

**Acoustics - Determination of sound immissions from sound sources placed closed to the ears - Part 1: Technique using a microphone in real ear (MIRE-technique)**

Acoustics - Determination of sound immissions from sound sources placed closed to the ears - Part 1: Technique using a microphone in real ear (MIRE-technique)

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

<p>Käesolev Eesti standard EVS-EN ISO 11904-1:2003 sisaldab Euroopa standardi EN ISO 11904-1:2002 ingliskeelset teksti.</p> <p>Käesolev dokument on jõustatud 18.02.2003 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes.</p> <p>Standard on kättesaadav Eesti standardiorganisatsioonist.</p>	<p>This Estonian standard EVS-EN ISO 11904-1:2003 consists of the English text of the European standard EN ISO 11904-1:2002.</p> <p>This document is endorsed on 18.02.2003 with the notification being published in the official publication of the Estonian national standardisation organisation.</p> <p>The standard is available from Estonian standardisation organisation.</p>
--	---

<p><b>Käsitlusala:</b></p> <p>This part of ISO 11904 specifies basic framework measurement methods for sound immission from sound sources placed close to the ear. These measurements are carried out with miniature or probe microphones inserted in the ear canals of human subjects</p>	<p><b>Scope:</b></p> <p>This part of ISO 11904 specifies basic framework measurement methods for sound immission from sound sources placed close to the ear. These measurements are carried out with miniature or probe microphones inserted in the ear canals of human subjects</p>
--	--

**ICS** 17.140.01

**Võtmesõnad:** acoustic measurement, acoustics, definitions, hearing impairment, hearing tests, laboratory testing, laboratory tests, noise (environmental), noise immission, reverberation, reverberation rooms, sound intensity, sound sources, testing

English version

Acoustics

Determination of sound immission from sound sources  
placed close to the ear

Part 1: Technique using a microphone in a real ear (MIRE technique)  
(ISO 11904-1 : 2002)

Acoustique – Détermination de l'exposition sonore due à des sources sonores placées à proximité de l'oreille – Partie 1: Technique du microphone placé dans une oreille réelle (technique MIRE) (ISO 11904-1 : 2002)

Akustik – Bestimmung der Schallimmission von ohrnahen Schallquellen – Teil 1: Verfahren mit Mikrofonen in menschlichen Ohren (MIRE-Verfahren) (ISO 11904-1 : 2002)

This European Standard was approved by CEN on 2002-08-29.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

The European Standards exist in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

**CEN**

European Committee for Standardization  
Comité Européen de Normalisation  
Europäisches Komitee für Normung

Management Centre: rue de Stassart 36, B-1050 Brussels

## Foreword

International Standard

ISO 11904-1 : 2002 Acoustics – Determination of sound immission from sound sources placed close to the ear – Part 1: Technique using a microphone in a real ear (MIRE technique),

which was prepared by ISO/TC 43 'Acoustics' of the International Organization for Standardization, has been adopted by Technical Committee CEN/TC 211 'Acoustics', the Secretariat of which is held by DS, as a European Standard.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by April 2003 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard:

Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

## Endorsement notice

The text of the International Standard ISO 11904-1 : 2002 was approved by CEN as a European Standard without any modification.

NOTE: Normative references to international publications are listed in Annex ZA (normative).

# Contents

	Page
Foreword .....	2
Introduction.....	4
1 Scope.....	6
2 Normative references.....	6
3 Terms and definitions .....	7
4 Measurement principle .....	8
5 Instrumentation .....	8
5.1 Ear canal microphone.....	8
5.2 Reference field microphone .....	9
5.3 Check of calibration .....	9
5.4 Filters.....	9
6 Subjects.....	9
7 Use of ear canal microphone .....	9
7.1 Choice of ear canal measurement position.....	9
7.2 Mounting of microphones .....	11
7.3 Safety.....	11
8 Determination of free-field or diffuse-field related equivalent continuous A-weighted sound pressure level .....	11
8.1 Measurement of ear canal sound pressure level.....	11
8.2 Conversion to free-field or diffuse-field related sound pressure level.....	12
8.3 A-weighting and summation .....	12
9 Free-field and diffuse-field frequency responses for selected ear canal measurement positions ....	12
10 Determination of free-field or diffuse-field frequency responses .....	12
10.1 General .....	12
10.2 Measurement principle .....	14
10.3 Establishment of a free reference sound field .....	14
10.4 Establishment of a quasi-free reference sound field .....	14
10.5 Establishment of a diffuse reference sound field.....	14
10.6 Measurement of the reference sound field.....	14
10.7 Measurement of ear canal sound pressure level in reference sound field .....	14
10.8 Determination of free-field or diffuse-field frequency response .....	15
10.9 Simplifications in specific cases .....	15
10.10 Optional check of the measurement arrangement .....	15
11 Test report.....	15
Annex A (informative) Example of sources of measurement uncertainty.....	16
Annex B (informative) Example of an uncertainty analysis .....	22
Bibliography.....	24

## Introduction

ISO 11904 is a series of standards which specify methods for the determination of sound immissions from sources located close to the ear, in which situations the sound pressure level measured at the position of the exposed person (but with the person absent) does not adequately represent the sound exposure.

In order to make it possible to assess the exposure by means of well established criteria, the exposure of the ear is measured and subsequently converted into a corresponding free-field or diffuse-field level. The result is given as free-field related or diffuse-field related equivalent continuous A-weighted sound pressure level,  $L_{FF,H,Aeq}$  or  $L_{DF,H,Aeq}$  when ISO 11904-1 is used, or  $L_{FF,M,Aeq}$  or  $L_{DF,M,Aeq}$  when ISO 11904-2 is used.

ISO 11904-1 describes measurements carried out using miniature or probe microphones inserted in the ears of human subjects (microphone in real ear, MIRE technique). ISO 11904-2 describes measurements carried out using a manikin equipped with ear simulators including microphones (manikin technique).

ISO 11904 may, for instance, be applied to equipment tests and the determination of noise exposure at the workplace where, in the case of exposure from sources close to the ears, the sound pressure level measured at the position of the exposed person (but with the person absent) does not adequately represent the sound exposure. Examples of applications are head- and earphones used to reproduce music or speech, whether at the workplace or during leisure, nailguns used close to the head, and combined exposure from a close-to-ear sound source and an external sound field.

When specific types of equipment are to be tested (e.g. portable cassette players or hearing protectors provided with radio receivers), test signals suitable for this particular type of equipment have to be used. Neither such test signals nor the operating conditions of the equipment are included in ISO 11904 but might be specified in other standards.

When workplace situations are measured, the various noise sources contributing to the immission should be identified. Operating conditions for machinery and equipment used might be specified in other standards.

Both parts of ISO 11904 strive for the same result: a mean value for a population of the free-field or the diffuse-field related level. ISO 11904-1 does this by specifying the mean of measurements on a number of human subjects; ISO 11904-2 does this by using a manikin, which aims at reproducing the acoustical effects of an average human adult. However, the two methods yield different measurement uncertainties which can influence the choice of method. Only the method described in ISO 11904-1 gives results which indicate the variance in a human population. Information on the uncertainties is given in annexes A and B.

When using the MIRE technique for measurement of sound from earphones of insert and stethoscopic types, practical problems can occur with the positioning of microphones in the ear canal. When using the manikin technique, the head- or earphone has to be coupled to the pinna simulator and ear canal extension as far as possible in the way it is coupled to the human ear. In cases where head- or earphones or other objects touch the pinna, a possible deviation in stiffness or shape of the artificial pinna from human pinnae has a significant impact on the result and can even make the results invalid.

An overview of the differences of the two parts of ISO 11904 is given in Table 0.1.



**Table 0.1 — Overview of differences between MIRE and manikin techniques**

Parameter	ISO 11904-1	ISO 11904-2
Type of method	Microphone in real ear technique	Manikin technique
Limitation of the method	With earphones of insert and stethoscopic type, practical problems can occur with positioning of microphones in the ear canal.	A proper coupling may not always be obtained if the artificial pinna deviates from human pinnae in stiffness or shape.  In some cases the exposed person cannot be replaced by a manikin, e.g. if the person has to operate equipment.
Main issues affecting accuracy	<ul style="list-style-type: none"> <li>— Number of subjects</li> <li>When tabulated values are used for <math>\Delta L_{FF,H}</math> or <math>\Delta L_{DF,H}</math>:</li> <li>— calibration of ear canal microphone</li> <li>— accuracy in positioning of microphones in the ear canal</li> <li>When individual values are used for <math>\Delta L_{FF,H}</math> or <math>\Delta L_{DF,H}</math>:</li> <li>— quality of reference sound field</li> <li>— stability of sensitivity and frequency response as well as position of ear canal microphone</li> </ul>	<ul style="list-style-type: none"> <li>— Similarity of manikin to human subjects</li> <li>— Calibration of manikin</li> </ul>
Frequency range	20 Hz to 16 kHz	20 Hz to 10 kHz

## 1 Scope

This part of ISO 11904 specifies basic framework measurement methods for sound immission from sound sources placed close to the ear. These measurements are carried out with miniature or probe microphones inserted in the ear canals of human subjects. The measured values are subsequently converted into corresponding free-field or diffuse-field levels. The results are given as free-field related or diffuse-field related equivalent continuous A-weighted sound pressure levels. The technique is denoted the microphone-in-real-ear technique (MIRE technique).

This part of ISO 11904 is applicable to exposure from sources close to the ear, for example during equipment tests or at the workplace by earphones or hearing protectors with audio communication facilities.

This part of ISO 11904 is applicable in the frequency range from 20 Hz to 16 000 Hz.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 11904. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 11904 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 8253-2:1992, *Acoustics — Audiometric test methods — Part 2: Sound field audiometry with pure tone and narrow-band test signals*

IEC 60065, *Audio, video and similar electronic apparatus — Safety requirements*

IEC 60268-7:1996, *Sound system equipment — Part 7: Headphones and earphones*

IEC 60601-1, *Medical electrical equipment — Part 1: General requirements for safety*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61094-1, *Measurement microphones — Part 1: Specifications for laboratory standard microphones*

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

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

GUM:1993<sup>1)</sup>, *Guide to the expression of uncertainty in measurement*, BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OILM

---

1) Corrected and reprinted in 1995.