

# **Ultrasonics - Hydrophones - Characteristics and calibration in the frequency range from 15 MHz to 40 MHz**

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

Käesolev Eesti standard EVS-EN 62092:2003 sisaldab Euroopa standardi EN 62092:2001 ingliskeelset teksti.

Standard on kinnitatud Eesti Standardikeskuse 15.01.2003 käskkirjaga ja jõustub sellekohase teate avaldamisel EVS Teatajas.

Standard on kättesaadav Eesti standardiorganisatsioonist.

This Estonian standard EVS-EN 62092:2003 consists of the English text of the European standard EN 62092:2001.

This standard is ratified with the order of Estonian Centre for Standardisation dated 15.01.2003 and is endorsed with the notification published in the official bulletin of the Estonian national standardisation organisation.

The standard is available from Estonian standardisation organisation.

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electrical, frequency ranges, frequency response, hydrophones, marking, measurement, medical technology, medicine, properties, ratings, sensitivity, sound fields, ultrasonic devices, ultrasonic frequencies, ultrasonic medic, ultrasonic medical apparatus, ultrasonics

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**Ultrasonics - Hydrophones -  
Characteristics and calibration in  
the frequency range from 15 MHz to 40 MHz  
(IEC 62092:2001)**

Ultrasons - Hydrophones  
Caractéristiques et étalonnage  
dans la gamme de fréquences  
de 15 MHz à 40 MHz  
(CEI 62092:2001)

Ultraschall - Hydrophone -  
Eigenschaften und Kalibrierung  
im Frequenzbereich von  
15 MHz bis 40 MHz  
(IEC 62092:2001)

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European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**Central Secretariat: rue de Stassart 35, B - 1050 Brussels**

## Foreword

The text of document 87/203A/FDIS, future edition 1 of IEC 62092, prepared by IEC TC 87, Ultrasonics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62092 on 2001-10-01.

The following dates were fixed:

- latest date by which the EN has to be implemented  
at national level by publication of an identical  
national standard or by endorsement (dop) 2002-07-01
- latest date by which the national standards conflicting  
with the EN have to be withdrawn (dow) 2004-10-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annex ZA is normative and annexes A, B, C, D and E are informative.

Annex ZA has been added by CENELEC.

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## Endorsement notice

The text of the International Standard IEC 62092:2001 was approved by CENELEC as a European Standard without any modification.

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## Annex ZA (normative)

### Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60866	1987	Characteristics and calibration of hydrophones for operation in the frequency range 0,5 MHz to 15 MHz	-	-
IEC 61101	1991	The absolute calibration of hydrophones using the planar scanning technique in the frequency range 0,5 MHz to 15 MHz	EN 61101	1993
IEC 61102	1991	Measurement and characterisation of ultrasonic fields using hydrophones in the frequency range 0,5 MHz to 15 MHz	EN 61102	1993
IEC 61161	1992	Ultrasonic power measurement in liquids in the frequency range 0,5 MHz to 25 MHz	EN 61161	1994
A1	1998		A1	1998
IEC 61828	2001	Ultrasonics - Focusing transducers - Definitions and measurement methods for the transmitted fields	EN 61828	2001

# INTERNATIONAL STANDARD

**IEC**  
**62092**

First edition  
2001-08

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**Ultrasonics – Hydrophones –  
Characteristics and calibration in the  
frequency range from 15 MHz to 40 MHz**

*Ultrasons – Hydrophones –  
Caractéristiques et étalonnage dans la gamme  
de fréquences de 15 MHz à 40 MHz*



Reference number  
IEC 62092:2001(E)

## Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

## Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

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# INTERNATIONAL ELECTROTECHNICAL COMMISSION

## ULTRASONICS – HYDROPHONES – CHARACTERISTICS AND CALIBRATION IN THE FREQUENCY RANGE FROM 15 MHz TO 40 MHz

### FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62092 has been prepared by IEC technical committee 87: Ultrasonics.

The text of this standard is based on the following documents:

FDIS	Report on voting
87/203A/FDIS	87/209/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

Annexes A, B, C, D and E are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

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

## INTRODUCTION

The spatial and temporal distribution of acoustic pressure in an ultrasonic field in a liquid medium is commonly determined using miniature ultrasonic **hydrophones**. The characteristics and calibration of these **hydrophones** have been dealt with in a number of IEC standards in the frequency range 0,5 MHz to 15 MHz. The purpose of this International Standard is to extend this frequency range up to 40 MHz. The main **hydrophone** application in this context is the measurement of ultrasonic fields emitted by medical diagnostic equipment in water. It has turned out in recent years that **hydrophone** operation in the frequency range above 15 MHz is important to characterize fully 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 which use frequencies above 15 MHz, particularly intra-operative probes, is growing.

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 which is used today in various areas of medical ultrasonics and particularly to characterize quantitatively the field structure of medical diagnostic instruments. With regard to other pressure sensor types such as those based on fibre optics, some of the prescriptions of this International Standard 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 have to be dealt with in a revised version of this International Standard or in a separate one.

In agreement with present measurement practice, **hydrophones** are dealt with in this International Standard as amplitude sensors and not as phase sensors. If phase measurements were to become important in the future, this standard would need revision, with more rigorous requirements being necessary for that kind of measurement.

NOTE 1 Accordingly, the **hydrophone** sensitivity is understood as a real quantity (expressing the ratio of amplitudes) throughout this International Standard.

NOTE 2 This International Standard covers the frequency range from 15 to 40 MHz. **Hydrophone** properties and **hydrophone** calibration up to 15 MHz are covered by the International Standards IEC 60866 and IEC 61101. In practice, the useful frequency range of a **hydrophone** may well extend into both frequency ranges, below and above 15 MHz. It has therefore been the aim to keep the regulations of this International Standard as far as possible similar to those of the aforementioned standards. Differences are due either to different technical needs in the respective frequency ranges or to the technical and scientific progress achieved since the publication of the aforementioned standards. At present there are maintenance activities aiming at re-structuring and merging, where possible, all existing **hydrophone** standards. It can be expected that this will lead to unified standards covering the whole field of practical **hydrophone** application.

# **ULTRASONICS – HYDROPHONES – CHARACTERISTICS AND CALIBRATION IN THE FREQUENCY RANGE FROM 15 MHz TO 40 MHz**

## **1 Scope**

This International Standard is applicable to

- **hydrophones** employing piezoelectric sensor elements, designed to measure the pulsed and continuous wave ultrasonic fields generated by ultrasonic equipment;
- **hydrophones** used for measurements made in water and in the frequency range between 15 MHz and 40 MHz;
- **hydrophones** with or without an integral amplifier;
- **hydrophones** with a circular piezoelectrically active element.

This International Standard specifies

- relevant **hydrophone** characteristics;
- methods of determining **directional response** and **hydrophone** sensitivity based on relative or comparative measurements;

and describes

- absolute **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 International Standard.

## **2 Normative references**

The following referenced documents are indispensable for the application 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 60866:1987, *Characteristics and calibration of hydrophones for operation in the frequency range 0,5 MHz to 15 MHz*

IEC 61101:1991, *The absolute calibration of hydrophones using the planar scanning technique in the frequency range 0,5 MHz to 15 MHz*

IEC 61102:1991, *Measurement and characterisation of ultrasonic fields using hydrophones in the frequency range 0,5 MHz to 15 MHz*

IEC 61161:1992, *Ultrasonic power measurement in liquids in the frequency range 0,5 MHz to 25 MHz*<sup>1</sup>

Amendment 1 (1998)

IEC 61828:—, *Ultrasonics – Focusing transducers – Definitions and measurement methods for the transmitted fields*<sup>2</sup>

<sup>1</sup> There exists a consolidated edition 1.1 (1998) that includes IEC 61161 (1992) and its amendment 1 (1998).

<sup>2</sup> To be published.

### 3 Definitions

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

#### 3.1

##### **acoustic centre**

the 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

[definition 3.3 of IEC 60866]

#### 3.2

##### **beam-alignment axis**

used for alignment purposes only, **beam-alignment axis** is a straight line joining two points of spatial-peak temporal-peak acoustic pressure on two hemispherical surfaces whose centres are at the approximate geometrical centre of an ultrasonic transducer or ultrasonic transducer element group. One hemisphere has a radius of curvature of approximately  $A_g/\pi\lambda$ , where  $A_g$  is the geometrical area of the ultrasonic transducer or ultrasonic transducer element group and  $\lambda$  is the wavelength of the ultrasound corresponding to the nominal frequency. The second hemisphere has a radius of curvature either  $2A_g/\pi\lambda$ , or  $A_g/3\pi\lambda$ , whichever is the more appropriate. For the purposes of alignment, this line may be projected to the face of the ultrasonic transducer or ultrasonic transducer element group.

For most practical applications, two plane surfaces perpendicular to the direction of propagation of the ultrasound are used. In cases where a unique peak is not located on a hemispherical surface, another hemispherical surface is chosen with a different radius of curvature yielding a unique peak

[definition 3.5 of IEC 61102]

#### 3.3

##### **directional response**

directional response of a hydrophone

description, generally presented graphically, of the response of a **hydrophone**, as a function of direction of propagation of the incident plane sound wave, in a specified plane through the **acoustic centre** and at a specified frequency

[definition 3.12 of IEC 60866]

#### 3.4

##### **effective radius**

effective radius of a hydrophone active element

radius of a stiff disc receiver **hydrophone** which has a predicted **directional response** function with an angular width equal to the observed angular width. The angular width is determined at a specified level below the peak of the **directional response** function. For the specified levels of 3 dB and 6 dB, the radii are denoted by  $a_3$  and  $a_6$  respectively

[definitions 3.4 of IEC 61101 and 3.13 of IEC 61102]

Symbols:  $a$ ,  $a_3$ ,  $a_6$

Unit: metre, m

#### 3.5

##### **electric load impedance**

electric input impedance (consisting of a real and an imaginary part) to which the **hydrophone** unit output cable is connected or is to be connected

Symbol:  $Z_L$

Unit: ohm,  $\Omega$