



IEC 62127-3

Edition 2.0 2022-12  
REDLINE VERSION

# INTERNATIONAL STANDARD



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**Ultrasonics – Hydrophones –  
Part 3: Properties of hydrophones for ultrasonic fields ~~up to 40 MHz~~**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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ICS 17.140.50

ISBN 978-2-8322-6313-6

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## ULTRASONICS – HYDROPHONES –

Part 3: Properties of hydrophones for ultrasonic fields **up to 40 MHz**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). 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. 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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**This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62127-3:2007+AMD1:2013 CSV. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.**

IEC 62127-3 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 to determine the effective hydrophone size have been changed according to the rationale outlined in Annex B.
- d) Requirements on the frequencies for which the effective hydrophone size shall be provided have been changed to achieve practicality for increased frequency bands.
- e) The new Annex B and Annex C have been added.
- f) Annex A has been updated to reflect the changes of the normative parts.

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

Draft	Report on voting
87/818/FDIS	87/824/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/publications](http://www.iec.ch/publications).

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**IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## 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 properties of these **hydrophones** have been dealt with in a number of IEC standards in various aspects. The purpose of this document is to bring together all these specifications and to establish a common standard on the properties of ultrasonic **hydrophones**. The main **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 therapy equipment such as that used in lithotripsy, high-intensity focused ultrasound (HIFU) and physiotherapy. **Hydrophones** are also used extensively in non-medical applications for both product development and quality control including:

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

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

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, even in the ocean, and this leads to different technical concepts and requirements. In addition, the main direction of acoustic incidence in underwater applications is ~~typically~~ at various angles and often at right angles to the **hydrophone axis**, whereas in this document it is assumed that the main direction of acoustic incidence is in the direction of the **hydrophone axis**.

~~In the past, ultrasonic **hydrophones** have been applied almost exclusively as amplitude sensors. At present a change can be seen and it is increasingly considered useful to have additional phase information, which, however, is only possible if the phase characteristics of the **hydrophone** have been determined during calibration. In this standard, therefore, requirements are specified for the amplitude aspect of the **hydrophone** sensitivity, and recommendations are provided for the phase aspect, as an option to be considered.~~

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 62127-1:2022 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 62127-1:2022.

## ULTRASONICS – HYDROPHONES –

### Part 3: Properties of hydrophones for ultrasonic fields ~~up to 40 MHz~~

#### 1 Scope

This part of IEC 62127 specifies relevant **hydrophone** characteristics.

This document 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;
- **hydrophones** with or without an associated pre-amplifier.

#### 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 62127-1, *Ultrasonics – Hydrophones – Part 1: Measurement and characterization of medical ultrasonic fields* ~~up to 40 MHz~~

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

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



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**Ultrasonics – Hydrophones –  
Part 3: Properties of hydrophones for ultrasonic fields**

**Ultrasons – Hydrophones –  
Partie 3: Propriétés des hydrophones pour les champs ultrasoniques**





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# INTERNATIONAL ELECTROTECHNICAL COMMISSION

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## ULTRASONICS – HYDROPHONES –

### Part 3: Properties of hydrophones for ultrasonic fields

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## COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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### ULTRASONS – HYDROPHONES –

#### Partie 3: Propriétés des hydrophones pour les champs ultrasoniques

##### AVANT-PROPOS

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L'IEC 62127-3 a été établie par le comité d'études 87 de l'IEC: Ultrasons. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2007 et son amendement 1:2013. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente.

- a) La limite de fréquence supérieure de 40 MHz a été supprimée.
- b) Les définitions de la sensibilité de l'hydrophone ont été modifiées afin de reconnaître les sensibilités comme des grandeurs à valeur complexe.
- c) Les procédures de détermination de la taille efficace de l'hydrophone ont été modifiées conformément à la justification donnée à l'Annexe B.

- d) Les exigences relatives aux fréquences pour lesquelles doit être fournie la taille efficace de l'hydrophone ont été modifiées afin de tenir compte des bandes de fréquences supérieures.
- e) De nouvelles annexes ont été ajoutées (Annexe B et Annexe C).
- f) L'Annexe A a été mise à jour afin de refléter les modifications apportées aux parties normatives.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
87/818/FDIS	87/824/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). Les principaux types de documents développés par l'IEC sont décrits plus en détail sous [www.iec.ch/publications](http://www.iec.ch/publications).

Une liste de toutes les parties de la série IEC 62127, publiées sous le titre général *Ultrasons – Hydrophones*, se trouve sur le site web de l'IEC.

NOTE Les termes en **gras** dans le texte sont définis à l'Article 3.

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## INTRODUCTION

La répartition spatiale et temporelle de la pression acoustique d'un champ ultrasonique en milieu liquide est généralement déterminée à l'aide d'**hydrophones** à ultrasons miniatures. Les propriétés de ces **hydrophones** ont été traitées sous différents aspects dans plusieurs normes de l'IEC. Le présent document a pour objet de compiler l'ensemble de ces spécifications et d'établir une norme commune pour les propriétés des **hydrophones** à ultrasons. Dans ce cadre, la principale application des **hydrophones** est la mesure des champs ultrasoniques émis par les appareils de diagnostic médical immergés dans l'eau. D'autres applications médicales consistent à mesurer les champs des appareils de thérapie comme ceux utilisés en lithotritie, en ultrasons focalisés de haute intensité (UFHI) et en physiothérapie. Les **hydrophones** sont également utilisés couramment dans les applications non médicales pour le développement de produits et le contrôle qualité, notamment:

- la cartographie du champ ultrasonique dans les bains de nettoyage à ultrasons;
- la caractérisation des champs acoustiques utilisés dans les systèmes de mesure de la transmission (spectromètres à ultrasons, appareils de mesure d'affaiblissement ultrasoniques et vélocimètres, par exemple);
- la caractérisation des champs acoustiques utilisés dans les systèmes de mesure par réflexion (débitmètres Doppler, par exemple).

Si le terme **hydrophone** peut être utilisé dans un sens plus large, il fait référence ici aux **hydrophones** piézoélectriques miniatures. Il s'agit d'un type d'instrument de mesure utilisé aujourd'hui dans différents domaines des ultrasons, notamment pour caractériser de manière quantitative la structure du champ des instruments de diagnostic médical. Concernant les autres types de capteurs de pression, comme les capteurs fibroniques, certaines exigences du présent document s'appliquent à des capteurs particuliers seulement. Si les méthodes de mesure de champ ultérieures privilégient d'autres types d'**hydrophones**, leurs propriétés devront être traitées dans une version révisée du présent document ou dans un document distinct.

Les **hydrophones** en milieu sous-marin couverts par l'IEC 60500, l'IEC 60565-1 et l'IEC 60565-2 ne sont pas traités dans le présent document, malgré un chevauchement dans les plages de fréquences. Les **hydrophones** en milieu sous-marin sont utilisés en eaux naturelles, et même dans l'océan, ce qui aboutit à différents concepts techniques et différentes exigences. En outre, la direction principale de l'incidence acoustique dans les applications sous-marines est décrite par plusieurs angles et souvent par des angles droits par rapport à l'**axe de l'hydrophone**, alors que le présent document admet par hypothèse que la direction principale de l'incidence acoustique est la direction de l'**axe de l'hydrophone**.

Historiquement, les **hydrophones** à ultrasons étaient pratiquement utilisés exclusivement comme détecteurs d'amplitude. Cependant, la nature à valeur complexe de la fonction de réponse du système d'un **hydrophone** est bien comprise et l'IEC 62127-1:2022 l'utilise dans ses procédures de déconvolution. Dans le présent document, les exigences sont spécifiées en se fondant sur les aspects liés à l'amplitude de la sensibilité de l'**hydrophone** et des recommandations sont fournies pour les aspects liés à la phase qui peut être déterminée par étalonnage ou à l'aide des méthodes de calcul décrites dans l'IEC 62127-1:2022.

## ULTRASONS – HYDROPHONES –

### Partie 3: Propriétés des hydrophones pour les champs ultrasoniques

#### 1 Domaine d'application

La présente partie de l'IEC 62127 spécifie les caractéristiques pertinentes des **hydrophones**.

Le présent document s'applique:

- aux **hydrophones** qui utilisent des capteurs piézoélectriques conçus pour mesurer les champs ultrasoniques à ondes par impulsions et entretenues générés par les appareils à ultrasons;
- aux **hydrophones** utilisés pour les mesurages réalisés dans l'eau;
- aux **hydrophones** avec ou sans préamplificateur associé.

#### 2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition mentionnée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 62127-1, *Ultrasons – Hydrophones – Partie 1: Mesurage et caractérisation des champs ultrasoniques médicaux*

IEC 62127-2, *Ultrasons – Hydrophones – Partie 2: Étalonnage des champs ultrasoniques jusqu'à 40 MHz*