the page length. If the printer has an automatic paper feed mechanism, at least three pages shall be printed.
- Folded stationery: measure during continuous printing over at least three pages.
- Rolled stationery: measure during continuous printing over a length equal to at least the paper width.
- Passbook: measure during printing of a single line on the middle pages during a complete operation cycle from insertion to ejection (for details see C.17).

## **C.4 Equipment category - Teleprinters**

### **C.4.1 Description**

Equipment operating as a send/receive machine basically comprising a keyboard, a printing unit, a mechanical or electronic send/receive unit (line control unit) and (integrated or optional) a memory unit (electronic, paper tape punch or reader, magnetic tape, disk or cassette).

Two typical uses are:

- a) Keyboard operation (when in local or transmission mode): the information is keyed-in by manual typing and immediately printed on paper and/or stored in the memory.
- b) Automatic operation (when in local or on-line mode): the machine prints automatically the information received from line network or from the memory unit.

When a teleprinter is fitted with an auxiliary unit which produces noise (e.g. paper tape punch/reader, magnetic tape, disk or cassette), the machine shall be tested with and without the unit in operation.

In some cases a teleprinter can be available in receive-only configuration (without keyboard). That machine is considered to be a printer (according to C.3).

### **C.4.2 Installation**

#### **C.4.2.1 General**

For keyboard operation of the teleprinter, the general installation conditions for typewriters shall apply (see C.2).

For automatic operation of the teleprinter, the general installation conditions for printers shall apply (see C.3).

#### **C.4.2.2 Paper**

Either single sheets of paper weighing 70 g/m<sup>2</sup> to 80 g/m<sup>2</sup> or continuous, folded or rolled stationery weighing 50 g/m<sup>2</sup> to 60 g/m<sup>2</sup> shall be used, unless the printer is designed for special paper having a different weight; in this case, the special paper shall be used. The quantity of paper available for printing shall be as close as possible to the maximum capacity of the printer. The form width shall be the widest that is commonly available for the printer and shall be described in the test report. For special applications (e.g. passbook or cheque processing) the material shall be typical for customer usage and shall be described in the test report.

If in typical use, multi-part stationery is employed, an additional test with such stationery shall be carried out and reported.

Paper storage and unpacking shall be carried out in accordance with the machine manufacturer's instructions. If there are no such instructions, paper shall have been stored with the material unpacked and exposed to the environmental conditions specified in 6.3.4 for at least 24 hours immediately prior to the test.

### **C.4.3 Operation**

#### **C.4.3.1 Idle mode**

The power shall be switched on and paper shall be inserted.

#### **NOTE C.7**

*If the teleprinter has both standby and ready modes, the idle mode corresponds to the standby mode.*

#### **C.4.3.2 Operating mode (Print mode)**

For keyboard operation of the teleprinter, the operating conditions specified for keyboards shall apply (see C.5).

For automatic operation of the teleprinter, the operating conditions specified for printers shall apply (see C.3).

#### **C.4.4 Measurement duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2.

For keyboard operation of the teleprinter, the requirements specified for typewriters shall apply (see C.2.4).

For automatic operation of the teleprinter, the requirements specified for printers shall apply (see C.3.4).

### **C.5 Equipment category - Keyboards**

#### **C.5.1 Description**

Equipment for manual data entry fixed or connected (via a cable) to other units, e.g. visual display units, computer console, hand-held calculator, etc.

#### **C.5.2 Installation**

Keyboards shall be installed in accordance with the relevant clauses of this Standard, except for measurements according to clause 5 or 6 the keyboard may be placed in the centre of the top plane of the test table if required for operation and shall be reported.

#### **C.5.3 Operation**

##### **C.5.3.1 Operating mode (keying-in)**

Keying-in shall be performed at a rate of 5 characters per second.

A suitable robot (see A.2 in annex A) should be used to simulate manual keystrokes. The noise level due to the operation of the robot alone shall be at least 6 dB and preferably more than 10 dB below the level of operation.

If the keyboard has an acoustical feedback, the minimum volume setting shall be used for the test.

*NOTE C.8*

*If a typing robot is not available, manual keying-in may be used.*

##### **C.5.3.2 Test pattern**

- a) For alphanumeric keyboards, the test pattern shall be as specified for typewriters (see C.2.3.2.6).
- b) For numeric keyboards, the test pattern shall be four digits plus function key, the keys selected shall be reported.

#### **C.5.4 Measurement duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2; the requirements specified for typewriters shall apply (C.2.4).

#### **C.5.5 Measurement uncertainty**

The measurement uncertainty for determining sound levels for keyboard operation has not yet been verified and may be greater than that given in 5.2, 6.2 and 7.2.



## **C.6 Equipment category - Duplicators (copiers)**

### **C.6.1 Description**

Equipment which can produce one or more copies from a master. Such equipment can be coupled with one or more additional attachments & features. These may be in the form of input, output or internal devices for a variety of duplicating needs. Input devices can be in the form of master document loading, handling and registering, or special paper feeders for continuous stationery or label printing. Output devices can be in the form of copy handlers such as sorters, automatic staplers, stackers and binders. The equipment may have an internal reversing device(s) for handling two-sided originals and producing two-sided copies; i.e. automatic duplexing. The duplicator may also offer full colour duplicating from full colour masters, or highlight colour duplicating.

### **C.6.2 Installation**

Floor-standing duplicators shall be installed on the hard reflecting floor. Duplicators which are normally placed on a special stand or table shall be installed on such a stand or table on the reflecting floor. Duplicators which are placed on a normal office table or desk and which do not take paper from, or stack paper on, the floor, shall, if possible, be placed in the centre of the test table, using the floor to support the paper. For such measurements according to clause 6 the measurement surface terminates on the reflecting floor.

Table-top duplicators, which do not use the floor for the paper supply or exit stack, shall be placed on the hard reflecting floor for measurements according to clause 5 or 6 and on the test table for measurements according to clause 7.

The same installation conditions shall be followed when the duplicator has attachments.

#### **Paper**

Either single sheets of paper weighing 70 g/m<sup>2</sup> to 80 g/m<sup>2</sup> or continuous, folded or rolled stationery weighing 50 g/m<sup>2</sup> to 60 g/m<sup>2</sup> shall be used, unless the printer is designed for special paper having a different weight; in this case, the special paper shall be used. The quantity of paper available for printing shall be as close as possible to the maximum capacity of the printer. The form width shall be the widest that is commonly available for the printer and shall be described in the test report. For special applications (e.g. passbook or cheque processing) the material shall be typical for customer usage and shall be described in the test report.

Paper storage and unpacking shall be carried out in accordance with the machine manufacturer's instructions. If there are no such instructions, paper shall have been stored with the material unpacked and exposed to the environmental conditions specified in 6.3.4 for at least 24 hours immediately prior to the test.

### **C.6.3 Operation**

#### **C.6.3.1 Idle mode**

Power shall be switched on and the duplicator loaded with a suitable paper supply.

#### **C.6.3.2 Operating mode**

The nominal speed for which the duplicator has been designed shall be used; if several speeds are provided, the one which is typical for the majority of the uses shall be employed. The copier shall be adjusted to normal exposure, and tests shall be carried out without using any reduction/enlargement facility, if provided.

Additional machine set-up conditions may be considered.

- a) Duplicating without additional attachments

An operation cycle shall consist of continuously copying of a single master.

- b) Duplicating with additional attachments: input and output devices

When a copying/duplicating system combines several features/attachments, a "full system" operation cycle shall comprise the use of the maximum number of feature/attachments allowable at least once. This may include using all the features/attachments on the duplicator or just some of them. Where all the features/attachments cannot be used together in one operation cycle, several different operating combinations should be considered. The combination which is typical of use shall be selected and described in the test report.

#### **Input devices**

- a) Automatic loading of originals

An operation cycle shall consist of placing 5 masters in the device input tray and making 5 copies of each master. Copies are ejected into a single stationery output tray.

- b) Duplication from continuous stationery

An operation cycle shall consist of feeding 5 pages of continuous stationery through the registering device and making 5 copies of each master. Copies are ejected into a single stationery output tray.

#### **Output devices**

- a) Sorting

The operation shall start with an empty sorter. An operation cycle shall comprise the registering of 1 master and making 5 copies ejected into 5 consecutive sorter bins. (Any copies made during additional operation cycles shall be sorted into the same 5 consecutive bins.)

- b) Stacking

If the duplicator is equipped with an integral mechanism to separate copy sets generated sequentially, it will generally be fitted with an input master loading device. The operation cycle shall comprise the placing of 5 originals into the device input tray and 1 copy of each shall be ejected into the stacker.

- c) Automatic stapling

Automatic stapling may be provided in the form of a separate output device, or being fitted as integral to a sorter or stacker. Duplicators equipped with this device will generally be fitted with an input master loading device. The operation cycle shall comprise the stapling of a set of copies from 5 masters for a total of 5 stapled sets, and ejected into the output tray.

- d) Duplication on continuous stationery

An operation cycle shall comprise duplication of 1 master on 5 pages for folded stationery or a 2-metre length for rolled stationery.

- e) Auxiliary equipment

If a duplicator is supplied with an accessory or integral equipment (e.g. a binder), the tests shall be carried out with and without the use of this equipment in the operation cycle.

- f) Two-sided copying

Duplicators equipped with this feature can either:



- a) Handle two-sided masters and produce from them one-sided or two-sided copies, or,
- b) Handle one-sided masters only, and produce from them one-sided or two-sided copies.

Duplicators equipped with this device will generally be fitted with an input master loading device.

An operation cycle for type a) above shall comprise the making of 2 one-sided copies (1 of each of the sides of the master) or 1 two-sided copy from one two-sided master. This to be repeated five times. An operation cycle for type b) above shall comprise the making of 1 two-sided copy from two one-sided masters, this to be repeated five times.

g) **Colour copying**

The operation cycle for duplicators fitted with this feature shall be the copying from 1 one-sided full colour master; 1 copy is made and automatically ejected into a single stationery output tray.

h) **Highlight-colour copying**

The operation cycle for duplicators fitted with this feature shall be as for monochrome. (Copies should contain highlight-colour from a full text master, e.g. 4 lines in highlight-colour using the test pattern as in C.2).

#### **C.6.4 Measurement duration**

The time-average sound pressure level shall be measured for at least five operation cycles and for at least the duration specified in 5.7.2 or 6.7.2.

### **C.7 Equipment category - Card readers - Card punches**

#### **C.7.1 Description**

Equipment of this category may perform a single function, such as reading the information from, or punching it into, a punched card. The two functions may also be combined in one machine which allows the use of both functions in one process or to use them separately. The number of cards processed per unit time depends for readers mainly on the nominal processing speed; for punches it may be significantly influenced by the total number of columns to be punched per card.

*NOTE C.9*

*For equipment which performs similar functions such as card duplicating machines, card verifiers, card or document sorters and collators, code interpreters (with printing features), paper tape readers and punches, the following installation and operating conditions may also be applied.*

#### **C.7.2 Installation**

The equipment shall be installed in accordance with the relevant clauses of this Standard.

#### **C.7.3 Operation**

##### **C.7.3.1 Idle mode**

The power shall be switched on and the equipment shall be ready for reading or punching cards.

##### **C.7.3.2 Operating mode (Reading or Punching mode)**

If equipment of this category is capable of both reading and punching in one process, the operating mode shall consist of both punching and reading cards as specified below. If equipment allows only the use of these functions separately, the operating mode shall be punching.



The specified character pattern shall be read from, or punched into and/or read from, each card; approximately 40 % of the maximum number of columns (usually 80) shall contain information. The specified character pattern shall be arranged in groups of five characters followed by five spaces:

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#### C.7.4 Measurement duration

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2 during processing of a random card deck of at least 10 cards.

### C.8 Equipment category - Magnetic tape units

#### C.8.1 Description

Equipment for writing on, and reading from, a magnetic tape wound on reels or within a cassette or a cartridge. A unit may contain one or more separately operable tape drives.

#### C.8.2 Installation

Installation shall be in accordance with the relevant clauses of this Standard.

#### C.8.3 Operation

##### C.8.3.1 Idle mode

###### C.8.3.1.1 Idle unloaded mode

The power shall be switched on and the tape shall not be in the tape path.

###### C.8.3.1.2 Idle loaded mode

The power shall be switched on and the tape shall be loaded and the equipment shall be ready to receive and respond to control line commands to any drive. In multiple drive units, all drives shall be loaded and ready.

##### C.8.3.2 Operating modes

One of the modes specified below shall be used as applicable.

In multiple drive units, only one drive shall be in operating mode; all other drives shall be in the idle loaded mode.

###### C.8.3.2.1 Read/Write mode

Start, read or write, stop - with command timing for capstan (or equivalent) operation as follows:

The capstan on-time in ms is set at the time needed to pass 130 mm of tape at the rated tape speed, given by

$$\frac{130 \text{ mm}}{\text{rated tape speed in m/s}} \quad \text{ms}$$

rounded to the nearest millisecond. The off-time is equal to 0,7 to 1 times the on-time.

#### NOTE C.10

*For a magnetic tape of 12,7 mm width, 130 mm of tape corresponds to a block length of 4096 bytes at 32 bpmm. Higher densities should use correspondingly larger block sizes, such that the total on-time for all density machines will be approximately equal. At 63 bpmm, use a block length of 8 192 bytes; at 246 bpmm, use a block of 32 768 bytes.*

###### C.8.3.2.2 Streaming mode

Logical forward run while writing.

#### C.8.4 Measurement duration

The time-average sound pressure level shall be measured, for at least the duration given in 5.7.2 or 6.7.2, for at least twenty consecutive start/stop operations in accordance with C.8.3.2.1 or streaming operations in accordance with C.8.3.2.2.

### C.9 Equipment category - Disk units and storage subsystems

#### C.9.1 Description

Equipment for writing on, and reading from, one or more rotating magnetic or optical disks. Disks may be removable or non-removable. Magnetic disks may be flexible or rigid. A unit may contain one or more separately operable disk drives.

#### C.9.2 Installation

Installation shall be in accordance with 5.5.1 or 6.5.1 and 7.5 of this Standard. Disk units which form part of a personal computer or rack mounted equipment shall be tested according to C.15 or C.18 as appropriate. Disk units which are tested as sub-assemblies shall be installed as sub-assemblies per 5.5.1 or 6.5.1.

#### C.9.3 Operation

##### C.9.3.1 Idle mode

###### C.9.3.1.1 Idle ready

Disk(s) loaded, power on, unit ready to receive and respond to control link commands with spindle up to speed and read/write heads in track following mode.

For systems having a single drive, the drive shall be as described above. For systems with multiple drives or for storage subsystems, the number of drives that are simultaneously operable by the host CPU shall be operated as specified above. All other drives shall be in the idle mode typical of normal use for the system.

###### C.9.3.1.2 Idle standby

If power savings are available, such modes may be tested and shall be described in the report.

##### C.9.3.2 Operating mode

For units having a single drive, the drive shall be operating as described below.

For units with multiple drives, or for storage subsystems, the number of drives that are simultaneously operable by the host CPU shall be operated as specified below. All other drives shall be in the idle mode, typical of normal use for the system.

Randomly select a cylinder/track to be sought where every cylinder/track has equal probability of being selected. (If the drive incorporates an algorithm to perform seeks in a more efficient non-random order, then this algorithm may be used. In this case the drive should be given a command or commands to read or write a random selection of files, and the drive algorithm will decide the order in which the commands are executed. The file length shall be adjusted to achieve the seek rate given below). Seek to that track, then delay for a time period  $t_D$  achieving the required seek rate  $n_s$  within  $\pm 10\%$  according to the following formula:

$$n_s = 0,4 / (t_T + t_L)$$

$$t_D = 1,5 t_T + 2,5 t_L$$

where:

$n_s$  = average seek rate in seeks/s



$t_T$  = manufacturer's published time to seek from one random track to another without including rotational latency.

$t_L$  = equivalent time, in seconds, for the drive to rotate by half a revolution.

Repeat the seek process. No other intentional delay while selecting the cylinder is allowed. The average number of seeks per second along with the seek algorithm shall be reported with the acoustical data.

If the drive is operating in a system and if the system is not capable of achieving the required seek rate, the drive shall be operated at the maximum seek rate achievable.

If the drive is operating in a multiple drive system in a Redundant Array of Inexpensive Disks (RAID) environment, the drive shall be operated at the maximum seek rate achievable compatible with the system RAID level in use.

#### **C.9.4 Measurement duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2.

### **C.10 Equipment category - Visual display units**

#### **C.10.1 Description**

Equipment which displays information on a screen, and which may be equipped with a keyboard for information entry. The keyboard may be fixed to the display unit or connected to it by means of a cable.

The units in this category may emit significant noise in the 16 kHz octave band. If the noise from the 16 kHz octave band is broad-band in character, the A-weighted levels shall be calculated from one-third octave band measurements which include the 16 kHz octave band. If the noise in the 16 kHz octave band contains discrete tone(s), then the 16 kHz octave band shall not be included in the determination of the A-weighted levels.

For equipment which emits sound in the 16 kHz octave band, the procedures specified in ECMA-108 for reporting sound power levels shall be used (see table 7).

#### **C.10.2 Installation**

Installation shall be in accordance with the relevant clauses of this Standard.

#### **C.10.3 Operation**

##### **C.10.3.1 Idle mode**

The power shall be switched on and the equipment shall be in a steady-state condition, with air-moving device(s), if any, running and the representative pattern shall be displayed on the screen. The keyboard shall not be operated.

Preliminary tests should be run to determine if the emissions are significantly sensitive to the pattern displayed on the screen. If so, a pattern representative of maximum emission values for a typical user shall be determined. If not, the representative pattern shall be defined to be a full character set displayed on the screen and repeated until all positions on the screen are used. The representative pattern used shall be documented and reported.

##### **C.10.3.2 Operating mode (Typing mode) if applicable**

The typing mode consists of keying-in the information specified for keyboards (see C.5).

#### **C.10.4 Measurement duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2.



## **C.11 Equipment category - Electronic units**

### **C.11.1 Description**

Equipment such as processors, electronic memories and controllers, containing only electronic circuits, power supplies but no moving mechanical parts except those associated with cooling.

### **C.11.2 Installation**

Installation shall be in accordance with the relevant clauses of this Standard.

### **C.11.3 Operation**

#### **C.11.3.1 Operating mode**

Steady state operation with normal load on all cooling devices, power supplies, and distributed power supply elements. No data operations are required. For electronic units the idle and operating modes are deemed to be the same.

#### **C.11.3.2 Power saving mode**

If power saving modes are available, such modes may be tested in addition to the modes defined in C.11.3.1, described and reported.

### **C.11.4 Measurement duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2.

## **C.12 Equipment category - Microform readers**

### **C.12.1 Description**

Equipment to display micro-images. Microform readers may differ from each other, depending on the different types of microforms to be used, such as microfiche, aperture cards and rollfilm.

### **C.12.2 Installation**

Installation shall be in accordance with the relevant clauses of this Standard.

### **C.12.3 Operation**

#### **C.12.3.1 Idle mode**

The power shall be switched on and the equipment shall be ready to display.

#### **C.12.3.2 Operating mode**

The microform shall be inserted and the micro-image adjusted and displayed.

The following two operations may be performed with partial or full automation:

- a) Equipment for microfiche and aperture cards: the micro-image shall be adjusted in two diagonal corners by moving its support; an image shall be kept stationery.
- b) Equipment for rollfilm with a full reel of microfilm loaded into the device; the image approximately in the middle of the film shall be sought and adjusted; the rollfilm shall be transported automatically.

The operation used during test shall be described and reported.

### **C.12.4 Measurement duration**

The time-average sound pressure level shall be measured for a minimum of three operation cycles and for at least the duration specified in 5.7.2 or 6.7.2.

## **C.13 Equipment category - Facsimile machines (Telecopiers) and page scanners**

### **C.13.1 Description**

#### **C.13.1.1 Facsimile machines**

Equipment operating as a send/receive machine, basically comprising a numeric keyboard, a paper feeding device, a scanner, a print unit and an electronic send/receive control unit. The telecopier is used for transmitting text, drawings and graphic information via public transmission networks.

#### **C.13.1.2 Page scanners**

Equipment operating as a scanner which detects text, drawing and graphical information from full sheets of paper and comprises a paper feeding device and a scanner.

### **C.13.2 Installation**

#### **C.13.2.1 General**

The telecopier shall be installed in accordance with the relevant clauses of this Standard. For the purposes of reporting A-weighted sound pressure levels in accordance with ECMA-109 the bystander positions are applicable.

#### **C.13.2.2 Paper**

The paper that is used shall be in accordance with the machine manufacturer's instructions. If there are no instructions, either single sheets of paper weighing 70 g/m<sup>2</sup> to 80 g/m<sup>2</sup>, or continuous, folded or rolled stationery weighing 50 g/m<sup>2</sup> to 60 g/m<sup>2</sup> shall be used. The width of the rolled stationery shall be typical for the device; if different widths can be used, the most common one shall be used and shall be described in the report.

Paper storage and unpacking shall be carried out in accordance with the machine manufacturer's instructions. If there are no such instructions, paper shall have been stored with the material unpacked and exposed to the environmental conditions specified in 6.3.4 for at least 24 hours immediately prior to the test.

### **C.13.3 Operation**

#### **C.13.3.1 Idle mode**

Power shall be switched on and the equipment shall be ready for sending or receiving.

#### **C.13.3.2 Operating mode (Sending or receiving mode)**

Information shall be transmitted at a rate and resolution for which the facsimile machine or scanner is designed to be used. If more than one speed and resolution are provided, the one which is typical of the majority of uses shall be employed and reported. The printing of transmission receipts shall be included in the measurement. Additional conditions may be specified and described in the test report. Both the sending and the receiving modes shall be measured for the facsimile machine. The highest value so determined shall be reported.

#### **C.13.3.3 Transmitted information**

One transmission cycle shall consist of two pages:

Page 1: CCITT - Standard Letter (Slerexe Letter) (see figure C.4).

Page 2: Telecopier testsheet according to DIN 32 742 Part 7 (see figure C.5).

### **C.13.4 Measurement duration**

The time-average sound pressure level shall be measured for at least one full transmission cycle, in either the sending or the receiving mode, and for at least the duration given in 5.7.2 or 6.7.2.



## THE SLEREXE COMPANY LIMITED

SAPORS LANE - BOOLE - DORSET - BH 25 8 ER

TELEPHONE BOOLE (945 13) 51617 - TELEX 123456

Our Ref. 350/PJC/EAC

18th January, 1972.

Dr. P.N. Cundall,  
Mining Surveys Ltd.,  
Holroyd Road,  
Reading,  
Berks.

Dear Pete,

Permit me to introduce you to the facility of facsimile transmission.

In facsimile a photocell is caused to perform a raster scan over the subject copy. The variations of print density on the document cause the photocell to generate an analogous electrical video signal. This signal is used to modulate a carrier, which is transmitted to a remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by a printing device. This device is scanning in a raster scan synchronised with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

Probably you have uses for this facility in your organisation.

Yours sincerely,

*Phil.*

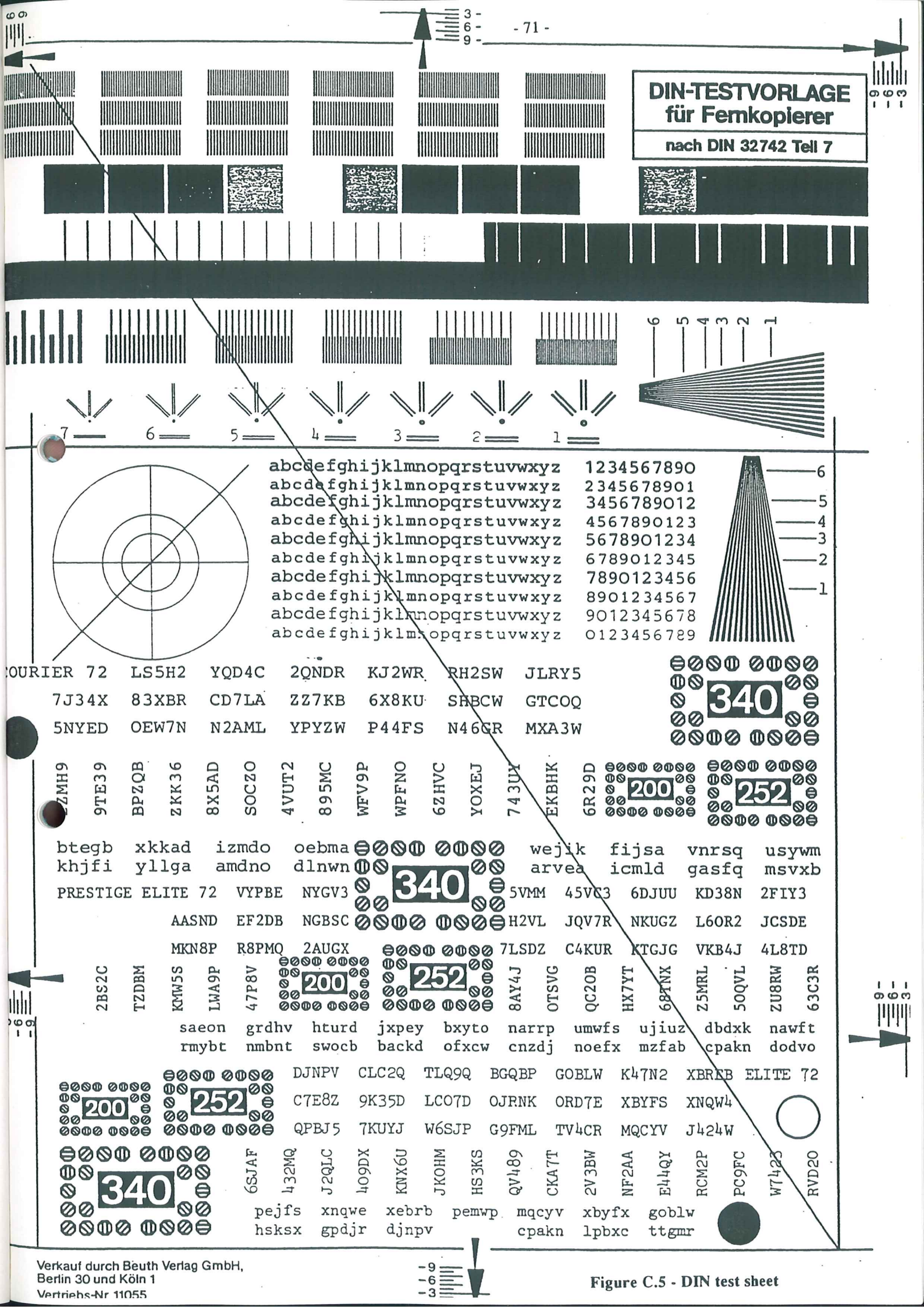
P.J. CROSS  
Group Leader - Facsimile Research

Figure C.4 - Slerexe letter



# DIN-TESTVORLAGE für Fernkopierer

nach DIN 32742 Teil 7





## **C.14 Equipment category - Cheque processors**

### **C.14.1 Description**

Equipment of this category may perform a single function such as printing (or encoding) information onto cheques, reading information from cheques, printing lists, storing/retrieving information from a flexible disk cartridge, or sorting cheques.

### **C.14.2 Installation**

#### **C.14.2.1 General**

The equipment shall be installed in accordance with the relevant clauses of this Standard.

#### **C.14.2.2 Paper**

##### **a) Cheque stock**

In typical use a large variety of cheque sizes and paper weights are used. To allow a standard method the following specification defines the properties of the cheques to be used.

Length: 140-160 mm

Height: 70-90 mm

Weight: 90-100 g/m<sup>2</sup>

##### **b) Printer paper**

If in typical use, multiple-part stationery is employed, an additional test with such stationery shall be performed and reported.

### **C.14.3 Operation**

#### **C.14.3.1 Idle mode**

The power shall be switched on and the equipment ready for use (i.e. stand-by mode).

#### **C.14.3.2 Operating Mode**

When a copying/duplicating system combines several features, a full system operation cycle shall comprise the use of each of those features at least once as described below under their respective operation cycle.

##### **a) Reading**

Random alpha-numeric data shall be read from the cheques in this mode and any additional operations which typically form part or are a result of this mode shall be performed (e.g. autofeed, listing, storing on flexible disk cartridge and sorting cheques). Repeat read cycles shall be performed at a rate typical of that expected in use.

##### **b) Printing (or encoding)**

Equipment of the type described in this category will in some cases contain a number of print mechanisms within one piece of equipment. The equipment shall be operated in a manner most typical of the expected use, with all print mechanisms operating in the proper sequence. Any additional operation which typically form part or result from this mode of operation shall be performed (e.g. autofeed, listing, storing on flexible disk cartridge and sorting cheques). The information to be printed by each type of printing mechanism (where appropriate) is defined in table C.3.

Repeat print cycle shall be performed at a rate typical of that expected in use.

**Table C.3 - Cheque processor printer types and their print pattern**

Printer Type	Characters to be printed Print Details
Encoder	*0000000085124* (amount field only)
Programmable Endorser	J1YY7 2DA90 8S8=2 6AI8Q
Fixed Endorser	any character

**c) Printing (listing)**

Repeat cycles of the character pattern shown below shall be printed at a rate typical of that expected in use. The full content of a 40-character pattern is given; if the line contains fewer characters, the left most ones shall be used.

The characters shall be arranged in groups of five followed by five spaces and each subsequent line shall be rotated five spaces to the right.

J1YY7 2DA90 8S8=2 6AI8Q B31AJ 5FTOE PG1TK X6D-4

Any additional operations which typically form part or are a result of this mode shall be performed.

**d) Storing/Retrieving from disk**

Consecutive seeks to a random track. Any additional operations which typically form part or are a result of this mode shall be performed.

**e) Sorting**

The cheques shall be sorted sequentially from the lowest numbered pocket to the highest numbered pocket and this sort pattern repeated as necessary for the duration of the measurement period.

**C.14.4 Measurement duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2. For the operating mode the measurement duration shall be at least that of eight complete operation cycles.

**C.15 Equipment category - Personal computers and workstations**

**C.15.1 Description**

Small systems such as personal computers, workstations and word processors, which include a keyboard, visual display unit, and a processor unit which itself may contain combinations of one or more flexible disk and/or rigid disk drives, magnetic tape units or printers.

The units in this category may emit significant noise in the 16 kHz octave band. If the noise from the 16 kHz octave band is broad-band in character, the A-weighted levels shall be calculated from octave or one-third octave band measurements which include the 16 kHz octave band. If the noise in the 16 kHz octave band contains discrete tone(s), then the 16 kHz octave band shall not be included in the determination of the A-weighted levels.

For equipment which emits sound in the 16 kHz octave band, the procedures specified in ECMA-108 (ISO 9295) for sound power levels shall be used (see table 7).



### **C.15.2 Installation**

The constituent units of the system may be tested individually and reported accordingly. In this case the installation conditions are as in 5.5.1, 6.5.1, 7.5 and the relevant clauses of annex C of this Standard.

Alternatively the equipment may be tested as a complete system. In this case for the measurement of sound power levels, the equipment shall be mounted on the hard reflecting floor and the setup used recorded.

For the measurement of bystander and/or operator sound pressure levels, the separate enclosures shall be arranged in a set-up that is typical of actual use. Table-top equipment shall be tested on the test table. If some of the separate enclosures are floor-standing equipment and others are table-top equipment, the floor-standing equipment shall be installed next to the test table on the left or right of the table and the table-top equipment installed on the test table.

### **C.15.3 Operation**

Operation of the equipment shall be in accordance with 5.5.3 and 6.5.3 of this Standard for the following modes of operation.

#### **C.15.3.1 Idle Mode**

Power shall be switched on, the equipment shall be in a steady state condition, with air moving device(s) running, disk drives in the idle mode, a full character set displayed on the screen and all other devices idling.

If power saving modes are available, such modes may be tested in addition to the above idle mode, and shall be described and reported.

#### **C.15.3.2 Operating mode(s)**

One or more of the following operating modes shall be used where applicable. Noise due to keyboard operation shall not be included.

Equipment with flexible disk drives as C.9.

Equipment with rigid disk drives as C.9.

In combinations of rigid and flexible disk drives the operating mode is defined as one rigid disk drive operating and all other drives idle as C.9.

Equipment with magnetic tape units as C.8.

Equipment with built in printers as C.3.

Other types of equipment as required.

### **C.15.4 Measurement Duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2

## **C.16 Equipment category - Page printers**

### **C.16.1 Description**

Equipment which produces printed output from computers, the noise output of which is independent of the material printed on the page. Such equipment may have peripheral equipment such as envelope feeders, sorters, and special paper feeders. It may print single-sided or two-sided out-put.

### **C.16.2 Installation**

#### **C.16.2.1 General**

Floor-standing printers shall be installed on the hard reflecting floor. Printers which are normally placed on a special stand or table shall be installed on such a stand or table on the reflecting floor. Printers which are placed on a normal table or desk and which take paper from, or stack paper on, the floor,

shall, if possible, be placed in the centre of the top plane of the test table, using the floor to support the paper. For such measurements according to clause 6 the measurement surface terminates on the reflecting floor.

Table-top printers, which do not use the floor for the paper supply or exit stack, shall be placed on the hard reflecting floor for measurements according to clause 5 or 6 and on the test table for measurements according to clause 7.

#### **C.16.2.2 Paper**

The paper that is used shall be in accordance with the machine manufacturer's instructions. If there are no such instructions, either single sheets of paper weighing 70 g/m<sup>2</sup> to 80 g/m<sup>2</sup>, or continuously folded or rolled stationery weighing 50 g/m<sup>2</sup> to 60 g/m<sup>2</sup> shall be used. Paper dimensions shall be typical of normal use and described in the test report. For special applications (e.g., label printing or envelope printing) the material shall be typical of customer usage and described in the test report).

Paper storage and unpacking shall be carried out in accordance with manufacturer's instructions. If there are no such instructions, paper shall have been stored with the material unpacked and exposed to the environmental conditions specified in 6.3.4 for at least 24 hours immediately prior to the test.

#### **C.16.3 Operation**

##### **C.16.3.1 Idle mode**

The power shall be switched on and the printer shall be ready for printing.

##### *NOTE C.11*

*If the page printer has both standby and ready modes, the idle mode corresponds to the standby mode.*

##### **C.16.3.2 Operating mode (Print mode)**

A print job (consisting of a text pattern) shall be sent to the printer such that it will print at its rated speed.

##### **C.16.3.2.1 Single-sheet printers operation**

Operation shall comprise the continuous printing of one side of single sheets for at least 3 sheets. If printing on both sides of sheets is available, this mode shall also be measured. The higher of the modes shall be reported. Operation shall be performed for the required measurement duration.

##### **C.16.3.2.2 Continuous form printers operation**

Operation shall comprise the continuous printing of at least 3 pages of folded stationery or a length of 2 m for rolled stationery.

##### **C.16.3.2.3 Operation cycle with features**

When a printing system combines several features, a full system operation cycle shall comprise the use of each of the features at least once as described under the respective operation cycle.

##### **a) Sorter**

The sorting operation shall start with an empty sorter. An operation cycle shall comprise the sorting of one page in one bin. Pages printed during additional cycles shall be sorted into consecutive bins.

##### **b) Stacking**

If the printer is equipped with an accessory or integral mechanism to separate jobs generated sequentially, an operation cycle shall comprise two jobs and print one page for each of them.



- c) If the printer is supplied with auxiliary equipment (e.g. a mechanism for cutting continuous forms), the tests shall be carried out with and without the use of such equipment in the operation cycle.

#### **C.16.4 Measurement duration**

For each set-up the time-average sound pressure level shall be measured, for at least the duration given in 5.7.2 or 6.7.2, for a minimum of three operation cycles for single-sheet printers (C.16.3.2.1) and for one operation cycle for continuous form printers (C.16.3.2.2) and for at least one operation cycle with features (C.16.3.2.3).

### **C.17 Equipment category - Self-service automatic teller machines**

#### **C.17.1 Description**

Equipment of this category is mainly used in banking environments and provides various services to customers such as cash dispense, funds transfer between accounts, account balance inquiry, balance statement issuing and envelope deposit.

Depending on the purpose of the equipment, a variety of different functions can be performed and combined in one machine. Typical examples for operating modes are given in C.17.3; it is not assumed that these conditions apply to all cases; therefore, the test conditions shall be described in the test report.

#### **C.17.2 Installation**

The equipment shall be installed in accordance with the relevant clauses of this Standard. For the purposes of reporting A-weighted sound pressure levels in accordance with ECMA-109 the bystander positions are applicable.

#### **C.17.3 Operation**

##### **C.17.3.1 Idle mode**

The power shall be switched on and the equipment shall be ready for use.

##### **C.17.3.2 Operating mode**

The operating mode which is typical for average customer usage shall be defined and reported. For some equipment, examples are defined as follows:

- a) Money dispenser  
Card insertion, key-in PIN, task selection (e.g. cash issue), selection of amount of money, issue card, open cash gate, issue cash, issue receipt, close cash gate.
- b) Passbook operation  
Insert passbook, read magnetic stripe data, key-in PIN, print one line in passbook, write and verify magnetic stripe data, issue passbook, or  
Insert passbook, read magnetic stripe data, key-in PIN, task selection (e.g. cash issue), selection of amount, write and verify magnetic stripe data, issue passbook, issue cash.
- c) Banking information print-out  
Insert check card, key-in PIN, task selection (e.g. statement of account), issue card, print output, issue output.
- d) Cash envelope deposit  
Card insertion, key-in PIN, task selection (e.g. cash deposit), key-in amount of deposit, insert envelope into depository device, remove card and receipt.



#### **C.17.4 Measurement duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2. For the operating mode, an average value shall be determined for at least three typical transactions, during which manual access may be needed, which however shall not be intentionally delayed.

### **C.18 Equipment category - Enclosures or rack systems**

#### **C.18.1 Description**

Systems comprising several similar or different system sub-assemblies which are installed in a rack or enclosure. The sub-assemblies can have different configurations as required by the user to meet his specific requirements. The sub-assemblies may be self-contained with their own power supplies and cooling assemblies or may rely on power supplies and cooling assemblies installed separately in the rack or enclosure.

##### *NOTE C.12*

*This equipment category does not include sub-assemblies not installed in a rack or enclosure.*

#### **C.18.2 Installation**

The constituent sub-assemblies of the system may be tested in the rack or enclosure and reported individually, or the system may be tested and reported as a whole for a specified configuration.

When sub-assemblies are tested individually in the rack or enclosure they shall be installed in the position specified in the rack or enclosure manufacturer's installation manual with all other positions either empty with blanking plates in place and/or filled with unpowered sub-assemblies. Only the noise of the sub-assembly shall be reported together with its position in the rack or enclosure. All necessary external devices such as power supplies and cooling assemblies housed separately in the rack or enclosure shall be considered as sub-assemblies and measured and reported accordingly.

For configurations tested as complete systems the sub-assemblies shall be installed in the positions given in the rack or enclosure manufacturer's installation manual for a given configuration and shall be described in the test report.

The installation conditions for the rack or enclosure systems are as in 5.5.1, 6.5.1, 7.5 and the relevant clauses of annex C.

#### **C.18.3 Operation**

Operation of the equipment shall be in accordance with 5.5.3 and 6.5.3 of this Standard for the following modes of operation.

##### **C.18.3.1 Idle mode**

The power shall be switched on, and all sub-assemblies shall be in idle mode ready to receive command signals from the system CPU.

##### **C.18.3.2 Operating mode**

One or more of the following operating modes should be used as applicable.

Rigid and flexible disk drives as C.9.

##### *NOTE C.13*

*Measurements on individual disk drives should be made at the seek rate typical of the multiple-drive configuration if system limitations do not allow the seek rate specified in C.9. This is necessary so as not to overestimate the system sound levels as calculated in C.18.5 from individual measurements.*

Magnetic tape units as C.8.

Built-in printers as C.3.

Other types of equipment as required.

**C.18.4 Measurement duration**

The time-average sound pressure level shall be measured for at least the duration specified in 5.7.2 or 6.7.2 and as further required in annex C for the operation of the sub-assemblies.

**C.18.5 Calculation of the system A-weighted sound power level and system sound pressure level from sub-assembly sound levels**

The system A-weighted sound power level shall be calculated using the following equation:

$$L_{WA,sys} = 10 \log \sum_{i=1}^n 10^{(0,1 L_{WAi})}$$

where

$L_{WA,sys}$  is the system A-weighted sound power level in dB

$L_{WAi}$  is the A-weighted sound power level of the  $i$ -th sub-assembly installed in a rack or enclosure

$n$  = number of sub-assemblies.

The system A-weighted sound pressure level shall be calculated using the following equation:

$$L_{pA,sys} = 10 \log \sum_{i=1}^n 10^{(0,1 L_{pAi})}$$

where

$L_{pA,sys}$  is the system A-weighted sound pressure level, in dB

$L_{pAi}$  is the A-weighted sound pressure level of the  $i$ -th sub-assembly installed in a rack or enclosure

$n$  = number of sub-assemblies.

**C.18.6 Calculation of A-weighted sound power level and A-weighted sound pressure level for low noise level sub-assemblies**

In some cases the noise level of sub-assemblies may be within 6 dB of the background noise level which would preclude an accurate value if measured individually. In this case enough identical sub-assemblies shall be tested and measured in the enclosure, so that the noise level of the  $n$  sub-assemblies is sufficiently greater than the background noise level (it may be convenient to test the maximum number allowed).

The sub-assembly A-weighted sound power level shall be calculated from the following equation:

$$L_{WA,s} = L_{WA,sn} - 10 \log n$$

where

$L_{WA,s}$  is the averaged individual sub-assembly A-weighted sound power level, in dB

$L_{WA,sn}$  is the total A-weighted sound power level for  $n$  identical installed sub-assemblies, in dB

$n$  is the number of sub-assemblies installed and tested.

The sub-assembly A-weighted sound pressure level shall be calculated from the following equation:

$$L_{pA,s} = L_{pA,sn} - 10 \log n$$

where

$L_{pA,s}$  is the sub-assembly A-weighted sound pressure level, in dB

$L_{pA,sn}$  is the total A-weighted sound pressure level for  $n$  identical installed sub-assemblies, in dB

$n$  is the number of sub-assemblies installed and tested.





**Annex D**  
**(informative)**

**Identification of prominent discrete tones**

**D.1 General**

This annex describes a procedure for determining whether or not noise emissions include prominent discrete tones.

The method of this annex is primarily applicable to operator-attended equipment. However, the methods may be applied to other equipment that is intended to be installed in low-noise areas.

**D.2 Background**

A discrete tone which occurs in a broadband noise is partially masked by the noise contained in a relatively narrow frequency band, called the critical band, that is centred at the frequency of the tone. Noise at frequencies outside the critical band does not contribute significantly to the masking effect. The width of a critical band is a function of frequency (see D.6). In general, a tone is just audible when the sound pressure level of the tone is about 4 dB below the sound pressure level of the masking noise contained in the critical band centred around the tone. For the purposes of this annex, a discrete tone is defined as being prominent if the sound pressure level of the tone exceeds the sound pressure level of the masking noise in the critical band by 6 dB. This corresponds, in general, to a tone being prominent when it is more than 10 dB above the threshold of audibility.

**D.3 Microphone position**

The measurements shall be performed at the operator position, or, if none, at the bystander position with the highest A-weighted sound pressure level. If there is more than one operator position, the measurements shall be performed at the operator position with the highest A-weighted sound pressure level.

For the purposes of identifying prominent discrete tones of sub-assemblies, the sub-assembly exclusion of 7.1 does not apply. For sub-assemblies which will be installed in table top products, the sub-assembly shall be installed in the centre of a test table and isolated from the surface by three or four elastomeric feet, approximately 12 mm high. For sub-assemblies which will be installed in other enclosures or racks, the sub-assembly shall be installed as in 5.5.1 h). For sub-assemblies which will be installed in equipment with a defined operator position, this operator position shall be used for the sub-assembly measurement, otherwise, the loudest bystander position having the highest A-weighted sound pressure level shall be used.

**D.4 Instrumentation**

The information contained in this annex is sufficiently complete to allow the identification of prominent discrete tones to be made using a variety of measurement equipment, and, therefore, no specific type of instrumentation is prescribed. The instruments shall meet the requirements of 6.4.1, 6.4.2, 6.4.3 and 6.4.5. However, the procedure of this annex requires the measurement of

- the sound pressure level of the tone, and
- the sound pressure level of the noise in the critical band centred at the frequency of the tone.

The instrumentation used should be capable of determining these levels with a tolerance of 1 dB. Commercially available or specially designed analog or digital instruments may be used to measure the levels directly, or raw data may be acquired and then processed by a digital computer. To measure the sound

pressure levels, a narrow band analysis shall be performed with the analyser frequency bandwidth resolution less than one per cent of the frequency of the tone.

#### D.5 Measurement procedure

Aural examination of the noise emitted by the equipment under test shall be made at the microphone position. If one or more discrete tones are audible, the procedure described below shall be followed for each tone.

In cases where there is doubt whether audible tones are present or not, the benefit of other, more objective, evidence should be sought (such as a narrow-band analysis of the noise).

The sound pressure level (in dB) of the discrete tone  $L_t$ , and the sound pressure level (in dB) of the masking noise  $L_n$ , exclusive of the tone, contained within the critical band centred at the frequency of the tone, shall be determined for the same mode(s) of operation and measurement conditions as used for the measurements in 7.5 to 7.7. When bandpass filters are used and the band sound pressure levels are measured, care must be taken to ensure that the measurement of the masking noise is not corrupted by the tone, and vice versa. The tone-to-noise ratio (in dB) is then taken as  $(L_t - L_n)$ .

##### NOTE D.1

*Since the tone-to-noise ratio is a difference in levels, absolute calibration of the instrumentation is not necessary; relative levels may be used.*

##### NOTE D.2

*When working with linear quantities, the sound power of the tone  $W_t$ , and the sound power of the masking noise  $W_n$ , are determined, and the tone-to-noise ratio is taken as  $(W_t/W_n)$ . Since this is a dimensionless ratio, absolute calibration of the instrumentation is not necessary.*

#### D.6 Critical bandwidths

The width of the critical band  $\Delta f_c$ , centred at any frequency  $f$ , can be calculated from the following equation.

$$\Delta f_c = 25,0 + 75,0 \left[ 1,0 + 1,4 (f / 1000)^2 \right]^{0,69}$$

e.g.  $\Delta f_c = 162,2 \text{ Hz}$  for  $f = 1 \text{ kHz}$

For the purpose of determining the value of  $L_n$ , the critical band is modelled as a rectangular filter with centre frequency  $f_0$ , lower band edge frequency  $f_1$ , and upper band edge frequency  $f_2$ , where

$$f_1 = f_0 - \Delta f_c / 2$$

and

$$f_2 = f_0 + \Delta f_c / 2$$

#### D.7 Prominent discrete tones

A discrete tone is identified as prominent if

$$(L_t - L_n) \geq 6,0 \text{ dB}$$

##### NOTE D.3

*When working with linear quantities, the above criterion corresponds to  $(W_t/W_n) \geq 4,0$ .*



#### **D.8 Multiple tones in a single critical band**

The noise emitted by a machine may contain many tones; several of these may fall within a single critical band. There are no special techniques required to deal with this situation. Those tones that are individually audible are identified and the procedure above followed for each tone. For the purposes of this annex, other tonal components that are contained within the critical band around the primary tone being evaluated are considered part of the masking noise, and are included in the determination of the masking noise level  $L_n$ .

##### **NOTE D.4**

*The effects of multiple tones in a critical band are not easily quantified and further research is necessary.*

#### **D.9 Complex tones containing harmonic components**

A machine may emit a complex tone comprising a series of harmonic components (partials) at integral multiples of some fundamental frequency. Although several peaks may occur in a narrow-band spectrum of such noise emissions, the tone complex is usually perceived as having a single pitch. For the purposes of this annex, when an audible discrete tone comprises two or more harmonic components, only that component with the highest A-weighted sound pressure level need be evaluated. If the criterion in D.7 is met for that component, the discrete tone shall be identified as prominent.



**Annex E**  
**(informative)**

**Detection of impulsive sound pressure levels**

**E.1 Scope**

This annex provides an objective test method for determining whether the noise emissions are impulsive in character, viz. are of short duration and relatively high amplitude.

This method is primarily applicable to operator-attended equipment with non-steady noise emissions.

**E.2 Instruments**

The instruments shall meet the requirements of 6.4. The sound level meter shall be equipped with the IMPULSE meter characteristic.

**E.3 Microphone position**

The measurements shall be performed at the operator position, or, if none, at the bystander position with the highest A-weighted sound pressure level. If there is more than one operator position the measurements shall be performed at the operator position with the highest A-weighted sound pressure level.

For the purpose of detection of impulsive sound pressure levels of sub-assemblies, the sub-assembly exclusion of 7.1 does not apply. For sub-assemblies which will be installed in table top products, the sub-assembly shall be installed in the centre of a test table and isolated from the surface by three or four elastomeric feet, approximately 12 mm high. For sub-assemblies which will be installed in other enclosures or racks, the sub-assembly shall be installed as in 5.5.1 h). For sub-assemblies which will be installed in equipment with a defined operator position, this operator position shall be used for the sub-assembly measurement, otherwise, the bystander position having the highest A-weighted sound pressure level shall be used.

**E.4 Measurement Procedure**

Aural examination of the noise emitted by the equipment under test shall be made at the microphone position described above. If the noise emissions are perceived to include impulsive sound, the following test shall be performed.

The time average A-weighted impulse sound pressure level,  $L_{pAI}$ , shall be measured for the same mode(s) of operation and measurement conditions as used for the measurements in 7.5 to 7.7. The difference in dB between the time average A-weighted impulse sound pressure level,  $L_{pAI}$ , and the A-weighted sound pressure level,  $L_{pA}$ , shall be obtained. The difference ( $L_{pAI} - L_{pA}$ ) is the impulsive parameter,  $\Delta L_I$ . If  $\Delta L_I > 3$  dB the noise is considered to be impulsive.

The time average A-weighted impulse sound pressure level,  $L_{pAI}$ , is used only to determine whether the noise emissions are impulsive. The impulsive parameter  $\Delta L_I$  is zero for steady, non-impulsive noises, and increases in value with increasing impulsiveness of the noise.

If the impulse sound level is recorded, the DC level output of the impulse sound level meter shall be used. The dynamic response of the recorder shall be such that it will respond to at least 90% of full scale for a rectangular pulse the duration of which is 0,2 s.





**Annex F**  
**(informative)**

**Main differences between the third and second edition**

**F.1 Scope**

This annex lists the main differences between the 3rd and the 2nd edition of ECMA-74.

The Standard was rewritten to take into account:

- experience gained by the use of the 1st and 2nd editions,
- experience from the preparation of ISO 7779,
- experience from the publication of ANSI S12.10-1985,
- experience from the preparation of Standards ECMA-108, 109 and 160.
- the results of laboratory research on the test methods, particularly with respect to the detection of discrete tones and impulsive sound, performed by the members of TC26 and other organizations.

**F.2 Main differences**

**F.2.1 General**

References to more recent Standards have been added.

Many paragraphs have been reworded for consistency with ISO 7779.

In clauses 5, 6 and 7, the corrections for background levels now use a formula in place of tabulated values.

**F.2.2 Clause 4: Frequency range of interest**

Modified definition to clarify that the only time 16 kHz noise is included in A-weighting is then 16 kHz noise does not contain discrete tones.

**F.2.3 Clause 5: Method for determining sound power levels in reverberation rooms**

The clause using the direct method has been deleted.

For the comparison method, the formulae for calculating the measuring distance and the number of source locations have been amended to eliminate the use of the reverberation time.

**F.2.4 Clause 5: High frequency noise**

Extended tables 5 and 6 for  $A_j$  to include 16 kHz octave band for case of broad-band noise in 16 kHz octave band. Included table from ECMA-108 (ISO 9295) as table 7.

**F.2.5 Clause 6: Method for determining sound power levels under essentially free-field conditions over a reflecting plane**

All microphone arrays are now described in annex B.

Require band pressure level measurements if room qualified per ISO 3744 annex A for compatibility with ISO 3744 since computer and business equipment spectrum is different from ISO 9296 reference sound source.

Changed environmental correction factor  $K_2$  for compatibility with ISO 3744.

**F.2.6 Clause 7: Method for measuring sound pressure levels at operator and bystander positions**

A new clause has been added to calculate the mean value of the sound pressure level at the bystander positions from the values measured at all bystander positions.

The method for the detection of prominent discrete tones has been revised and moved to annex D.

The method for the detection of impulsive sound pressure levels has been revised and moved to annex E.

Required measurement of C-weighted peak sound pressure level if it exceeds 120 dB.

Permitted determination of  $L_{pA}$  from band levels and provided method for such determination.

**F.2.7 Annex A: Test accessories**

The description of the test table has been amended.

The specification for a typing robot has been added.

**F.2.8 Annex B: Measurement surfaces**

This annex now includes all the permitted microphone arrays including the 5-ring array and an array for large machines.

**F.2.9 Annex C: Installation and operating conditions**

Existing conditions have been amended and new categories added, including:

- Telecopiers (facsimile machines)
- Page printers
- Self-service automatic teller machines
- Rack mounted modular systems and system modules.

**F.2.10 Annexes D and E**

Split annex D into two annexes: D and E with D for prominent discrete tones and E for impulsive sound pressure levels.



