SLOVENSKI STANDARD

SIST EN 62092:2002

01-september-2002

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

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

Ultraschall - Hydrophone - Eigenschaften und Kalibrierung im Frequenzbereich von 15 MHz bis 40 MHz

Ultrasons - Hydrophones - Caractristiques et talonnage dans la gamme de frquences de 15 MHz 40 MHz

Ta slovenski standard je istoveten z: **EN 62092:2001**

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17.140.50	Elektroakustika	Electroacoustics

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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)

This European Standard was approved by CENELEC on 2001-10-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

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

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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.

Endorsement notice

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

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.

Publication	Year	Title	EN/HD	Year
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

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Utrasonics – 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

International Electrotechnical Commission 3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300 e-mail: inmail@iec.ch IEC web site http://www.iec.ch

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CONTENTS

FOREWORD 4
INTRODUCTION 5

1 Scope 6
2 Normative references 6
3 Definitions 7
4 List of symbols 9
5 Hydrophone characteristics 11
5.1 General 11
5.2 Basic information 11
5.3 Hydrophone class 11
5.4 Sensitivity 12
5.5 Frequency response 12
5.6 Directional response 13
5.7 Effective radius 13
5.8 Dynamic range and linearity 14
5.9 Electric output characteristics 14
5.9.1 Electric output termination 14
5.9.2 Output lead configuration and ringing resonance in cable 15
5.10 Information on the integral amplifier, if included 15
5.11 Environmental and other aspects 16
5.11.1 Temperature range 16
5.11.2 Water tightness 16
5.11.3 Water properties and incompatible materials 16
5.11.4 Other aspects 16
6 Relative measurements of hydrophone characteristics 16
6.1 General concepts 16
6.1.1 Relative measurement for directional response and for comparison of sensitivity 16
6.1.2 Temporal waveform and frequency concepts and hydrophone position 17
6.2 Measurement concepts 18
6.2.1 Source transducer 18
6.2.2 Types of measurement 18
6.2.3 Temporal waveform concepts 19
6.2.4 Hydrophone position concepts 21

6.3 Requirements 24
6.3.1 Measurement vessel and water 24
6.3.2 Temperature stability 24
6.3.3 Positional accuracy 24
6.3.4 Maximum hydrophone size 25
6.3.5 Requirements for the electronic equipment 27
6.3.6 Requirements with particular respect to time delay spectrometry 27
7 Hydrophone calibration 27

Annex A (informative) Tables 29
Annex B (informative) Behaviour of PVDF polymer sensors in high intensity ultrasonic fields 31
Annex C (informative) Hydrophone positioning in the ultrasonic near field 34
Annex D (informative) Time delay spectrometry – Requirements and a brief review of the technique 36
Annex E (informative) The absolute calibration of hydrophones up to 40 MHz 39

Bibliography 50

Figure 1 – Coordinates of a field point P in the near field of a plane- circular source transducer of radius a_t 28
Figure E.1 – Experimental set-up of the interferometric foil technique 42
Figure E.2 – Hydrophone waveform generated by a 9 µm coplanar membrane hydrophone positioned at the focus of a 5 MHz transducer (focal length 51 mm) 45
Figure E.3 – Interferometer (displacement) waveform generated with the pellicle positioned at the focus of the 5 MHz transducer (focal position 51 mm) 45
Figure E.4 – Frequency spectrum of the displacement waveform (lower curve) and the differentiated displacement waveform (upper curve) 46
Figure E.5 – Sensitivity of a 0,2 mm active element 9 µm bilaminar membrane hydrophone determined at 5 MHz intervals over the frequency range 5 MHz to 60 MHz 46

Table A.1 – List of typical uncertainty values obtained by the calibration methods given in this standard and for the frequency range dealt with here 29
Table A.2 – Speed of sound c [18, 19] and linear amplitude attenuation coefficient α divided by the frequency squared ([20], interpolated), as a function of the temperature, in water 29
Table A.3 – List of the waveform concepts and the hydrophone position concepts 30
Table A.4 – List of decibel (dB) values and the corresponding amplitude ratios 30

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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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

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* [1]
Amendment 1 (1998)

IEC 61828:—, *Ultrasonics – Focusing transducers – Definitions and measurement methods for the transmitted fields* [2]

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[1] There exists a consolidated edition 1.1 (1998) that includes IEC 61161 (1992) and its amendment 1 (1998).

[2] 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 λ 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, Ω

3.6
end-of-cable loaded sensitivity
end-of-cable loaded sensitivity of a hydrophone
ratio of the instantaneous voltage at the end of any integral cable or connector of a **hydrophone**, when connected to a specified electrical input impedance, to the instantaneous acoustic pressure in the undisturbed free field of a plane wave in the position of the **acoustic centre** of the **hydrophone** if the **hydrophone** were removed

[definitions 3.5 of IEC 61101 and 3.14 of IEC 61102, modified]

Symbol: M_L

Unit: volt per pascal, V/Pa

3.7
end-of-cable open-circuit sensitivity
end-of-cable open-circuit sensitivity of a hydrophone
ratio of the instantaneous open-circuit voltage at the end of any integral cable or connector of a **hydrophone** to the instantaneous acoustic pressure in the undisturbed free field of a plane wave in the position of the **acoustic centre** of the **hydrophone** if the **hydrophone** were removed

[definition 3.15 of IEC 61102, modified]

Symbol: M_c

Unit: volt per pascal, V/Pa

3.8
far field
the sound field at a distance from the source where the instantaneous values of the sound pressure and particle velocity are substantially in phase

[definition 3.2 of IEC 60866]

NOTE 1 In the **far field** the sound pressure appears to be spherically divergent from a point on or near the radiating surface. Hence the pressure produced by the sound source is approximately inversely proportional to the distance from the source.

NOTE 2 The term "**far field**" is used in this International Standard only in connection with non-focusing source transducers. For focusing transducers a different terminology for the various parts of the transmitted field applies (see IEC 61828).

3.9
hydrophone geometrical radius
geometrical radius of a hydrophone active element
radius defined by the dimensions of the active element of a **hydrophone**

[definition 3.18 of IEC 61102]

Symbol: a_g

Unit: metre, m

3.10
hydrophone
transducer that produces electrical signals in response to waterborne acoustic signals

[See 3.4 of IEC 60866 and 3.19 of IEC 61102]

3.11
hydrophone axis
nominal symmetry axis of the **hydrophone** active element

NOTE Unless stated otherwise (explicitly and quantitatively) by the manufacturer, it is understood for the purposes of this standard that this is given by the apparent geometrical symmetry axis of the **hydrophone**.

3.12
integral amplifier
active electronic device connected firmly to the **hydrophone** and reducing its output impedance

NOTE 1 An **integral amplifier** requires a supply voltage (or supply voltages).

NOTE 2 The **integral amplifier** may have a forward voltage transmission factor of less than one, i.e., it need not necessarily be a voltage amplifier in the strict sense.

3.13
pulse duration
1,25 times the interval between the time when the time integral of the square of the instantaneous acoustic pressure reaches 10 % and 90 % of its final value

[definition 3.30 of IEC 61102, modified]

3.14
uncertainty
parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

[See 2.2.3 of the ISO/IEC Guide to the Expression of Uncertainty in Measurement [1][3]]

4 List of symbols

a	=	**effective radius** (a_3, a_6: with special reference to a 3 dB or 6 dB definition, respectively)
a_g	=	**hydrophone geometrical radius**
a_{max}	=	maximum **effective radius**
a_t	=	radius of a source transducer
A_g	=	geometrical area of a source transducer
B/A	=	Fox-Wallace non-linearity parameter
c	=	speed of sound in the measurement liquid (water)
e	=	base of natural logarithms
f	=	frequency
f_t	=	fundamental drive frequency of a signal used to generate non-linear distortion
f_u	=	upper frequency limit of the stated frequency band of a **hydrophone**
F	=	geometric focal length of a focusing transducer
k	=	circular wave number
M_c	=	**end-of-cable open-circuit sensitivity**

[3] Numbers in square brackets refer to the bibliography in annex F.