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Ultrasonics - Hydrophones - Part 1: Measurement and characterization of medical ultrasonic fields



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Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
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ICS 17.140.50

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English Version

## Ultrasonics - Hydrophones - Part 1: Measurement and characterization of medical ultrasonic fields (IEC 62127-1:2022)

Ultrasons - Hydrophones - Partie 1: Mesurage et  
caractérisation des champs ultrasoniques médicaux  
(IEC 62127-1:2022)

Ultraschall - Hydrophone - Teil 1: Messung und  
Charakterisierung von medizinischen Ultraschallfeldern bis  
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(IEC 62127-1:2022)

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## European foreword

The text of document 87/783/FDIS, future edition 2 of IEC 62127-1, prepared by IEC/TC 87 "Ultrasonics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62127-1:2022.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-01-29
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IEC 60500	NOTE Harmonized as EN 60500
IEC 60601-2-5	NOTE Harmonized as EN 60601-2-5
IEC 60601-2-37	NOTE Harmonized as EN 60601-2-37
IEC 60601-2-62	NOTE Harmonized as EN 60601-2-62
IEC 61157	NOTE Harmonized as EN 61157
IEC 61161	NOTE Harmonized as EN 61161
IEC 61828	NOTE Harmonized as EN IEC 61828
IEC 61846	NOTE Harmonized as EN 61846
IEC 61847	NOTE Harmonized as EN 61847
IEC/TS 61949	NOTE Harmonized as CLC/TS 61949
IEC 62359	NOTE Harmonized as EN 62359
IEC 63045	NOTE Harmonized as EN IEC 63045

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

**Ultrasonics – Hydrophones –  
Part 1: Measurement and characterization of medical ultrasonic fields**

**Ultrasons – Hydrophones –  
Partie 1: Mesurage et caractérisation des champs ultrasoniques médicaux**



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# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

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**Ultrasonics – Hydrophones –  
Part 1: Measurement and characterization of medical ultrasonic fields**

**Ultrasons – Hydrophones –  
Partie 1: Mesurage et caractérisation des champs ultrasoniques médicaux**

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ICS 17.140.50

ISBN 978-2-8322-1080-1

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## ULTRASONICS – HYDROPHONES –

## Part 1: Measurement and characterization of medical ultrasonic fields

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IEC 62127-1 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 and Amendment 1:2013. 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) Procedures and requirements for narrow-band approximation and broadband measurements have been modified; details on waveform deconvolution have been added.
- d) Procedures for spatial averaging correction have been amended.
- e) Annex D, Annex E and bibliography have been updated to support the changes of the normative parts.

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

Draft	Report on voting
87/783/FDIS	87/788/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/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

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## INTRODUCTION

The main purpose of this document is to define various acoustic parameters that can be used to specify and characterize ultrasonic fields propagating in liquids, and, in particular, water, using hydrophones. Measurement procedures are outlined that may be used to determine these parameters. Specific device related measurement standards, for example IEC 61689, IEC 61157, IEC 61847 or IEC 62359, can refer to this document for appropriate acoustic parameters. In IEC 62359, some additional measurement methods for attenuated parameters and indices are described addressing the specific needs of acoustic output characterization of ultrasonic diagnostic equipment in accordance with IEC 60601-2-37.

The philosophy behind this document is the specification of the acoustic field in terms of acoustic pressure parameters, acoustic pressure being the primary measurement quantity when hydrophones are used to characterize the field.

Intensity parameters are specified in this document, but these are regarded as derived quantities that are meaningful only under certain assumptions related to the ultrasonic field being measured.

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## ULTRASONICS – HYDROPHONES –

### Part 1: Measurement and characterization of medical ultrasonic fields

#### 1 Scope

This part of IEC 62127 specifies methods of use of calibrated **hydrophones** for the measurement in liquids of acoustic fields generated by ultrasonic medical equipment including **bandwidth** criteria and calibration frequency range requirements in dependence on the spectral content of the fields to be characterized.

This document:

- defines a group of acoustic parameters that can be measured on a physically sound basis;
- defines a second group of parameters that can be derived under certain assumptions from these measurements, and called derived intensity parameters;
- defines a measurement procedure that can be used for the determination of acoustic pressure parameters;
- defines the conditions under which the measurements of acoustic parameters can be made using calibrated **hydrophones**;
- defines procedures for correcting for limitations caused by the use of **hydrophones** with finite **bandwidth** and finite active element size, and for estimating the corresponding **uncertainties**.

NOTE 1 Throughout this document, SI units are used. In the specification of certain parameters, such as **beam areas** and intensities, it can be convenient to use decimal multiples or submultiples. For example, **beam area** is likely to be specified in  $\text{cm}^2$  and intensities in  $\text{W}/\text{cm}^2$  or  $\text{mW}/\text{cm}^2$ .

NOTE 2 The **hydrophone** as defined can be of a piezoelectric or an optic type.

#### 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 60565-1, *Underwater acoustics – Hydrophones – Calibration of hydrophones – Part 1: Procedures for free-field calibration of hydrophones*

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

IEC 62127-2, *Ultrasonics – Hydrophones – Part 2: Calibration for ultrasonic fields up to 40 MHz*

IEC 62127-3, *Ultrasonics – Hydrophones – Part 3: Properties of hydrophones for ultrasonic fields up to 40 MHz*

IEC 63009, *Ultrasonics – Physiotherapy systems – Field specifications and methods of measurement in the frequency range 20 kHz to 500 kHz*

ISO 16269-6, *Statistical interpretation of data – Part 6: Determination of statistical tolerance intervals*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62127-2, IEC 62127-3 and the following apply.

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

- IEC Electropedia: available at <http://www.electropedia.org/>
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#### 3.1

##### **acoustic pulse waveform**

temporal waveform of the **instantaneous acoustic pressure** at a specified position in an acoustic field and displayed over a period sufficiently long to include all significant acoustic information in a single pulse or tone-burst, or one or more cycles in a continuous wave

Note 1 to entry: Temporal waveform is a representation (e.g. oscilloscope presentation or equation) of the **instantaneous acoustic pressure**.

#### 3.2

##### **acoustic repetition period**

*arp*

**pulse repetition period** for non-automatic scanning systems and the **scan repetition period** for automatic scanning systems, equal to the time interval between corresponding points of consecutive cycles for continuous wave systems

Note 1 to entry: The **acoustic repetition period** is expressed in seconds (s).

#### 3.3

##### **acoustic-working frequency**

##### **acoustic frequency**

frequency of an acoustic signal based on the observation of the output of a **hydrophone** placed in an acoustic field at the position corresponding to the **spatial-peak temporal-peak acoustic pressure**

Note 1 to entry: The signal is analysed using either the **zero-crossing acoustic-working frequency** technique or a spectrum analysis method. Acoustic-working frequencies are defined in 3.3.1, 3.3.2, 3.3.3, 3.3.4 and 3.3.5.

Note 2 to entry: In a number of cases the present definition is not very helpful or convenient, especially for **broadband transducers**. In that case, a full description of the frequency spectrum is expected to be given in order to enable any frequency-dependent correction to the signal.

Note 3 to entry: **Acoustic frequency** is expressed in hertz (Hz).

#### 3.3.1

##### **zero-crossing acoustic-working frequency**

$f_{awf}$

number,  $n$ , of consecutive half-cycles (irrespective of polarity) divided by twice the time between the commencement of the first half-cycle and the end of the  $n$ -th half-cycle

Note 1 to entry: None of the  $n$  consecutive half-cycles are expected to show evidence of phase change.

Note 2 to entry: The measurement are performed at terminals in the receiver that are as close as possible to the receiving transducer (**hydrophone**) and, in all cases, before rectification.

Note 3 to entry: This frequency is determined according to the procedure specified in IEC TR 60854.

Note 4 to entry: This frequency is intended for continuous-wave systems only.