

SLOVENSKI STANDARD oSIST prEN IEC 62127-3:2022

01-maj-2022

Ultrazvok - Hidrofoni - 3. del: Lastnosti hidrofonov za ultrazvočna polja

Ultrasonics - Hydrophones - Part 3: Properties of hydrophones for ultrasonic fields

Ultraschall - Hydrophone - Teil 3: Eigenschaften von Hydrophonen zur Verwendung in Ultraschallfeldern **iTeh STANDARD**

Ultrasons - Hydrophoes - Partie 3: Propriétés des hydrophones pour les champs ultrasoniques jusqu'à 40 MHz

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Ta slovenski standard je istoveten z: prEN IEC 62127-3:2022

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ICS:	https://standards.iteh.ai/catalog/standards/sist/bd834bdf- ab85-4ad8-a701-86a5928a0d7c/osist-pren-iec-62127-3- CS: 2022			
11.040.01	Medicinska oprema na splošno	Medical equipment in general		
17.140.50	Elektroakustika	Electroacoustics		

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en

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87/786/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: IEC 62127-3 ED2	
DATE OF CIRCULATION: 2022-02-25	CLOSING DATE FOR VOTING: 2022-05-20
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IEC TC 87 : ULTRASONICS				
Secretariat:	SECRETARY:			
United Kingdom	Mr Petar Luzajic			
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD:			
PRI	Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.			
FUNCTIONS CONCERNED:	QUALITY ASSURANCE			
SUBMITTED FOR CENELEC PARALLEL VOTING	NOT SUBMITTED FOR CENELEC PARALLEL VOTING			
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Attention IEC-CENELEC parallel voting about 2011-86a5928a0d7c/osist-pren-iec-62127-3-				
The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.	2022			
The CENELEC members are invited to vote through the CENELEC online voting system.				

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TITLE:

Ultrasonics - Hydrophones - Part 3: Properties of hydrophones for ultrasonic fields

PROPOSED STABILITY DATE: 2025

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58 59		INTERNATIONAL EL	ECTROTECHNICAL	
60 61 62		ULTRASON	IICS – HYDROPHO	NES –
63 64		Part 3: Properties of	hydrophones for ι	ıltrasonic fields
65			FOREWORD	
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99 100	Th arr	is second edition cancels and rep nendment 1 (2013-05). This edition c	places the first edition onstitutes a technical re	published in 2007-08 and its evision.
101 102	Th ed	is edition includes the following sig ition:	nificant technical chang	ges with respect to the previous
103	a)	The upper frequency limit of 40 MH	lz has been removed;	
104 105	b)	Hydrophone sensitivity definitions h complex-valued quantities;	nave been changed to r	ecognize sensitivities as
106 107	c)	Procedures to determine the effect the rationale outlined in Annex B;	ive hydrophone size ha	ve been changed according to
108 109	d)	Requirements on the frequencies for provided have been changed to ac	or which the effective hy hieve practicality for inc	ydrophone size shall be reased frequency bands;
110	e)	The new Annexes B and C have be	en added;	
111	f)	Annex A has been updated to refle	ct the changes of the no	ormative parts.

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- 113 International Standard IEC 62127-3 has been prepared by IEC technical committee 87:114 Ultrasonics.
- 115 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

116 A list of all parts of IEC 62127 series, published under the general title *Ultrasonics* – 117 *Hydrophones*, can be found on the IEC website.

118 NOTE Words in **bold** in the text are defined in Clause 3.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the maintenance result date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- 123 reconfirmed,
- 124 withdrawn,
- 125 replaced by a revised edition, or
- 126 amended.

127

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130

INTRODUCTION

131 The spatial and temporal distribution of acoustic pressure in an ultrasonic field in a liquid 132 medium is commonly determined using miniature ultrasonic hydrophones. The properties of these **hydrophones** have been dealt with in a number of IEC standards in various aspects. 133 134 The purpose of this part of IEC 62127 is to bring together all these specifications and to 135 establish a common standard on the properties of ultrasonic hydrophones. The main 136 hydrophone application in this context is the measurement of ultrasonic fields emitted by medical diagnostic equipment in water. Other medical applications are field measurements for 137 138 therapy equipment such as that used in lithotripsy, high-intensity focused ultrasound (HIFU) 139 and physiotherapy. Hydrophones are also used extensively in non-medical applications for 140 both product development and quality control including:

- 141 mapping of the ultrasound field within ultrasonic cleaning baths;
- 142 characterization of acoustic fields used in transmission measurement systems (e.g.
 143 ultrasonic spectrometers, ultrasonic attenuation meters and velocimeters);
- 144 characterization of acoustic fields used in reflection measurement systems (e.g. Doppler
 145 flowmeters).

146 While the term "hydrophone" can be used in a wider sense, it is understood here as referring 147 to miniature piezoelectric **hydrophones**. It is this instrument type that is used today in various 148 areas of ultrasonics and, in particular, to quantitatively characterize the field structure of 149 medical diagnostic instruments. With regard to other pressure sensor types, such as those 150 based on fibre optics, some of the requirements of this standard are applicable to these as well but others are not. If in the future these other "hydrophone" types gain more importance 151 in field measurement practice, their properties will have to be dealt with in a revised version of 152 153 this document or in a separate one.

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Underwater **hydrophones** as covered by IEC 60500, IEC 60565-1, and IEC 60565-2 are not included in this document, although there is an overlap in the frequency ranges. Underwater **hydrophones** are used in natural waters, leven in the frequency ranges. Underwater technical concepts and requirements is addition/the maih/direction of acoustic incidence in underwater applications is at various angles and/often at right angles to the **hydrophone axis**, whereas this standard it is assumed that the main direction of acoustic incidence is in the direction of the **hydrophone axis**.

Historically, ultrasonic hydrophones were used almost exclusively as amplitude sensors. However, the complex-valued nature of a hydrophone's system response function is well understood and IEC 62127-1 Ed 2 makes use of this within the deconvolution procedures it contains. In this document, requirements are specified for the amplitude aspect of the hydrophone sensitivity and recommendations are provided for the phase aspect which can be derived either via calibration, or via calculation methods that are discussed in IEC 62127-1 Ed 2.

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- 169 ULTRASONICS HYDROPHONES –
 170
 171 Part 3: Properties of hydrophones for ultrasonic fields
 172
- 173 **1 Scope**
- 174 This part of IEC 62127 specifies relevant **hydrophone** characteristics.
- 175 This standard is applicable to:
- hydrophones employing piezoelectric sensor elements, designed to measure the pulsed
 and continuous wave ultrasonic fields generated by ultrasonic equipment;
- 178 hydrophones used for measurements made in water;
- 179 **hydrophones** with or without an associated pre-amplifier.

180 2 Normative references

- 181 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.
- 184 IEC 62127-1, Ultrasonics Hydrophones Part 1: Measurement and characterization of 185 medical ultrasonic fields up to 40 MHz (standards.iteh.ai)
- 186 IEC 62127-2, Ultrasonics Hydrophones Part 2: Calibration for ultrasonic fields up to 187 40 MHz

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188 3 Terms, definitions and symbols 928a0d7c/osist-pren-iec-62127-3-

2022

- For the purposes of this document, the terms and definitions given in IEC 62127-1,
 IEC 62127-2 and the following apply.
- 191 ISO and IEC maintain terminological databases for use in standardization at the following192 addresses:
- 193 IEC Electropedia: available at http://www.electropedia.org/
- 194 ISO Online browsing platform: available at http://www.iso.org/obp
- 195 **3.1**

196 acoustic pulse waveform

- 197 temporal waveform of the **instantaneous acoustic pressure** at a specified position in an 198 acoustic field and displayed over a period sufficiently long to include all significant acoustic 199 information in a single pulse or tone-burst, or one or more cycles in a continuous wave
- 200 Note 1 to entry: Temporal waveform is a representation (e.g. oscilloscope presentation or formula) of the 201 instantaneous acoustic pressure.
- 202 [SOURCE: IEC 62127-1:2007 and Amendment 1:2013, definition 3.1]

203 **3.2**

204 directional response

description 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 reference centre and at a
 specified frequency

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- 8 -

- 208 NOTE 1 Definition adopted from IEC 60565:2006.
- 209 NOTE 2 Whilst directional response is a complex-valued function, it is generally the magnitude of directional 210 response that is of most interest and this commonly presented graphically.

211 3.3

212 effective hydrophone size

213 a_{h}

214 size of a theoretical receiver hydrophone that has a predicted directional response function 215 with an angular width equal to the observed angular width

- 216 NOTE 1 The size is usually the function of frequency. For representative experimental data, see [1].
- 217 NOTE 2 The effective hydrophone size is expressed in metres (m).
- 218 NOTE 3 For hydrophones with a circular geometry, the effective hydrophone size is a radius.
- 219 NOTE 4 For hydrophones with a rectangular geometry, the effective hydrophone size is the half the greatest 220 value of the length or width.

221 3.4

222 electric load impedance

223 <u>Z</u>L

complex electric input impedance (consisting of a real and an imaginary part) to which the 224 225 hydrophone or hydrophone assembly output is connected or is to be connected

KĽ

NOTE The electric load impedance is expressed in ohms (Ω). 226

227 3.5

228

end-of-cable (standards.iteh.ai) specification that relates to the end of the integral output cable if the hydrophone or 229 230 hydrophone assembly is provided with such a cable and if the hydrophone or hydrophone 231 assembly is not provided with an integral output cable, the specification relates to the output 232 connector firmly connected with the hydrophone or hydrophone assembly, not to an extra 233 cable

234 3.6

235 end-of-cable loaded sensitivity

236 $M_1(f)$

<of a hydrophone or hydrophone assembly> quotient of the Fourier transformed 237 238 **hydrophone** voltage-time signal $\mathcal{F}(u_1(t))$ at the end of any integral cable or output connector 239 of a hydrophone or hydrophone-assembly, when connected to a specified electric load 240 **impedance**, to the Fourier transformed **acoustic pulse waveform** $\mathcal{F}(p(t))$ in the undisturbed free field of a plane wave in the position of the reference centre of the hydrophone if the 241 242 hydrophone were removed

243
$$\underline{M}_{L}(f) = \frac{\mathcal{F}(u_{L}(t))}{\mathcal{F}(p(t))}$$
(1)

244 Note 1 to entry: The end-of-cable loaded sensitivity is a complex-valued parameter. Its modulus is expressed 245 246 in units of volt per pascal (V/Pa), its phase angle is expressed in degrees, and represents the phase difference between the electrical voltage and the sound pressure.

247 3.7

248 end-of-cable open-circuit sensitivity

- 249 $\underline{M}_{c}(f)$
- 250 <of a hydrophone> quotient of the Fourier transformed hydrophone open-circuit voltage-251 time signal $\mathcal{F}(u_c(t))$ at the end of any integral cable or output connector of a hydrophone to
- 252 the Fourier transformed acoustic pulse waveform $\mathcal{F}(p(t))$ in the undisturbed free field of a

-9-

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253 plane wave in the position of the **reference centre** of the **hydrophone** if the **hydrophone** 254 were removed

255
$$\underline{M}_{c}(f) = \frac{\mathcal{F}(u_{c}(t))}{\mathcal{F}(p(t))}$$
(2)

Note 1 to entry: The end-of-cable open-circuit sensitivity is a complex-valued parameter. Its modulus is expressed in units of volt per pascal (V/Pa), its phase angle is expressed in degrees, and represents the phase difference between the electrical voltage and the sound pressure.

259 **3.8**

260 end-of-cable loaded sensitivity level

261 $L_{M_{L}}(f)$

262 <of a hydrophone or hydrophone assembly> twenty times the logarithm to the base 10 of 263 the quotient of the modulus of the end-of-cable loaded sensitivity $|\underline{M}_{L}(f)|$ to a reference 264 sensitivity M_{ref}

265
$$L_{M_{L}}(f) = 20\log_{10}\frac{\left|\underline{M}_{L}(f)\right|}{M_{ref}}dB$$
(3)

- 266 Note 1 to entry: Commonly used values of the reference sensitivity M_{ref} are 1V/µPa or 1V/Pa.
- 267 Note 2 to entry: The end-of-cable loaded sensitivity level is expressed in decibels (dB).

268 **3.9**

269 free field

sound field in a homogeneous and isotropic medium in which the effects of boundaries are
 negligible

PREVIEW

272 Note 1 to entry: Definition adopted from JEC 60565:2006 3,13,127-3:2022

- 273 3.10 https://standards.iteh.ai/catalog/standards/sist/bd834bdf-
- hydrophone geometrical size 701-86a5928a0d7c/osist-pren-iec-62127-3-
- 275 geometrical size of a hydrophone active element
- 276 a_g

size defined by the lateral extents of the active element of a hydrophone

- 278 Note 1 to entry: The hydrophone geometrical size is expressed in metres (m).
- 279 Note 2 to entry: For hydrophones with a circular geometry, the hydrophone geometrical size is a radius.
- 280 Note 3 to entry: For hydrophones with a rectangular geometry, the hydrophone geometrical size is a half the greatest value of the length or width.
- 282 **3.11**
- 283 hydrophone
- transducer that produces electric signals in response to waterborne acoustic signals
- 285 [SOURCE: IEV 801-32-26]
- 286 **3.12**

287 hydrophone assembly

288 combination of hydrophone and hydrophone pre-amplifier

289 **3.13**

290 hydrophone axis

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

Note 1 to entry: 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**.

	87/786/CD	/	– 10 –	IEC CDV 62127-3 © IEC:2022
294 295 296 297	3.14 hydrophon active elect reducing its	e pre-amplifier tronic device connected to, or soutput impedance	to be connected to,	a particular hydrophone and
298	Note 1 to entr	y: A hydrophone pre-amplifier requ	ires a supply voltage (or	supply voltages).
299 300	Note 2 to entr i.e. it need no	y: The hydrophone pre-amplifier ma t necessarily be a voltage amplifier in th	ay have a forward voltage ne strict sense.	e transmission factor of less than one,
301 302 303	3.15 reference of point on or	c entre near a hydrophone about whicl	n its acoustic receivi	ng sensitivity is defined
304 305 306	Note 1 to entr the purposes active elemen	y: Unless stated otherwise (explicitly of this standard that this is given by the t.	r and quantitatively) by t he geometrical centre of	he manufacturer, it is understood for the front surface of the hydrophone
307	Note 2 to entr	y: Definition adopted from IEC 60565	:2006, 3.25.	
308 309 310 311	3.16 uncertainty parameter, the values t	y associated with the result of a that could reasonably be attribut	measurement, that o ed to the measuranc	characterizes the dispersion of
312	Note 1 to entr	y: See the ISO Guide to the Express	on of Uncertainty in Mea	surement [2], 2.2.3
313	Note 2 to entr	y: Definition adopted from IEC 62127		
314		ΓΝ		
315		(standa	rds.iteh.a	i)
316	4 List of	symbols <u>oSIST prEN</u>	<u>I IEC 62127-3:2022</u>	
317 318	a _g a _h	hydrophone geometrical size ab85-4ad8-a701-86a592 effective hydrophone size	catalog/standards/sis 28a0d7c/osist-pren-ic 2022	t/bd834bdf- ec-62127-3-
319	С	speed of sound in a medium	2022	
320 321	D _H	model function used during the a measured directional respor	determination of ef ise of a hydrophon	fective hydrophone size from e
322	f	frequency		
323	k	wavenumber = $2\pi / \lambda$		
324	$L_{M_{L}}(f)$	end-of-cable loaded sensitivit	y level	
325 326	<u>M</u>	general symbol for the comp modulus and $\arg(\underline{M})$ being its a	olex hydrophone s rgument (= phase ar	sensitivity, $M = \underline{M} $ being its ngle)
327	<u>M</u> c	end-of-cable open-circuit sensit	ivity	
328	<u>M</u> L	end-of-cable loaded sensitivity		
329	\underline{Z}_{h}	complex electric output impeda	nce of a hydrophon	e or hydrophone assembly
330	<u>Z</u> L	electric load impedance		
331	θ	angle of incidence of an ultraso	nic wave with respec	ct to the hydrophone axis
332				