

Specification for

Hydrophones for calibration purposes

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- Institution of Electronic and Radio Engineers
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- British Institute of Radiology
- Electro Medical Trade Association Limited
- Engineering Industries' Association
- Hospital Physicists' Association
- Institute of Larynology and Otology
- Medical Research Council
- University of Salford

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Contents

	Page
Cooperating organizations	Inside front cover
National foreword	ii
1 Scope	1
2 Purpose	1
3 Terminology	1
4 Introduction	1
5 Sensitivity	1
6 Electrical requirements	1
7 Mechanical requirements	1
7.1 Element suspension	1
7.2 Directivity	2
7.3 Metal parts exposed to the immersion medium	2
8 Information to be supplied by the manufacturer	2
8.1 Free-field voltage sensitivity	2
8.2 Directivity	3
8.3 Sensor element	3
8.4 Electrical parameters	3
8.5 Mechanical parameters	3
8.6 Environmental factors	3
Appendix A	4
Publications referred to	Inside back cover

National foreword

This British Standard has been prepared under the direction of the Electronic Equipment Standards Committee. It is identical with Publication 500:1974 “*IEC standard hydrophone*” published by the International Electrotechnical Commission (IEC).

Terminology and conventions. The text of the International Standard has been approved as suitable for publication, without deviation, as a British Standard. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

Wherever the words “IEC Recommendation” or “Publication” appear, referring to this standard, they should be interpreted as “British Standard”. The IEC recommendation for calibration of hydrophones, referred to in the note to **7.1**, has been published as IEC 565:1977.

Cross-references

International Standard	Corresponding British Standard
IEC 565:1977	BS 5652:1978 <i>Specification for the calibration of hydrophones</i> (Identical)
ISO/R 266 ^a	BS 3593:1963 <i>Recommendation on preferred frequencies for acoustical measurements</i> (Technically equivalent)

^a Since the publication of IEC 500, ISO/R 266 has been revised as ISO 266:1975.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This recommendation covers the design requirements of standard piezoelectric hydrophones and the data required to specify their characteristics.

2 Purpose

Requirements and characteristics are given to specify a hydrophone which is suitable as an *IEC standard hydrophone* for calibration purposes, to be used as a laboratory standard for comparison with other hydrophones intended for daily use.

3 Terminology

The acoustical and electrical terminology of the International Electrotechnical Vocabulary shall be used wherever possible.

4 Introduction

The requirements for a standard hydrophone to be used as a reference for underwater sound pressure levels are mainly concerned with its free-field open-circuit voltage sensitivity.

The following general specifications shall apply:

4.1 Over a frequency range of at least 3 decades the sensitivity level shall be constant within ± 1.5 dB.

Generally, the lower limit of this frequency range will not be lower than 1 Hz and the upper limit will not exceed 100 kHz.

4.2 Between the temperatures of 5 °C and 25 °C, the sensitivity level shall not deviate by more than ± 0.5 dB from the value at 15 °C.

4.3 Within a dynamic range of 60 dB, the output voltage of the hydrophone shall be linear with the free-field sound pressure within ± 0.5 dB.

4.4 At any depth between 0 and 10 metres, the sensitivity level shall not differ by more than ± 0.5 dB from the nominal value.

4.5 The stability of the hydrophone shall be such that a calibration can be trusted over a period of at least one year. Therefore the hydrophone should preferably be recalibrated at intervals not longer than one year.

4.6 The sensor shall be of the piezoelectric type. See Appendix A, Sub-clause A.1.2.

5 Sensitivity

Over the specified frequency and dynamic ranges, the free-field open-circuit voltage sensitivity level of the standard hydrophone shall be between -180 dB and -200 dB *re* 1 V per μPa (or -80 dB and -100 dB *re* 1 V per μbar).

NOTE The frequency response curve of a piezoelectric hydrophone has a flat part, limited at the lower frequency end by the lower cut-off frequency due to the capacitance of the piezoelectric element and the resistive load on this capacitance. At the higher frequency end, the sensitivity may change either by diffraction effects or as a result of mechanical resonance of the sensor element.

Approximately one octave below this resonance frequency, the frequency response curve starts to rise. In accordance with Sub-clause 4.1, the deviation in the flat part of the frequency response curve shall be less than 3 dB over at least three frequency decades. Hence the lower cut-off frequency and the resonance frequency shall be at least four decades apart.

6 Electrical requirements

The hydrophone shall be connected to a shielded cable with a length of at least 10 m.

The end-of-cable leakage resistance shall be at least 100 M Ω (test voltage 100 V).

Electrical shielding of the high impedance sensor element shall be provided and exposed metal parts of the hydrophone housing and shield shall be connected to the cable shield. If the sensor element has a capacitance smaller than the capacitance of the cable, a preamplifier shall be incorporated.

For the calibration of a complete signal measuring system, a resistor of 1 Ω to 10 Ω shall be inserted between the sensor element and the lower side of the preamplifier input. Insertion of a calibrated electrical signal across this resistor through two wires in the cable, independent of the preamplifier output circuit, yields an overall calibration of the hydrophone, analyser, tape recorder or other auxiliary equipment. In any case, the sensor element earth connection shall be kept separate from the hydrophone case and cable shield.

Long cables at higher frequency will alter the measured end-of-cable open circuit voltage due to cable losses and standing waves. Under these conditions, a cable terminated at each end by its characteristic impedance shall be used.

Both sides of the calibration resistor shall be connected to separate wires in the cable, so that the calibration current does not flow through the earth lead of the output signal, nor through the cable shield. Cross-talk between the calibration signal and the output signal shall be less than -40 dB.

NOTE Calibration of the system by the insert voltage technique is valid only when the shunt capacitance of the cable has an impedance much greater than the insert resistance.

7 Mechanical requirements

7.1 Element suspension

The suspension of the sensor element shall be such that the frequency of mechanical resonance, caused by the mass of the element and the compliance of the suspension, falls below the specified frequency range.