INTERNATIONAL STANDARD

**ISO 3382-3**

First edition
2012-01-15

# Acoustics — Measurement of room acoustic parameters —

## Part 3: Open plan offices

*Acoustique — Mesurage des paramètres acoustiques des salles — Partie 3: Bureaux ouverts*

SIST Preview
(https://ecommerce.sist.si)

ISO 3382-3:2012
https://ecommerce.sist.si/catalog/standards/sist/65396565-87ea-44b7-8528-69feb9062591/iso-3382-3-2012

Reference number
ISO 3382-3:2012(E)

© ISO 2012

SIST Preview
(https://ecommerce.sist.si)

ISO 3382-3:2012
https://ecommerce.sist.si/catalog/standards/sist/65396565-87ea-44b7-8528-69feb9062591/iso-3382-3-2012



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2012

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland



© ISO 2012 – All rights reserved

# Contents

Page

**Foreword** ... iv
**Introduction** ... v
1 **Scope** ... 1
2 **Normative references** ... 1
3 **Terms and definitions** ... 1
4 **Single number quantities** ... 2
5 **Measurement conditions** ... 3
5.1 **Equipment** ... 3
5.2 **Measurement procedure** ... 3
6 **Determination of single number quantities** ... 6
6.1 **Sound power spectrum of normal speech** ... 6
6.2 **Spatial decay rate of A-weighted sound pressure level of speech** ... 6
6.3 **Distraction and privacy distances** ... 9
6.4 **Background noise** ... 9
7 **Test report** ... 9
**Annex A** (informative) **Examples of target values for evaluation of measurement data** ... 11
**Annex B** (informative) **Relation between speech transmission index and work performance** ... 12
**Bibliography** ... 14

SIST Preview
(https://ecommerce.sist.si)
ISO 3382-3:2012
https://ecommerce.sist.si/catalog/standards/sist/65396565-87ea-44b7-8528-69feb9062591/iso-3382-3-2012

© ISO 2012 – All rights reserved

# Foreword

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

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

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

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

ISO 3382-3 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

ISO 3382 consists of the following parts, under the general title *Acoustics — Measurement of room acoustic parameters*:

— *Part 1: Performance spaces*

— *Part 2: Reverberation time in ordinary rooms*

— *Part 3: Open plan offices*

SIST Preview
(https://ecommerce.sist.si)
ISO 3382-3:2012
https://ecommerce.sist.si/catalog/standards/sist/65396565-87ea-44b7-8528-69feb9062591/iso-3382-3-2012


© ISO 2012 – All rights reserved

# Introduction

The phrase “open plan offices” in the context of this part of ISO 3382 covers offices and similar spaces where a large number of people can work, have a conversation, or concentrate independently in well-defined work stations. In open plan offices, the occupants are affected by activities surrounding them. Insufficient acoustic conditions lead to distraction and a lack of speech privacy. Distraction weakens the ability to concentrate and reduces productivity, especially in tasks requiring cognitive resources. Low speech privacy prevents confidential or partly confidential conversations. Speech can be intrusive for the listener, whereas for the speaker, it can be desirable to avoid involuntary spread of speech of a private nature.

The design of open plan spaces includes careful consideration of the layout of the workstations and mutual arrangement of teams or workgroups. Other factors affecting the acoustical performance of open plan spaces are sound absorption, height of screens and storage units, background noise, degree of workstation enclosure, distance between workstations, and room dimensions. The reverberation time of a room used to be regarded as the predominant indicator of its acoustical properties. However, there is evidence that other types of measurements such as rate of spatial decay of sound pressure levels, speech transmission index and background noise levels are needed for a more complete evaluation. If reverberation time is considered relevant, it should be measured in accordance with ISO 3382-2.

This part of ISO 3382 specifies a measurement method which results in single number quantities indicating the general acoustical performance of open plan offices. The principal aim is good speech privacy between workstations. The measurement method and resulting single number quantities correspond well with perceived acoustic conditions of the worker.

Furniture strongly affects acoustic conditions. Therefore, the measurements are performed only when the room is completely finished, including furniture. Measurement in an unfurnished room does not describe the perceived acoustical conditions. It is also important that the measurements are carried out when people are absent, but with the normal daytime background noise, whether it is caused by ventilation, traffic noise or an artificial masking sound system. If people are present, the background noise level varies strongly with time and the determination of reliable results becomes impossible.

The single number quantities are designed to represent the situation where a single person is talking and the rest are silent. Therefore, the measurements are made by using a single loudspeaker. If many people speak simultaneously, the masking is increased and the degree of distraction gets weaker (see Reference [10]). Therefore, the results describe the most distracting situation. However, this part of ISO 3382 can be used to determine the room acoustic quality of, for example, call centres where many speakers are active continuously. In such cases, the sound environment caused by many simultaneous speakers may cause a positive speech masking effect and the results of this part of ISO 3382 may underestimate the perceived speech privacy.

© ISO 2012 – All rights reserved

SIST Preview
(https://ecommerce.sist.si)

ISO 3382-3:2012
https://ecommerce.sist.si/catalog/standards/sist/65396565-87ea-44b7-8528-69feb9062591/iso-3382-3-2012

# Acoustics — Measurement of room acoustic parameters —

# Part 3:
# Open plan offices

## 1 Scope

This part of ISO 3382 specifies methods for the measurement of room acoustic properties in open plan offices with furnishing. It specifies measurement procedures, the apparatus needed, the coverage required, the method for evaluating the data, and the presentation of the test report.

The measurement results can be used to evaluate room acoustic properties in open plan offices. This part of ISO 3382 is intended for medium and large size open plan offices.

## 2 Normative references

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

SIST Preview
(https://ecommerce.sist.si)

ISO 3382-1, *Acoustics — Measurement of room acoustic parameters — Part 1: Performance spaces*

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

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

ISO 3382-3:2012
https://standards.iteh.ai/catalog/standards/sist/[illegible]/iso-3382-3-2012

ISO 14257, *Acoustics — Measurement and parametric description of spatial sound distribution curves in workrooms for evaluation of their acoustical performance*

ISO 16032, *Acoustics — Measurement of sound pressure level from service equipment in buildings — Engineering method*

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

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

IEC 60268-16:2011, *Sound system equipment — Part 16: Objective rating of speech intelligibility by speech transmission index*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**3.1**
**spatial sound distribution of the A-weighted sound pressure level of speech**
curve which shows how the A-weighted sound pressure level decreases as a function of the distance from the sound source emitting noise with the sound power spectrum of normal speech

© ISO 2012 – All rights reserved

**3.2**
**spatial decay rate of speech**
$D_{2,S}$
rate of spatial decay of A-weighted sound pressure level of speech per distance doubling

NOTE This definition is an application of $DL_2$ defined in ISO 14257, but using the spectrum of normal speech and A-weighting over the whole frequency range. The spatial decay is not determined for individual octave bands.

**3.3**
**A-weighted sound pressure level of speech at a distance of 4 m**
$L_{p,A,S,4\ m}$
nominal A-weighted sound pressure level of normal speech at a distance of 4,0 m from the sound source

NOTE The measurement position does not need to be located at this distance from the sound source. $L_{p,A,S,4\ m}$ is obtained using a linear regression line from the spatial sound distribution of the A-weighted sound pressure level (SPL) of speech.

**3.4**
**speech transmission index**
**STI**
physical quantity representing the transmission quality of speech with respect to intelligibility

[IEC 60268-16:2011]

**3.5**
**spatial sound distribution of the speech transmission index**
curve which shows how the speech transmission index decreases from a reference sound source when distance increases

SIST Preview
(https://ecommerce.sist.si)

**3.6**
**distraction distance**
$r_D$
distance from speaker where the speech transmission index falls below 0,50

NOTE 1 Distraction distance is expressed in metres.

ISO 3382-3:2012
https://ecommerce.sist.si/catalog/standards/sist/65396565-87ea-44b7-8528-69feb9062591/iso-3382-3-2012

NOTE 2 Above the distraction distance, concentration and privacy start to improve rapidly (see References [8][14]).

**3.7**
**privacy distance**
$r_P$
distance from speaker where the speech transmission index falls below 0,20

NOTE 1 Privacy distance is expressed in metres.

NOTE 2 Above the privacy distance, concentration and privacy are experienced very much the same as between separate office rooms (see References [8][14]). STI values less than 0,20 are difficult to achieve in offices with poor speech privacy or small volume.

**3.8**
**background noise level**
$L_{p,B}$
sound pressure level in octave bands present at the workstation during working hours with people absent

NOTE Background noise here means all such continuous sounds, which are not caused by people, e.g. heating, ventilation and air conditioning (HVAC) devices, environmental traffic noise, office equipment or a sound-masking system.

## 4 Single number quantities

The sound pressure levels and STI shall be measured in octave bands from 125 Hz to 8 000 Hz. STI shall be determined in accordance with the full method specified in IEC 60268-16.


© ISO 2012 – All rights reserved

The measurement data shall be converted into four simple single number quantities to facilitate the use in acoustic design and to enable the future establishment of simple target values. The single number quantities that are determined are:

— distraction distance, $r_D$;

— spatial decay rate of A-weighted SPL of speech, $D_{2,S}$;

— A-weighted SPL of speech at 4 m, $L_{p,A,S,4\ m}$;

— average A-weighted background noise level, $L_{p,A,B}$.

In addition to these, STI in the nearest workstation and the privacy distance, $r_P$, may also be determined.

## 5 Measurement conditions

### 5.1 Equipment

**5.1.1 Sound source**. In all measurements an omnidirectional sound source producing pink noise shall be used. Alternatively, it is also possible to use deterministic signals that have a pink spectrum like maximum-length sequence (MLS) or sweeps to measure the impulse response and derive the results from that (see Reference [13]).

An omnidirectional sound source is used since people in an open plan office do not continuously speak in any fixed direction. The requirements given in ISO 3382-1 for the omnidirectional sound source shall be fulfilled for measurements to be in accordance with this part of ISO 3382. Verification of the sound power of the source is performed as in ISO 3382-1, with the sound source positioned at the height of 1,2 m.

SIST Preview
Standard Preview

**5.1.2 Microphone**. Sound pressure levels in each octave band and at each microphone position shall be measured using a sound level meter meeting the requirements of IEC 61672-1, class 1. The microphone shall be omnidirectional (taking into account any supplementary equipment connected to it). Octave-band filters shall comply with IEC 61260.

ISO 3382-3:2012
https://standards.iteh.ai/catalog/standards/sist/6539656f-87ae-44b7-8828-d0f5b9062591/iso-3382-3-2012

If the signal is recorded (e.g. by using analogue or digital recorders) for off-line processing, it shall be ensured that the instrumentation as a whole complies with the above-mentioned requirements.

### 5.2 Measurement procedure

#### 5.2.1 Measurement conditions

Measurements in accordance with this part of ISO 3382 shall be made in furnished rooms, but without the presence of people, except the persons needed to carry out the measurements.

The background noise level is measured and applied for the determination of the STI value. The HVAC devices and other noise sources shall operate on the same power as during typical working hours. If the sources operate at reduced power, the STI values are too high, leading to overestimation of $r_D$ and $r_P$. If the office is equipped with a sound-masking system, it shall be switched on during the measurement.

Measurements in accordance with this part of ISO 3382 have to be carried out when people are absent. Thus the noise from people talking in the room is not included in the measured background noise level. It is recognized that noise from people talking in the open plan office can sometimes cause a positive masking effect (see Reference [10]). In such cases, the actual distraction distance and privacy distance are shorter than the measured $r_D$ and $r_P$, respectively. The evaluation of the acoustic conditions with people talking is not within the scope of this part of ISO 3382.

#### 5.2.2 Measurement positions

It is recommended that measurements be carried out along a line which crosses over workstations, as shown in Figure 1. The preferred number of successive measurement positions in the line is 6 to 10; the minimum

© ISO 2012 – All rights reserved

number is 4. The first measurement position shall be located at the nearest workstation on the line. The distance to the most remote measurement position depends on the size of the room; however, only positions within the range 2 m to 16 m are used for the determination of $D_{2,S}$; see 6.2.

NOTE The measurement positions need not be on a straight line; see Figure 1.

Open plan offices consist very often of two or more zones where the ceiling materials are of different types or the furniture design differs significantly. Then the measurements should preferably be made in each zone. Single number quantities are calculated for each zone separately. If the measurement line crosses zones, the spatial distribution curves can have different slopes along the line.

The measurements shall be carried out using source and microphone positions in workstations in the position of the person's head. The positions of loudspeaker and microphone shall be at least 0,5 m from tables and at least 2,0 m from walls and other reflecting surfaces. At least two sound source positions shall be used. If only one line of measurement positions is possible, measurements shall be made with two source positions in opposite directions on the measurement line.

The loudspeaker shall be placed at the height of 1,2 m above the floor.

The microphone shall be placed at 1,2 m above the floor. Standing working positions are not applicable for this part of ISO 3382.

### 5.2.3 Measurement quantities

At every measurement point, four measurements are made:

a) sound pressure level in octave bands of pink noise, $L_{p,\mathrm{Ls}}$;

b) STI;

c) background noise level in octave bands, $L_{p,\mathrm{B}}$;

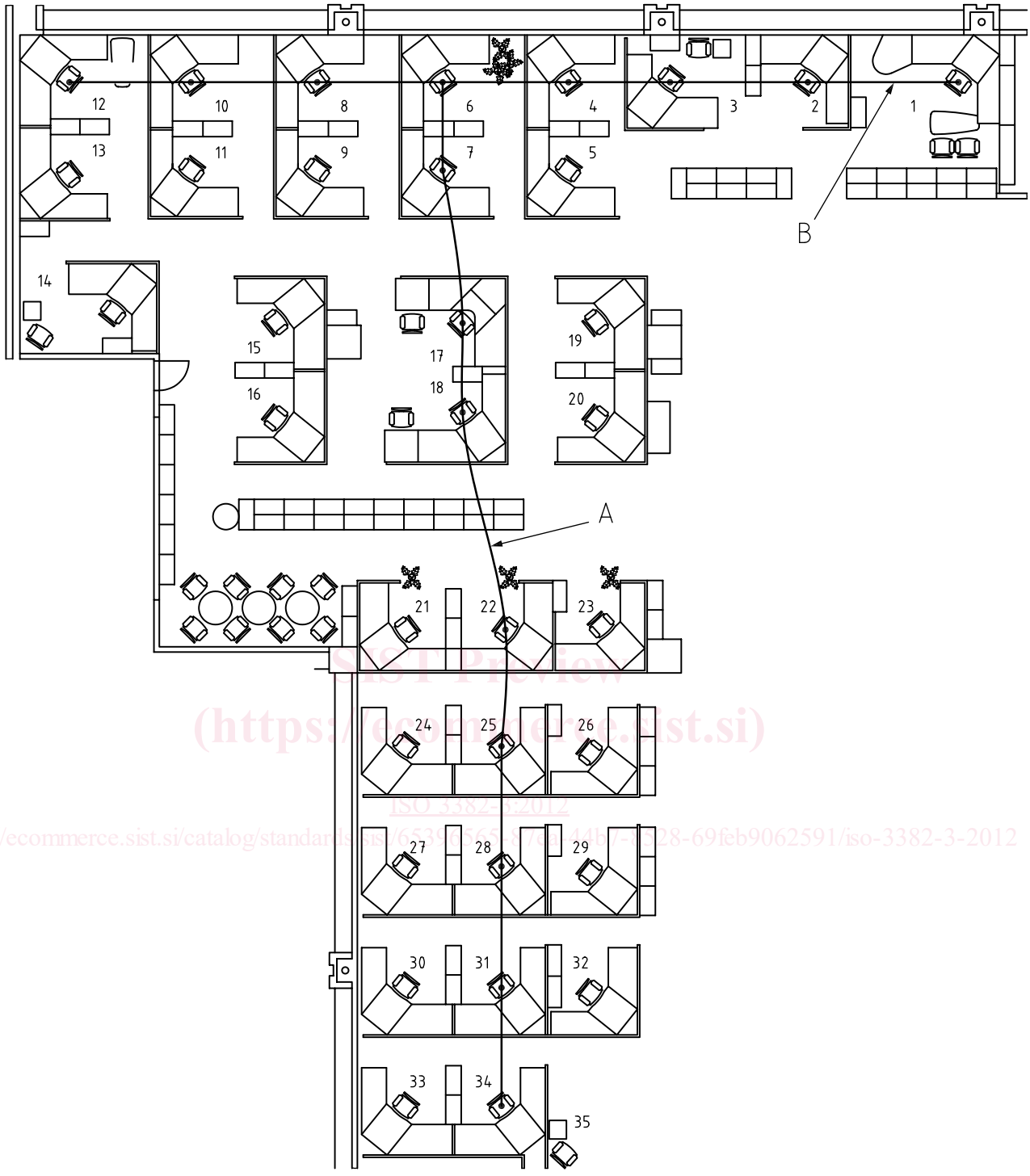
d) distance to the sound source, $r$.

SIST Preview
(https://ecommerce.sist.si)
ISO 3382-3:2012

Sound pressure level of pink noise and background noise level are measured in octave bands in the frequency range 125 Hz to 8 000 Hz in every measurement position. The integration time should be at least 10 s.

NOTE Integration times longer than 10 s are needed for non-stationary noise, e.g. traffic noise.


© ISO 2012 – All rights reserved




SIST ISO 3382-3:2012
(https://ecommerce.sist.si)
https://ecommerce.sist.si/catalog/standards/sist/653b6368-8f0d-44b1-8528-69feb9062591/iso-3382-3-2012

**Key**

A non-straight measurement path

B straight measurement path

**Figure 1 — Example of a straight and a non-straight measurement path in an open plan office**

© ISO 2012 – All rights reserved