

Australian Standard<sup>®</sup>

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**Acoustics—Instruments for the  
measurement of sound  
intensity—Measurement with  
pairs of pressure sensing  
microphones**

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[IEC title: Electroacoustics—Instruments for the measurement of sound intensity—Measurement with pairs of pressure sensing microphones]

This Australian Standard was prepared by Committee AV/2, Acoustics Instrumentation and Measurement Techniques. It was approved on behalf of the Council of Standards Australia on 3 August 1994 and published on 17 October 1994.

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The following interests are represented on Committee AV/2:

Association of Consulting Engineers, Australia  
Australian Acoustical Society  
Australian and New Zealand Environment and Conservation Council  
Australian Hearing Services  
Civil Aviation Authority  
CSIRO—Division of Applied Physics  
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First published as AS 4241—1994.

PUBLISHED BY STANDARDS AUSTRALIA  
(STANDARDS ASSOCIATION OF AUSTRALIA)  
1 THE CRESCENT, HOMEBUSH, NSW 2140

ISBN 0 7262 9210 9

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## PREFACE

This Standard was prepared by the Standards Australia Committee on Acoustics Instrumentation and Measurement Techniques. It is identical with and reproduced from IEC 1043:1993, *Electroacoustics—Instruments for the measurement of sound intensity—Measurement with pairs of pressure sensing microphones*.

The objective of this Standard is to specify the performance requirements for sound intensity instruments, comprising sound intensity probes and processors, which detect sound intensity by pairs of spatially separated pressure sensing microphones.

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| 942 Sound calibrators                                                                                                   | —                                                         |
| 1260 Specification for octave-band and fractional octave-band filters (under consideration). (Revision of IEC 225:1966) | —                                                         |
| ISO                                                                                                                     |                                                           |
| 9614 Acoustics—Determination of sound power levels of noise sources using sound intensity                               | —                                                         |
| 9614-1 Part 1: Measurement at discrete points                                                                           | —                                                         |

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## INTRODUCTION

This International Standard specifies the requirements for sound intensity instruments, comprising sound intensity probes and processors, which detect sound intensity by pairs of spatially separated pressure sensing microphones. These instruments, and others employing different detection methods, are still the subject of development.

Sound intensity instruments have two main applications. The first is the investigation of the radiation characteristics of sound sources. The second is the determination of the sound power of sources, especially *in situ*, where sound intensity measurement enables sound power determination to be made under acoustical conditions which render determination by sound pressure measurement impossible.

This International Standard applies to instruments to be used for the determination of sound power in accordance with the requirements of ISO 9614-1 and ensures well-defined performance for instruments used in other applications.

Specifications and tolerances are based on current instrument technology and on typical industrial requirements for dynamic capability index.

Requirements for the verification of performance of probes and processors are written in terms of type tests. A scheme for periodic verification, serving as the basis of the periodic recalibrations required in many countries, is given in annex A.

Probes and processors are treated separately and together; in the latter case they are called "instruments".

NOTES

## AUSTRALIAN STANDARD

**Acoustics—Instruments for the measurement of sound intensity—  
Measurement with pairs of pressure sensing microphones****1 Scope**

The primary purpose of this Standard is to ensure the accuracy of measurements of sound intensity applied to the determination of sound power in accordance with ISO 9614-1. To meet the requirements of that standard, instruments are required to analyse the sound intensity in one-third octave or octave bands, and optionally to provide A-weighted band levels. They are also required to measure sound pressure level in addition to sound intensity level to facilitate the use of the field indicators described in ISO 9614-1.

This International Standard only applies to instruments which detect sound intensity by pairs of spatially separated pressure sensing microphones.

This International Standard specifies performance requirements for instruments used for the measurement of sound intensity, and their associated calibrators.

The requirements are intended to reduce to a practical minimum any differences in equivalent measurements made using different instruments, including instruments comprising probes and processors from different manufacturers.

**2 Normative references**

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 9614-1: 1993, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points*

IEC 651: 1979, *Sound level meters*

IEC 942: 1988, *Sound calibrators*

IEC 1260: 19XX, *Specification for octave-band and fractional octave-band filters* (under consideration). (Revision of IEC 225: 1966)

### 3 Definitions

For the purpose of this International Standard, the following definitions apply.

**3.1 sound intensity probe:** Transducer system from which signals may be processed to obtain the sound intensity component in a specific direction.

**3.2 p-p probe (also known as a two microphone probe):** Probe composed of two pressure sensing microphones spaced apart by a fixed and known distance, in which the sound pressure component is measured by the two microphones and the mean value is considered as the sound pressure existing at the reference point of the probe, while the sound pressure differential is used for the purpose of deriving the sound particle velocity component.

#### NOTES

- 1 A side-by-side p-p probe has the two microphones arranged as shown in figure 1.
- 2 A face-to-face p-p probe has the two microphones facing each other and separated by a spacer as shown in figure 2.

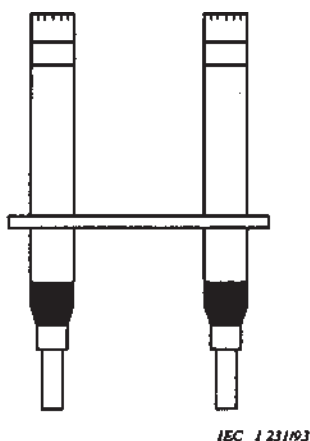


Figure 1 — A side-by-side p-p probe



Figure 2 — A face-to-face p-p probe

**3.3 reference point of a probe:** Point at which the sound intensity is deemed to be measured.

NOTE — The reference point of a probe is not necessarily the physical midpoint, but occurs halfway between the effective microphone centres.

**3.4 probe axis:** Axis passing through the reference point and along which a component of particle velocity is sensed.

**3.5 reference direction:** Direction of incidence of plane progressive waves on the probe, parallel to the probe axis, for which the sound intensity response of the probe is specified.

**3.6 phase difference between probe channels for a p-p probe:** Difference in phase response between the channels in a p-p probe, including microphones, preamplifiers and cables, if they are an integral part of the probe, when subjected to the same input. It is a function of frequency.

**3.7 nominal separation of microphones in a p-p probe:** Fixed value of separation used for the purpose of computing sound intensity directly in an instrument. It is the mean value of the effective separation of the microphones in a specified frequency range.

**3.8 sound intensity processor:** Device whose function is the determination of sound intensity in conjunction with a specified probe. The processor presents results in one octave or one-third octave bands, in terms of sound intensity and sound pressure, or sound intensity level and sound pressure level.

**3.9 sound intensity instrument:** Comprises a sound intensity probe and a compatible sound intensity processor.

**3.10 residual intensity:** False intensity produced by phase differences between measurement channels, which occurs when the processor is subjected to identical electrical inputs to the two channels, or when the transducers in the probe connected to the processor are subjected to identical sound pressure inputs.

**3.11 pressure-residual intensity index:** Difference between the indicated sound pressure levels and the indicated residual intensity levels, calculated with air density of  $1,2048 \text{ kg/m}^3$ , in one octave or one-third octave bands, when the processor is subjected to identical electrical pink noise inputs to the two channels, or when the transducers connected to the inputs are subjected to identical pink noise sound pressure inputs. This index applies only where it is essentially independent of indicated sound pressure level.

**3.12 dynamic capability index:** Difference between pressure-residual intensity index found in an instrument and K factor, described as bias error factor, in ISO 9614. It signifies the maximum difference between sound pressure level and sound intensity level within which measurements according to ISO 9614 can be made for different grades of measurement accuracy.

**3.13 operating range:** Range of sound pressure levels, in decibels, between the highest and lowest levels of pink noise indicated by a processor or instrument, within which the pressure-residual intensity index meets the requirements of this standard.

**3.14 electrostatic actuator:** Device used for electrical measurements of the frequency response of condenser microphones. It is a metallic grid which is held close and parallel to the microphone diaphragm. An alternating test voltage, normally superimposed on a high static voltage, is applied between the actuator and the diaphragm. The resulting electrostatic forces mimic the effect of a sound pressure on the microphone.

**3.15 real time operation:** Mode of operation of a processor such that all pertinent data appearing at inputs within the total averaging time are used in computing sound pressure and sound intensity.

NOTE — Depending upon particular characteristics of the processor, even in real time operation some pertinent data can be effectively lost or not fully taken into account, as described in annex c.

**3.16 phase difference compensation:** Function provided in some processors which, by applying corrections for phase difference, offers an increase in the pressure-residual intensity index found during the process of calibration.

NOTE — Application of this function does not reduce the component of residual intensity caused by electrical noise.

**3.17 autoranging:** Function provided in some processors which automatically selects the optimum range for accuracy, linearity and pressure-residual intensity index.

NOTE — The use of an autoranging function is described in annex B.

**3.18 sound pressure calibrator:** Calibrator suitable for the pressure calibration of microphones or sound pressure measuring/analysing channels in a sound intensity instrument.

**3.19 residual intensity testing device:** Device which, by application of identical sound pressure simultaneously to the microphones of a p-p probe, allows direct computation of pressure-residual intensity index in a frequency band and at one or more sound pressure levels.

**3.20 sound intensity calibrator:** Calibrator which allows direct calibration of the sound intensity indication of an instrument.

**3.21 type test:** Examination of one or more measuring instruments or transducers of the same type which are submitted to a national service of legal metrology; this examination includes the tests necessary for the approval of the type.

**3.22 verification:** All the operations carried out by an organ of the national service of legal metrology (or other legally authorized organisation) having the object of ascertaining and confirming that the measuring instrument entirely satisfies the requirements of the regulations for verification.

**3.23 initial verification:** Verification of a measuring instrument which has not been verified previously.

**3.24 periodic verification:** Subsequent verification of a measuring instrument carried out periodically at intervals and according to the procedures laid down by regulations.

## 4 Grades of accuracy

Instruments, processors and probes are classified according to the measurement accuracy achieved. There are two degrees of accuracy, designated as class 1 and class 2. The same requirements apply to both classes, the differences are only in the tolerances allowed, and in pressure-residual intensity indices, where class 2 requirements are less stringent than those for class 1.

There is an additional class, designated as 2X, which applies to processors and instru-