



TECHNICAL REPORT



Electroacoustics – Measurement microphones – Part 10: Absolute pressure calibration of microphones at low frequencies using calculable pistonphones

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 17.140.50

ISBN 978-2-8322-4374-9

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Reference environmental conditions	7
5 Principles of absolute pressure calibration of microphones using a calculable pistonphone.....	7
5.1 General principle	7
5.2 Basic expressions.....	7
5.3 Heat conduction correction	9
5.4 Operating frequency range.....	9
6 General characteristics	9
6.1 The pistonphone	9
6.2 Measuring the piston volume velocity.....	10
6.3 Test signals	10
6.4 Mounting the microphone and pressure-equalizing tube.....	10
6.5 Measuring the output voltages of the microphones.....	10
7 Factors influencing the pressure sensitivity.....	10
7.1 General.....	10
7.2 Polarizing voltage	11
7.3 Shield configuration	11
7.4 Dependence on environmental conditions	11
7.4.1 General	11
7.4.2 Static pressure	11
7.4.3 Temperature.....	11
7.4.4 Humidity	12
7.5 Vibration	12
7.6 Distortion	12
8 Calibration uncertainty components	12
8.1 General.....	12
8.2 Measurements of microphone output voltage	12
8.3 Piston	12
8.3.1 Frequency	12
8.3.2 Measurement of the volume velocity	12
8.4 Acoustic transfer impedance	13
8.4.1 Cavity properties	13
8.4.2 Physical quantities.....	13
8.5 Microphone parameters	13
8.5.1 Front cavity.....	13
8.5.2 Acoustic impedance.....	13
8.5.3 Polarizing voltage	14
8.6 Uncertainty on pressure sensitivity level	14
Annex A (informative) Example designs of pistonphones using laser interferometry	16

Annex B (informative) Measurement uncertainties	18
B.1 General.....	18
B.2 Example of a typical uncertainty analysis	18
B.2.1 General	18
B.2.2 Uncertainty budget	18
B.2.3 Combined and expanded uncertainties	19
Bibliography.....	20
Figure 1 – Equivalent circuit for evaluating the sound pressure over the exposed surface of the diaphragm of the microphone	8
Figure A.1 – Schematic cross-section of a laser pistonphone.....	16
Figure A.2 – Example of laser pistonphone	17
Figure A.3 – Example of laser pistonphone	17
Table 1 – Uncertainty components	14
Table B.1 – Example of uncertainty budget at 1 Hz	19

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTROACOUSTICS –
MEASUREMENT MICROPHONES –**

**Part 10: Absolute pressure calibration of microphones
at low frequencies using calculable pistonphones**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 61094-10 has been prepared by IEC technical committee 29: Electroacoustics. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
29/1113/DTR	29/1124/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61094 series, published under the general title *Electroacoustics – Measurement microphones*, can be found on the IEC website.

Future documents in this series will carry the new general title as cited above. Titles of existing documents in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

ELECTROACOUSTICS – MEASUREMENT MICROPHONES –

Part 10: Absolute pressure calibration of microphones at low frequencies using calculable pistonphones

1 Scope

This part of IEC 61094

- is applicable to laboratory standard microphones meeting the requirements of IEC 61094-1 and other types of measurement microphones,
- describes one possible absolute method for determining the complex pressure sensitivity, based on a device capable of generating a known sound pressure, especially at low frequencies, and
- provides a reproducible and accurate basis for the measurement of sound pressure at low frequencies.

All quantities are expressed in SI units.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 61094-1:2000, *Measurement microphones – Part 1: Specifications for laboratory standard microphones*

IEC 61094-2:2009, *Electroacoustics – Measurement microphones – Part 2: Primary method for pressure calibration of laboratory standard microphones by the reciprocity technique*
IEC 61094-2:2009/AMD1:2022