

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Ultrasonics – Hydrophones –  
Part 2: Calibration for ultrasonic fields**

**Ultrasons – Hydrophones –  
Partie 2: Etalonnage des champs ultrasoniques**



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Part 2: Calibration for ultrasonic fields**

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## CONTENTS

FOREWORD.....	8
INTRODUCTION.....	10
1 Scope.....	11
2 Normative references .....	11
3 Terms and definitions .....	12
4 List of symbols .....	21
5 Overview of calibration procedures.....	24
5.1 Principles.....	24
5.2 Summary of calibration procedures.....	25
5.3 Reporting of results.....	26
5.4 Recommended calibration periods .....	28
6 Generic requirements of a hydrophone calibration system .....	28
6.1 Mechanical positioning.....	28
6.1.1 General .....	28
6.1.2 Accuracy of the axial hydrophone position .....	28
6.1.3 Accuracy of the lateral hydrophone position.....	29
6.2 Temperature measurements and temperature stability.....	29
6.3 Hydrophone size.....	29
6.4 Measurement vessel and water properties .....	30
6.5 Measurement of output voltage .....	30
7 Electrical considerations.....	30
7.1 Signal type.....	30
7.2 Earthing .....	31
7.3 Measurement of hydrophone output voltage.....	31
7.3.1 General .....	31
7.3.2 Electrical loading by measuring instrument.....	31
7.3.3 Electrical loading by extension cables .....	31
7.3.4 Noise.....	32
7.3.5 Cross-talk (near-field frequency rf pick-up) and acoustic interference .....	32
7.3.6 Integral hydrophone pre-amplifiers .....	32
8 Preparation of hydrophones.....	32
8.1 General.....	32
8.2 Wetting .....	32
8.3 Hydrophone support.....	32
8.4 Influence of cable .....	33
9 Near-field reciprocity calibration .....	33
9.1 General.....	33
9.2 Object.....	33
9.3 General principles.....	33
9.3.1 General .....	33
9.3.2 Three-transducer reciprocity calibration method .....	33
9.3.3 Self-reciprocity calibration method .....	34
9.3.4 Two-transducer reciprocity calibration method .....	34
9.4 Two-transducer reciprocity calibration method .....	34
9.4.1 General .....	34
9.4.2 Auxiliary transducers .....	34

9.4.3	Reflector.....	35
9.4.4	Measurement field.....	35
9.4.5	Reciprocity approach.....	35
9.4.6	Measurement procedure.....	35
10	Free field calibration by planar scanning.....	35
10.1	General.....	35
10.2	Object.....	36
10.3	General principle.....	36
10.4	Procedural requirements.....	38
10.4.1	Hydrophone scanning.....	38
10.4.2	Power measurement.....	38
10.4.3	Transducer mounting.....	38
10.4.4	Measurement conditions.....	38
10.4.5	Measurements.....	39
10.5	Corrections and sources of uncertainty.....	39
11	Free field calibration by optical interferometry.....	39
11.1	General.....	39
11.2	Principle.....	39
12	Calibration by comparison using a standard hydrophone.....	39
12.1	General.....	39
12.2	Object.....	39
12.3	Principle.....	40
12.4	Procedural requirements.....	40
12.4.1	Source transducer.....	40
12.4.2	Source transducer drive signal.....	40
12.4.3	Measurement system.....	40
12.5	Procedure.....	41
12.5.1	Measurements (Type I): determination of the directional response of a hydrophone.....	41
12.5.2	Measurements (Type II): calibration by comparison using a standard hydrophone.....	42
12.6	Maximum hydrophone size.....	42
Annex A (informative) Assessment of uncertainty in free field calibration of hydrophones.....		43
A.1	General.....	43
A.2	Overall (expanded) uncertainty.....	43
A.3	Common sources of uncertainty.....	43
Annex B (informative) Behaviour of PVDF polymer sensors in high-intensity ultrasonic fields.....		45
B.1	General.....	45
B.2	Theoretical background.....	45
B.3	Tests.....	45
B.4	Results.....	46
B.5	Conclusions.....	47
Annex C (informative) Electrical loading corrections.....		48
C.1	General.....	48
C.2	Corrections using complex impedance.....	48
C.3	Corrections using only capacitances.....	49

Annex D (informative) Absolute calibration of hydrophones using the planar scanning technique.....	50
D.1 Overview.....	50
D.2 Hydrophone scanning methodology.....	50
D.3 Corrections and sources of measurement uncertainty .....	51
D.3.1 Total power .....	51
D.3.2 Received hydrophone signal.....	51
D.3.3 Integration .....	52
D.3.4 Directional response.....	52
D.3.5 Finite size of the hydrophone.....	53
D.3.6 Noise.....	53
D.3.7 Nonlinear propagation .....	54
D.3.8 Planar scanning.....	55
D.3.9 Intensity proportional to pressure squared .....	55
D.4 Rationale behind the planar scanning technique for calibrating hydrophones .....	56
D.4.1 General .....	56
D.4.2 Relationship between hydrophone and transducer effective radii .....	56
D.4.3 Justification for $a_t / l \leq 0,5$ .....	56
D.4.4 Derivation of Formula (D.2).....	57
D.4.5 Effect of nonlinear propagation, D.3.7.....	58
Annex E (informative) Properties of water.....	60
E.1 General.....	60
E.2 Attenuation coefficient for propagation in water.....	61
Annex F (informative) The absolute calibration of hydrophones by optical interferometry .....	62
F.1 Overview.....	62
F.2 Present position.....	62
F.2.1 "Magnonic" or nonlinear propagation-based method .....	62
F.2.2 Optical interferometry.....	63
F.2.3 High-frequency implementations of optical interferometry .....	63
Annex G (informative) Waveform concepts .....	78
G.1 Overview.....	78
G.2 Temporal waveform, frequency concepts and hydrophone positioning for comparison calibrations of hydrophones .....	78
G.3 Temporal waveform and frequency coverage concepts .....	79
G.3.1 Using a narrow-band tone-burst (concept a) .....	79
G.3.2 Using a broadband waveform resulting from a narrow-band tone-burst after nonlinear propagation (concept b) .....	80
G.3.3 Using a broadband pulse (concept c).....	80
G.3.4 Using a continuous wave frequency sweep with time delay spectrometry (concept d) .....	81
G.3.5 Continuous wave frequency sweep with TGFA (concept e) .....	81
G.4 Hydrophone position concepts .....	81
G.4.1 Near-field hydrophone position (concept A) .....	81
G.4.2 Far field hydrophone position (concept B).....	81
G.4.3 Far field hydrophone position with special reference to a long propagation path in order to achieve nonlinear distortion (concept C) .....	82
G.4.4 Geometric spherical focus position with focusing source transducer (low voltage or linear excitation) (concept D).....	82

G.4.5	Geometric spherical focus position with focusing source transducer and high voltage excitation in order to achieve nonlinear distortion (concept E) .....	82
G.5	Special considerations for calibrations close to the face of a transducer .....	83
G.5.1	General requirement .....	83
G.5.2	Influence of edge waves .....	83
G.5.3	Potential influence of head waves .....	84
G.5.4	Treatment of head waves close to the transducer .....	84
G.5.5	Statements on the usable paraxial plane wave region in the case of a near-field hydrophone position, considering both edge wave and head wave contributions .....	86
Annex H (informative)	Time delay spectrometry – Requirements and a brief review of the technique .....	87
H.1	General .....	87
H.2	Calibration and performance evaluation of ultrasonic hydrophones using time delay spectrometry .....	87
H.2.1	Ultrasonic field parameter measured .....	87
H.2.2	Ultrasonic frequency range over which the technique is applicable .....	87
H.2.3	Ultrasonic field configuration for which the technique is applicable .....	87
H.2.4	Spatial resolution .....	88
H.2.5	Sensitivity of the technique .....	88
H.2.6	Range over which the sensitivity is measured .....	88
H.2.7	Reproducibility .....	88
H.2.8	Impulse response .....	88
H.2.9	Procedure for performing measurements .....	88
H.3	Measurement procedure for sensitivity inter-comparison .....	89
H.4	Measurement procedure (reciprocity calibration) .....	89
H.5	Limitations .....	89
Annex I (informative)	Determination of the phase response of hydrophones .....	90
I.1	Overview .....	90
I.2	Coherent time delay spectrometry .....	91
I.2.1	Principle of operation .....	91
I.2.2	Example results .....	91
I.2.3	Uncertainties .....	92
I.2.4	Limitations .....	93
I.3	Pulse calibration technique with optical multilayer hydrophone .....	93
I.3.1	Principle of operation .....	93
I.3.2	Example of results .....	93
I.3.3	Uncertainties .....	94
I.3.4	Limitations .....	94
I.4	Nonlinear pulse propagation modelling .....	95
I.4.1	Principle of operation .....	95
I.4.2	Limitations .....	95
Annex J (informative)	Maximum size considerations for the active element of a hydrophone .....	96
J.1	Maximum hydrophone size in the near field case (Annex G – hydrophone position concept A) .....	96
J.2	Maximum hydrophone size in the far field case (Annex G – hydrophone position concept B) .....	96

J.3	Maximum hydrophone size in the far field case with special reference to a long propagation path in order to achieve nonlinear distortion (Annex G – hydrophone position concept C).....	96
Annex K (informative)	Two-transducer reciprocity calibration method.....	98
K.1	General.....	98
K.2	Fundamentals of reciprocity.....	98
K.3	Electrical quantities.....	99
K.4	Diffraction correction and loss due to nonlinear sound propagation.....	100
K.5	Ultrasonic field.....	100
K.6	Experimental set-up.....	101
K.6.1	General.....	101
K.6.2	Twisting reflector.....	101
K.6.3	Translational reflector.....	102
K.6.4	Translational auxiliary transducer.....	102
K.7	Hydrophone calibration using a calibrated spherically curved auxiliary transducer based on the self-reciprocity method.....	103
Bibliography	.....	107
Figure F.1	– Experimental set-up of the interferometric foil technique.....	65
Figure F.2	– End-of-cable open-circuit sensitivity level $L_{M_c}$ of a coplanar membrane hydrophone.....	67
Figure F.3	– Experimental set-up of the heterodyne vibrometer technique.....	69
Figure F.4	– Measured frequency-dependent radial profiles of the acoustic pulse field.....	71
Figure F.5	– Experimentally determined spatial averaging correction versus frequency for hydrophones of different effective element diameter, $d_{eff}$ .....	72
Figure F.6	– End-of-cable loaded sensitivity level and sensitivity phase of a coplanar membrane hydrophone assembly at 50 Hz termination.....	73
Figure F.7	– Hydrophone waveform generated by a 9 µm coplanar membrane hydrophone positioned at the focus of a 5 MHz transducer (focal length 51 mm).....	74
Figure F.8	– Interferometer displacement waveform generated with the pellicle positioned at the focus of the 5 MHz transducer (focal position 51 mm).....	75
Figure F.9	– Frequency spectrum of the displacement waveform (lower curve) and the differentiated displacement waveform (upper curve).....	75
Figure F.10	– Sensitivity of a 0,2 mm active element diameter of a 9 µm bilaminar membrane hydrophone determined at 5 MHz intervals over the frequency range 5 MHz to 60 MHz.....	76
Figure G.1	– Coordinates of a field point P in the near field of a plane-circular source transducer of radius $a_t$ .....	84
Figure I.1	– Phase of end-of-cable open-circuit sensitivity for two membrane hydrophones.....	92
Figure I.2	– Phase of end-of-cable open-circuit sensitivity for a 0,2 mm diameter needle hydrophone.....	94
Figure K.1	– Experimental set-up with a twisting reflector [22].....	102
Figure K.2	– Experimental set-up with a translational reflector [23].....	102
Figure K.3	– Experimental set-up with a translational auxiliary transducer [24].....	103
Figure K.4	– Relationship of $G_C$ and $\theta_m(^{\circ})$ for several values of $ka_h$ .....	105

Table 1 – List of typical uncertainty values (for 95 % coverage) obtained by the calibration methods specified in this document and for the frequency range listed .....	26
Table E.1 – Speed of sound $c$ [54],[55] and specific acoustic impedance, $\rho c$ , as a function of temperature, for propagation in water .....	60
Table G.1 – Temporal waveform and hydrophone position concepts described in Annex G .....	78
Table I.1 – Example of uncertainties (where a coverage factor, $k = 2$ , is used) for a HTDS phase calibration of a needle hydrophone with a diameter of 0,2 mm, expressed at a confidence level of 95 % .....	92
Table K.1 – Values of the correction coefficient $G_c(ka_h, \theta_m)$ for the spatial average effect of the free-field acoustic pressure over the hydrophone surface if it were removed .....	107

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**ULTRASONICS – HYDROPHONES –****Part 2: Calibration for ultrasonic fields**

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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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

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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]<sup>1</sup>. 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].

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<sup>1</sup> 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*