IEC 62127-2

Edition 2.0 2025-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Ultrasonics – Hydrophones –
Part 2: Calibration for ultrasonic fields

Ultrasons – Hydrophones –
Partie 2: Etalonnage des champs ultrasoniques

IEC 62127-2:2025-01(en-fr)

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FOREWORD

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IEC 62127-2 has been prepared by IEC technical committee 87: Ultrasonics. It is an International Standard.

This second edition cancels and replaces the first edition published in 2007, Amendment 1:2013 and Amendment 2:2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the upper frequency limit of 40 MHz has been removed;
b) hydrophone sensitivity definitions have been changed to recognize sensitivities as complex-valued quantities;
c) directional response measurement and effective size determination procedures have been updated in 12.5.1 to align with recent changes in IEC 62127-3;

d) Annex F has been amended to comprise a calibration technique for high-frequency complex-valued calibration;

e) the reciprocity method description in Annex K was extended to also comprise focusing transducers;

The text of this International Standard is based on the following documents:

Draft	Report on voting
87/878/FDIS	87/884/RVD

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 International Standard 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 of IEC 62127 series, published under the general title *Ultrasonics – Hydrophones,* can be found on the IEC website.

NOTE Terms in **bold** in the text are defined in Clause 3.

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- withdrawn, or
- revised.

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INTRODUCTION

The spatial and temporal distribution of acoustic pressure in an ultrasonic field in a liquid medium is commonly determined using miniature ultrasonic **hydrophones**. These devices are not absolute measurement instruments and it is important that they are calibrated. This part of IEC 62127 specifies the calibration methods to use in determining the response of a **hydrophone** in the ultrasonic range, i.e. above 50 kHz. The main **hydrophone** application in this context lies in the measurement of ultrasonic fields emitted by medical diagnostic equipment in water. It is important to understand **hydrophone** behaviour over a wide frequency band in order to reliably characterize the acoustic parameters of the applied acoustic field. In particular, the frequency range above 15 MHz is important to fully characterize this equipment, primarily due to the increased appearance of high-frequency components in the ultrasonic signals, caused by nonlinear propagation. In addition, the number of medical ultrasonic systems that use frequencies above 15 MHz, particularly intra-operative probes, is growing. It has turned out in recent years that the **hydrophone** response below 0,5 MHz is also important in order to reliably determine the peak-negative (rarefactional) acoustic pressure.

While the term "**hydrophone**" can be used in a wider sense, it is understood here as referring to miniature piezoelectric **hydrophones**. It is this instrument type that is used today in various areas of medical ultrasonics and, in particular, to characterize quantitatively the field structure of medical diagnostic instruments [1][1]. With regard to other pressure sensor types, such as those based on fibre optics, some of the requirements of this document are applicable to these as well but others are not. If in the future these other "**hydrophone**" types gain more importance in field measurement practice, their characteristics and calibration will be dealt with in a future edition of IEC 62127-2 or in a separate part of IEC 62127.

NOTE 1 This document covers the ultrasonic frequency range, from 50 kHz to an upper frequency of 100 MHz. Not all techniques described are applicable to the full frequency range. Standards dealing with **hydrophone** properties (IEC 62127-3) and **hydrophone** use (IEC 62127-1) are being maintained in parallel. This will eventually lead to unified standards covering the whole field of practical **hydrophone** application.

NOTE 2 **Hydrophone** calibration in the lower ultrasonic and in the underwater sound frequency range is particularly addressed in the IEC 60565 series [2],[3].

[1] Numbers in square brackets refer to the Bibliography.

ULTRASONICS – HYDROPHONES –

Part 2: Calibration for ultrasonic fields

1 Scope

This part of IEC 62127 specifies:

- absolute **hydrophone** calibration methods;
- relative (comparative) **hydrophone** calibration methods.

Recommendations and references to accepted literature are made for the various relative and absolute calibration methods in the frequency range covered by this document.

This document is applicable to

- **hydrophones** used for measurements made in water and in the ultrasonic frequency range 50 kHz to 100 MHz;

  NOTE 1 Although some physiotherapy medical applications of medical ultrasound are developing which operate in the frequency range 40 kHz to 100 kHz, the primary frequency range of diagnostic imaging remains above 2 MHz. It has recently been established that, even in the latter case, the **hydrophone** response at substantially lower frequencies can influence measurements made of key acoustic parameters [4].

  NOTE 2 Calibration methods for underwater acoustics **hydrophones** applicable in the frequency range from 200 Hz to 1 MHz are available in IEC 60565-1 [2], and for frequencies from 0,01 Hz to several kilohertz in IEC 60565-2 [3].

- **hydrophones** employing piezoelectric sensor elements, designed to measure the pulsed wave and continuous wave ultrasonic fields generated by ultrasonic equipment;

  NOTE 3 Some **hydrophones** can have non-circular active elements, arising from slight deviations from a circular structure caused, for example, by electrode structure; or, conversely, the active elements can actually be squares. It is important in these cases to pay special attention to the **directional response** and to the effective radii of the active element through various axes of rotation.

- **hydrophones** with or without a **hydrophone** pre-amplifier.

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 61161, *Ultrasonics – Power measurement – Radiation force balances and performance requirements*

IEC 61689, *Ultrasonics – Physiotherapy systems – Field specifications and methods of measurement in the frequency range 0,5 MHz to 5 MHz*

IEC 62127-1, *Ultrasonics – Hydrophones – Part 1: Measurement and characterization of medical ultrasonic fields*

IEC 62127-3:2022, *Ultrasonics – Hydrophones – Part 3: Properties of hydrophones for ultrasonic fields*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62127-1, IEC 62127-3 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
acoustic centre
point on or near a transducer from which the spherically divergent sound waves emitted by the transducer, and observable at remote points, appear to diverge

Note 1 to entry: This point is the boundary between the **near field** and the **far field**.

Note 2 to entry: In this region, the sound field has plane wave fronts changing to spherical wave fronts with divergence.

3.2
beam axis
straight line that passes through the **beam centrepoints** of two planes perpendicular to the line which connects the point of maximal **pulse-pressure-squared integral** with the centre of the **external transducer surface**

Note 1 to entry: The location of the first plane is the location of the plane containing the maximum **pulse-pressure-squared integral** or, alternatively, is one containing a single main lobe which is in the focal Fraunhofer zone. The location of the second plane is as far as is practicable from the first plane and parallel to the first with the same two orthogonal scan lines (x and y axes) used for the first plane.

Note 2 to entry: In a number of cases, the term **pulse-pressure-squared integral** is replaced in the above definition by any linearly related quantity, for example

a) in the case of a continuous wave signal the term **pulse-pressure-squared integral** is replaced by mean square acoustic pressure as defined in IEC 61689,

b) in cases where signal synchronization with the scanframe is not available the term **pulse-pressure-squared integral** may be replaced by **temporal average intensity**.

Note 3 to entry: See IEC 62127-1:2022, Figure 1.

[SOURCE: IEC 62127-1:2022, 3.8, modified – In the definition, "aperture" has been replaced with "surface".]

3.3
beam centrepoint
position determined by the intersection of two lines in the same beam area plane xy passing through the **beamwidth midpoints** of two orthogonal planes, xz and yz, perpendicular to their respective **beamwidth** lines

[SOURCE: IEC 62127-1:2022, 3.9]