SLOVENSKI STANDARD
SIST EN 61102:2002
01-september-2002

Measurement and characterisation of ultrasonic fields using hydrophones 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

Messung und Charakterisierung von Ultraschallfeldern mit Hydrophonen im Frequenzbereich von 0,5 MHz bis 15 MHz

Mesurage et caractrisation des champs ultrasonores l'aide d'hydrophones dans la gamme de frquences de 0,5 MHz 15 MHz

Ta slovenski standard je istoveten z: **EN 61102:1993**

ICS:

17.140.50	Elektroakustika	Electroacoustics

SIST EN 61102:2002 **en**

EUROPEAN STANDARD

NORME EUROPEENNE

EUROPÄISCHE NORM

EN 61102

November 1993

UDC 621.396:534.86

Descriptors: Ultrasound, ultrasonic field, hydrophone, measurement

ENGLISH VERSION

Measurement and characterisation of ultrasonic fields using hydrophones in the frequency range 0,5 MHz to 15 MHz (IEC 1102:1991)

Mesurage et caractérisation des champs ultrasonores à l'aide d'hydrophones dans la gamme de fréquences de 0,5 MHz à 15 MHz (CEI 1102:1991)

Messung und Beschreibung von Ultraschallfeldern mit Hydrophonen im Frequenzbereich von 0,5 MHz bis 15 MHz (IEC 1102:1991)

This European Standard was approved by CENELEC on 1993-09-22. 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, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, 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

Ref. No. EN 61102:1993 E

FOREWORD

The CENELEC questionnaire procedure, performed for finding out whether or not the International Standard IEC 1102:1991 could be accepted without textual changes, has shown that no common modifications were necessary for the acceptance as European Standard.

The reference document was submitted to the CENELEC members for formal vote and was approved by CENELEC as EN 61102 on 22 September 1993.

The following dates were fixed:

- latest date of publication of an identical national standard	(dop)	1994-10-01
- latest date of withdrawal of conflicting national standards	(dow)	1994-10-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given only for information.
In this standard, annexes A, B, C, and D are informative and annex ZA is normative.

ENDORSEMENT NOTICE

The text of the International Standard IEC 1102:1991 was approved by CENELEC as a European Standard without any modification.

ANNEX ZA (normative)

OTHER INTERNATIONAL PUBLICATIONS QUOTED IN THIS STANDARD WITH THE REFERENCES OF THE RELEVANT 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.

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

IEC Publication	Date	Title	EN/HD	Date
50(801)	1984	International Electrotechnical Vocabulary (IEV) Chapter 801: Acoustics and electro-acoustics	-	-
469-1	1987	Pulse techniques and apparatus Parat 1: Pulse terms and definitions	-	-
854	1986	Methods of measuring the performance of ultrasonic pulse-echo diagnostic equipment	-	-
866	1987	Characteristics and calibration of hydrophones for operation in the frequency range 0,5 MHz to 15 MHz	-	-

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NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
1102

Première édition
First edition
1991-11

Mesurage et caractérisation des champs ultrasonores à l'aide d'hydrophones dans la gamme de fréquences de 0,5 MHz à 15 MHz

Measurement and characterisation of ultrasonic fields using hydrophones in the frequency range 0,5 MHz to 15 MHz

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE XA

Pour prix, voir catalogue en vigueur
For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MEASUREMENT AND CHARACTERISATION OF ULTRASONIC FIELDS USING HYDROPHONES IN THE FREQUENCY RANGE 0,5 MHz TO 15 MHz

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

This International Standard has been prepared by IEC Technical Committee No. 87: Ultrasonics.

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

Six Months' Rule	Report on Voting
87(CO)6	87(CO)8

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

This International Standard sets out requirements for the performance of ultrasonic hydrophones in addition to those given in IEC 866.

All annexes are informative.

In this standard, the following print types are used:

- requirements and definitions: in roman type;
- NOTES: in smaller roman type;
- *compliance: in italic type;*
- terms used throughout this standard which have been defined in clause 3: **small case roman bold type.**

INTRODUCTION

The main purpose of this International Standard is to define various acoustic parameters which can be used to specify and characterise ultrasonic fields propagating in liquids, and in particular water, using hydrophones. Measurement procedures are outlined which may be used to determine these parameters. There is much in common between this International Standard and the AIUM/NEMA Safety Standard [1]. However, whilst every effort has been made to try to maintain consistency with the AIUM/NEMA Standard, there are fundamental differences in approach.

The philosophy behind this International Standard 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 characterise the field. Of course, if other measurement devices come into use in the future, a new International Standard with additional definitions and procedures will be necessary. Examples of such devices would be thermistors or thermocouples.

Intensity parameters similar to those given in [1] are specified in this International Standard, but these are regarded as derived quantities which are meaningful only under certain assumptions related to the ultrasonic field being measured.

Alternative simplified procedures that may be used when less accuracy is required will be given in an IEC Guidance Document (in preparation).

MEASUREMENT AND CHARACTERISATION OF ULTRASONIC FIELDS USING HYDROPHONES IN THE FREQUENCY RANGE 0,5 MHz TO 15 MHz

1 Scope

This International Standard specifies the methods of use of calibrated piezoelectric hydrophones for the measurement in liquids of acoustic fields generated by ultrasonic medical equipment operating in the frequency range 0,5 MHz to 15 MHz.

The objectives of this International Standard are

– To define a group of acoustic parameters which can be measured on a physically sound basis.

– To define a second group of parameters which can be derived under certain assumptions from these measurements, and called derived intensity parameters.

– To define a measurement procedure which may be used for the determination of acoustic pressure parameters.

– To define the conditions under which the measurements of acoustic parameters can be made in the frequency range 0,5 MHz to 15 MHz using calibrated piezoelectric hydrophones.

NOTE - Throughout this International Standard SI units are used. In the specification of certain parameters, such as beam-areas and intensities, it may be convenient to use other units. For example, beam-area may be specified in cm^2 and intensities in W/cm^2 or mW/cm^2.

2 Normative references

The following standards contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(801): *International Electrotechnical Vocabulary (IEV), Chapter 801: Acoustics and electro-acoustics (1984).*

IEC 469-1: 1987, *Pulse techniques and apparatus - Part 1: Pulse terms and definitions.*

IEC 854: 1986, *Methods of measuring the performance of ultrasonic pulse-echo diagnostic equipment.*

IEC 866: 1987, *Characteristics and calibration of hydrophones for operation in the frequency range 0,5 MHz to 15 MHz.*

3 Definitions

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

3.1 **acoustic pulse crest factor:** Ratio of the **spatial-peak temporal-peak acoustic pressure** to the **r.m.s. acoustic pressure** calculated over the **pulse-peak cycle.** Both pressures are measured at the position in the acoustic field corresponding to the **spatial-peak temporal-peak acoustic pressure.**

3.2 **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. See 2.3.1 of IEC 469-1.

3.3 **acoustic repetition period: Pulse repetition period** for non-automatic scanning systems and the **scan repetition period** for automatic scanning systems. Equal to the time interval between consecutive cycles for continuous-wave systems.

Unit: second, s.

3.4 **acoustic-working frequency (awf):** 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.** The signal is analysed either using the zero-crossing frequency technique or using a spectrum analysis method. The following acoustic-working frequencies are defined:

3.4.1 *Zero-crossing acoustic-working frequency*

This is determined according to the procedure described in IEC 854.

For the spectral analysis method the acoustic pressure versus frequency is displayed and there are three different methods of deriving the acoustic-working frequency which, referring to figure 1, are:

3.4.2 *Arithmetic-mean acoustic-working frequency*

The arithmetic mean of the frequencies f_1 and f_2 at which the amplitude of the acoustic pressure spectrum is 3 dB below the peak amplitude.

3.4.3 *Geometric-mean acoustic-working frequency*

The geometrical mean of the frequencies f_1 and f_2.

3.4.4 *Modal acoustic-working frequency*

The frequency corresponding to the maximum amplitude in the acoustic pressure spectrum.

NOTE - Arithmetic-mean acoustic-working frequency is equivalent to center frequency in [1].

Symbol: f_{awf}
Unit: hertz, Hz.

3.5 **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. (See figure 2.)

3.6 **beam-area:** Area in a specified plane perpendicular to the **beam alignment axis** consisting of all points at which the **pulse-pressure-squared integral** is greater than a specified fraction of the maximum value of the **pulse-pressure-squared integral** in that plane. If the position of the plane is not specified, it is the plane passing through the point of **spatial-peak temporal-peak acoustic pressure** in the whole acoustic field.

The specified levels are 0,25 and 0,01 for the –6 dB and –20 dB beam-areas respectively.

NOTE - The beam-area may be composed of several sections.

Symbol: A_b
Unit: metre squared, m^2.

3.7 **beam-average pulse acoustic pressure:** **Pulse acoustic pressure** from one **ultrasonic transducer** or **ultrasonic transducer element group** averaged over the **–6 dB beam-area** in a specified plane or in a plane containing the **spatial-peak temporal-peak acoustic pressure** for that particular **ultrasonic transducer** or **ultrasonic transducer element group**.

NOTE - –6 dB beam-area is commonly used. However, other beam-areas may be used (see 3.6).

Symbol: p_{bap}
Unit: pascal, Pa.

3.8 beam-average pulse-average intensity: Pulse-average intensity from one ultrasonic transducer or ultrasonic transducer element group averaged over the –6 dB beam-area in a specified plane or in a plane containing the spatial-peak temporal-peak acoustic pressure for that particular ultrasonic transducer or ultrasonic transducer element group.

NOTE - –6 dB beam-area is commonly used. However, other beam-areas may be used (see 3.6).

Symbol: I_{bapa}
Unit: watt per metre squared, W/m^2.

3.9 beam-average r.m.s. acoustic pressure: R.M.S. acoustic pressure from one ultrasonic transducer or ultrasonic transducer element group averaged over the –6 dB beam-area in a specified plane or in a plane containing the spatial-peak temporal-peak acoustic pressure for that particular ultrasonic transducer or ultrasonic transducer element group.

NOTE - –6 dB beam-area is commonly used. However, other beam-areas may be used (see 3.6).

Symbol: p_{bar}
Unit: pascal, Pa.

3.10 beam-average temporal-average intensity: Temporal-average intensity from one ultrasonic transducer or ultrasonic transducer element group averaged over the –6 dB beam-area in a specified plane or in a plane containing the spatial-peak temporal-peak acoustic pressure for that particular ultrasonic transducer or ultrasonic transducer element group.

NOTE - –6 dB beam-area is commonly used. However, other beam-areas may be used (see 3.6).

Symbol: I_{bata}
Unit: watt per metre squared, W/m^2.

3.11 central scan line: For automatic scanning systems, the ultrasonic scan line closest to the symmetry axis of the scan plane.

3.12 effective area of an ultrasonic transducer: Area of a perfect piston-like ultrasonic transducer which has a predicted axial acoustic pressure distribution approximately equivalent to the observed axial acoustic pressure distribution over a limited axial distance, see IEC 866.

Symbol: A_1
Unit: metre squared, m^2.

3.13 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.