

# INTERNATIONAL STANDARD

**Ultrasonics – Physiotherapy systems – Field specifications and methods of measurement in the frequency range 0,5 MHz to 5 MHz**

(<https://standards.iteh.ai>)

Document Preview

IEC 61689:2007

<https://standards.iteh.ai/catalog/standards/iec/2821b747-120c-4ceb-98ce-16c76460e8dd/iec-61689-2007>

WITHDRAWN



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2007 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
Web: [www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

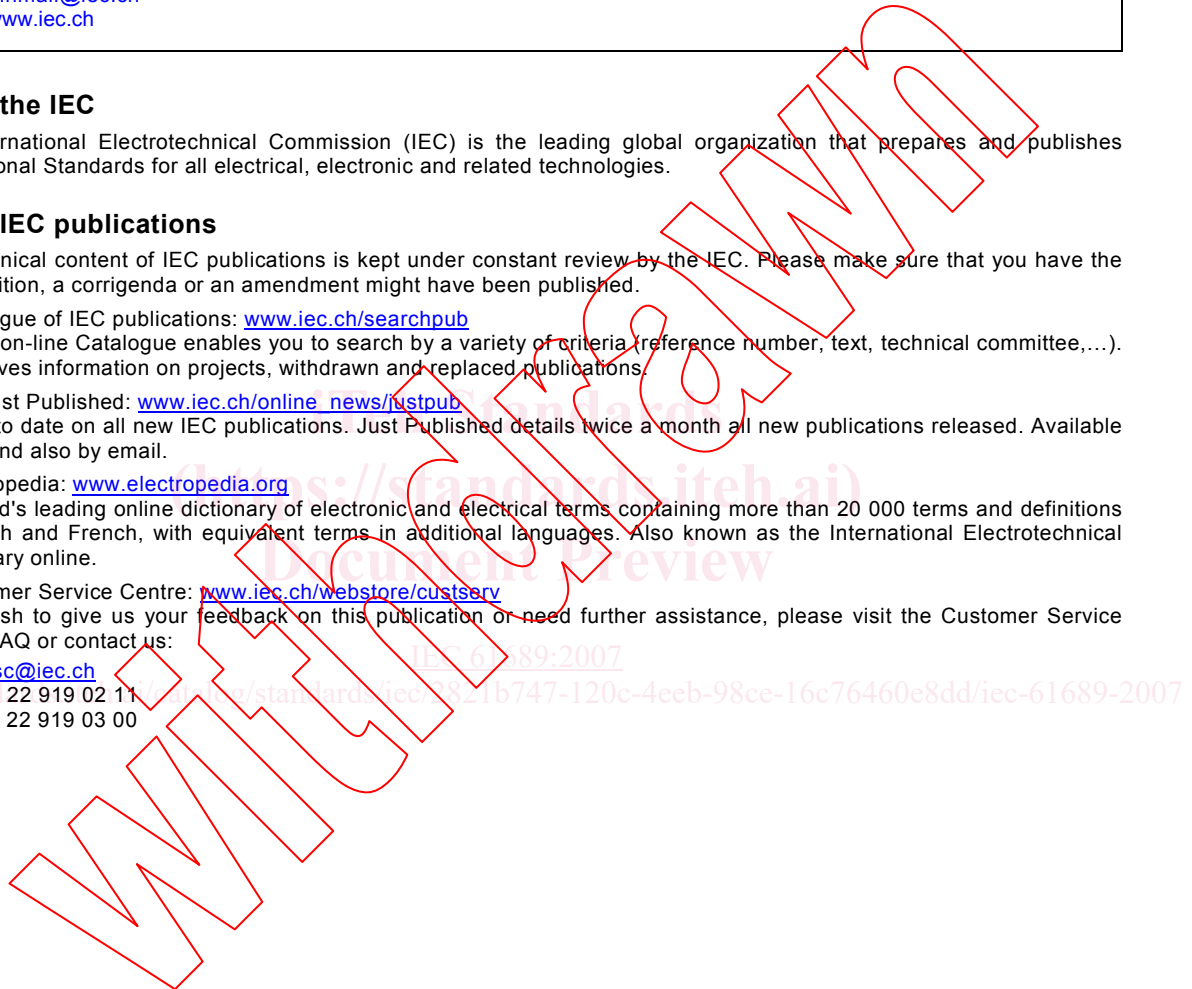
- Customer Service Centre: [www.iec.ch/webstore/custserv](http://www.iec.ch/webstore/custserv)

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: [csc@iec.ch](mailto:csc@iec.ch)

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00



<https://standards.iteh.ai/document/iec-61689-2007>  
<https://www.iec.ch/standards/iec-61689-2007>

# INTERNATIONAL STANDARD

**Ultrasonics – Physiotherapy systems – Field specifications and methods of measurement in the frequency range 0,5 MHz to 5 MHz**

(<https://standards.iteh.ai>)  
Document Preview

IEC 61689:2007

<https://standards.iteh.ai/en/standards/iec/2821b747-120c-4ceb-98ce-16c76460e8dd/iec-61689-2007>

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

PRICE CODE **XB**

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Terms and definitions .....	8
4 List of symbols .....	15
5 Ultrasonic field specifications .....	16
6 Conditions of measurement and test equipment used .....	17
6.1 General.....	17
6.2 Test vessel.....	18
6.3 Hydrophone.....	18
6.4 RMS or peak signal measurement.....	18
7 Type testing reference procedures and measurements.....	19
7.1 General.....	19
7.2 Rated output power .....	19
7.3 Hydrophone measurements.....	19
7.4 Effective radiating area .....	20
7.5 Reference type testing parameters.....	22
7.6 Acceptance criteria for reference type testing.....	22
8 Routine measurement procedure.....	23
8.1 General.....	23
8.2 Rated output power.....	23
8.3 Effective radiating area .....	23
8.4 Beam non-uniformity ratio.....	24
8.5 Effective intensity.....	24
8.6 Acceptance criteria for routine testing .....	24
9 Sampling and uncertainty determination.....	24
9.1 Reference type testing measurements.....	24
9.2 Routine measurements.....	24
9.3 Uncertainty determination.....	25
Annex A (informative) Guidance for performance and safety.....	26
Annex B (normative) Raster scan measurement and analysis procedures.....	31
Annex C (normative) Diametrical or line scan measurement and analysis procedures.....	33
Annex D (informative) Rationale concerning the beam cross-sectional area definition.....	36
Annex E (informative) Factor used to convert the beam cross-sectional area ( $A_{BCS}$ ) at the face of the treatment head to the effective radiating area ( $A_{ER}$ ).....	42
Annex F (informative) Determining acoustic power through radiation force measurements.....	44
Annex G (informative) The validity of low-power measurements of the beam cross-sectional area ( $A_{BCS}$ ).....	46
Annex H (informative) Influence of hydrophone effective diameter .....	47
Annex I (informative) Effective radiating area measurement using a radiation force balance and absorbing apertures.....	49
Annex J (informative) Guidance on uncertainty determination .....	59

Bibliography.....	61
Figure A.1 – The normalized, time-averaged values of the acoustic intensity (unbroken line) and of one of its plane-wave approximations (broken line), existing on the axis of a circular piston source of $ka = 30$ , versus the normalized distance $s$ , where $s = \lambda z/a^2$ .....	29
Figure A.2 – Histogram of $R_{BN}$ values for 37 treatment heads of various diameter and frequency.....	30
Figure D.1 – Iso-pressure lines of a typical physiotherapy treatment head of small geometrical area ( $ka = 17$ ) .....	38
Figure D.2 – Plot of beam cross-sectional area against different limit values for a small variation in distance along the beam alignment axis, $z$ .....	39
Figure D.3 – Normalized values of beam cross-sectional area for IEC and FDA limit values for five transducers of different $ka$ values, $z = 0,5$ cm .....	40
Figure D.4 – Variation of the beam cross-sectional area ( $A_{BCS}$ ) with distance from the face of the treatment head .....	41
Figure D.5 – Variation of the normalized beam cross-sectional area ( $A_{BCS}$ ) with transducer $ka$ .....	41
Figure E.1 – Conversion factor $F_{ac}$ as a function of the $ka$ product for $ka$ product between 40 and 160 .....	43
Figure I.1 – Schematic representation of aperture measurement set-up .....	49
Figure I.2 – Measured power as a function of aperture diameter for commercially-available 1 MHz physiotherapy treatment heads .....	54
Figure I.3 – Cumulative sum of annular power contributions, previously sorted in descending order of intensity contribution, plotted against the cumulative sum of their respective annular areas .....	57
Table C.1 – Constitution of the transformed array $[B]$ used for the analysis of half-line scans .....	34
Table F.1 – Necessary target size, expressed as the minimum target radius $b$ , as a function of the ultrasonic frequency, $f$ , the effective radius of the treatment head, $a_1$ , and the target distance, $z$ , calculated according to 5.3 of IEC 61161 (see [5])......	45
Table G.1 – Variation of the beam cross-sectional area ( $A_{BCS}(z)$ ) with the indicated output power from two transducers .....	46
Table H.1 – Comparison of measurements of the beam cross-sectional area ( $A_{BCS}(z)$ ) made using hydrophones of geometrical active element radii 0,3 mm, 0,5 mm and 2,0 mm .....	48
Table I.1 – Aperture measurement check sheet .....	53
Table I.2 – Annular power contributions .....	55
Table I.3 – Annular intensity contributions .....	55
Table I.4 – Annular intensity contributions, sorted in descending order .....	56
Table I.5 – Annular power contributions, sorted in descending order of intensity contribution.....	56
Table I.6 – Cumulative sum of annular power contributions, previously sorted in descending order of intensity contribution, and the cumulative sum of their respective annular areas.....	57

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ULTRASONICS –  
PHYSIOTHERAPY SYSTEMS –  
FIELD SPECIFICATIONS AND METHODS OF  
MEASUREMENT IN THE FREQUENCY RANGE 0,5 MHz TO 5 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61689 has been prepared by IEC technical committee 87: Ultrasonics.

This second edition cancels and replaces the first edition published in 1996 and constitutes a technical revision.

This second edition is a result of maintenance on this standard and the referenced standards IEC 61161 (2006) and IEC 62127-1. A relatively large technical change is the determination of the effective radiating area. This is now no longer based on the measurement of four areas but only on one. This change was needed to improve the accuracy of the determination of this parameter for small transducers. Be aware that this change may alter the value obtained for this and related parameters.

The text of this standard is based on the following documents:

CDV	Report on voting
87/351/CDV	87/370/RVC

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.

This standard should be read in conjunction with IEC 60601-2-5, which, as indicated in its preface, will be revised in order to be compatible with this standard.

NOTE The following print types are used:

- Requirements: in roman type
- *Test specifications: in italic type*
- Notes: in small roman type
- Words in **bold** in the text are defined in Clause 3

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

<https://standards.iteh.ai/> <https://standards.iteh.ai/standards/iec/3821b747-120c-4ceb-98ce-16c76460e8dd/iec-61689-2007>

## INTRODUCTION

**Ultrasound** at low megahertz frequencies is widely used in medicine for the purposes of physiotherapy. Such equipment consists of a generator of high-frequency electrical energy and usually a hand-held **treatment head**, often referred to as an applicator. The **treatment head** consists of a transducer, usually a disk of piezoelectric material, for converting the electrical energy to **ultrasound** and is often designed for contact with the human body.

Withdrawing

iTech Standards  
(<https://standards.iteh.ai>)  
Document Preview

IEC 61689:2007  
<https://standards.iteh.ai/catalog/standards/iec/2821b747-120c-4ceb-98ce-16c76460e8dd/iec-61689-2007>



# ULTRASONICS – PHYSIOTHERAPY SYSTEMS – FIELD SPECIFICATIONS AND METHODS OF MEASUREMENT IN THE FREQUENCY RANGE 0,5 MHz TO 5 MHz

## 1 Scope

This International Standard is applicable to **ultrasonic equipment** designed for physiotherapy consisting of an **ultrasonic transducer** generating continuous or quasi-continuous wave ultrasonic energy in the frequency range 0,5 MHz to 5 MHz.

This standard only relates to **ultrasonic physiotherapy equipment** employing a single plane unfocused circular transducer per **treatment head**, producing static beams perpendicular to the face of the **treatment head**.

This standard specifies:

- methods of measurement and characterization of the output of **ultrasonic physiotherapy equipment** based on reference testing methods;
- characteristics to be specified by manufacturers of **ultrasonic physiotherapy equipment** based on reference testing methods;
- guidelines for safety of the ultrasonic field generated by **ultrasonic physiotherapy equipment**;
- methods of measurement and characterization of the output of **ultrasonic physiotherapy equipment** based on routine testing methods;
- acceptance criteria for aspects of the output of **ultrasonic physiotherapy equipment** based on routine testing methods.

Therapeutic value and methods of use of **ultrasonic physiotherapy equipment** are not covered by the scope of this 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 60050-801:1994, *International Electrotechnical Vocabulary (IEV) – Chapter 801: Acoustics and electroacoustics*

IEC 60469-1:1987, *Pulse techniques and apparatus – Part 1: Pulse terms and definitions*

IEC 60601-1, *Medical electrical equipment – Part 1: General requirements for basic safety and essential performance*

IEC 60601-2-5:2000, *Medical electrical equipment – Part 2-5: Particular requirements for the safety of ultrasonic physiotherapy equipment*

IEC 61161:2006, *Ultrasonics – Power measurement – Radiation force balances and performance requirements*

IEC 62127-1:2007, *Ultrasonics – Hydrophones – Part 1: Measurement and characterization of medical ultrasonic fields up to 40 MHz using hydrophones*

IEC 62127-3:2007, *Ultrasonics – Hydrophones – Part 3: Properties of hydrophones for ultrasonic fields up to 40 MHz*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1

##### **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

NOTE 1 Temporal waveform is a representation (e.g. oscilloscope presentation or equation) of the **instantaneous acoustic pressure**.

NOTE 2 Definition adopted from IEC 60469-1.

#### 3.2

##### **acoustic repetition period**

**arp**

**pulse repetition period** for non-automatic scanning systems and the **scan repetition period** for automatic scanning systems, equal to the time interval between corresponding points of consecutive cycles for continuous wave systems

NOTE 1 **Acoustic repetition period** is expressed in seconds (s).

NOTE 2 Definition adopted from IEC 62127-1.

#### 3.3

##### **acoustic frequency**

##### **acoustic-working frequency**

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**

NOTE 1 The signal is analysed using either the **zero-crossing acoustic-working frequency** technique or a spectrum analysis method. Acoustic-working frequencies are defined in 3.3.1 and 3.3.2.

NOTE 2 In a number of cases the present definition is not very helpful or convenient, especially for **broadband transducers**. In that case a full description of the frequency spectrum should be given in order to enable any frequency-dependent correction to the signal.

NOTE 3 Acoustic frequency is expressed in hertz (Hz).

NOTE 4 Definition adopted from IEC 62127-1.

##### 3.3.1

##### **zero-crossing acoustic-working frequency**

**$f_{awf}$**

this is determined according to the procedure specified in IEC/TR 60854.

NOTE This frequency is intended for continuous wave systems only.

**3.3.2****arithmetic-mean acoustic-working frequency** $f_{\text{awf}}$ 

arithmetic mean of the most widely separated frequencies  $f_1$  and  $f_2$ , within the range of three times  $f_1$ , at which the magnitude of the acoustic pressure spectrum is 3 dB below the peak magnitude

NOTE 1 This frequency is intended for pulse-wave systems only.

NOTE 2 It is assumed that  $f_1 < f_2$ .

**3.4****amplitude modulated wave**

wave in which the ratio  $p_p / \sqrt{2} p_{\text{rms}}$  at any point in the **far field** on the **beam alignment axis** is greater than 1,05, where  $p_p$  is the **temporal-peak acoustic pressure** and  $p_{\text{rms}}$  is the **r.m.s. acoustic pressure**

**3.5****attachment head**

accessory intended to be attached to the **treatment head** for the purpose of modifying the ultrasonic beam characteristics

NOTE Definition adopted from IEC 60601-2-5.

**3.6****beam alignment axis**

straight line joining two points of spatial-peak temporal-peak acoustic pressure on two plane surfaces parallel to the faces of the treatment head. One plane is at a distance of approximately  $A_{\text{ERN}} / (\pi\lambda)$  where  $A_{\text{ERN}}$  is the nominal value of the effective radiating area of the treatment head and  $\lambda$  is the wavelength of the ultrasound corresponding to the nominal value of the acoustic working frequency. The second plane surface is at a distance of either  $2A_{\text{ERN}} / (\pi\lambda)$  or  $A_{\text{ERN}} / (3\pi\lambda)$ , whichever is the more appropriate. For the purposes of alignment, this line may be projected to the face of the treatment head

NOTE 1 If the nominal value of the **effective radiating area** is unknown, then another suitable area may be used to define the **beam alignment axis** such as the area of the active element of the **ultrasonic transducer**.

NOTE 2 As the **beam alignment axis** is used purely for the purposes of alignment, the definitions of specific distances may be relaxed slightly to reflect the constraints of the measurement system employed. For example, some **treatment heads** will have  $A_{\text{ERN}} / (\pi\lambda)$  considerably greater than 12 cm, in which case a maximum distance of 12 cm may be used to define the first plane. General guidelines for determining the **beam alignment axis** are given in 8.3.

**3.7****beam cross-sectional area** $A_{\text{BCS}}$ 

minimum area in a specified plane perpendicular to the **beam alignment axis** for which the sum of the **mean square acoustic pressure** is 75 % of the **total mean square acoustic pressure**

NOTE **Beam cross-sectional area** is expressed in centimetre squared ( $\text{cm}^2$ ).

**3.8****beam maximum intensity**

product of the beam non-uniformity ratio and effective intensity

NOTE **Beam maximum intensity** is expressed in watt per centimetre squared ( $\text{W}/\text{cm}^2$ ).

**3.9  
beam non-uniformity ratio**

$R_{BN}$

ratio of the square of the **maximum r.m.s. acoustic pressure** to the spatial average of the square of the **r.m.s. acoustic pressure**, where the spatial average is taken over the **effective radiating area**. **Beam non-uniformity ratio** is given by:

$$R_{BN} = \frac{p_{\max}^2 A_{ER}}{pms_t A_o} \quad (1)$$

where

- $p_{\max}$  is the **maximum r.m.s. acoustic pressure**;
- $A_{ER}$  is the **effective radiating area**;
- $pms_t$  is the **total mean square acoustic pressure**;
- $A_o$  is the unit area for the raster scan.

**3.10  
absolute maximum beam non-uniformity ratio**

**beam non-uniformity ratio** plus the 95 % confidence overall uncertainty in the beam non-uniformity ratio

**3.11  
beam type**

descriptive classification for the ultrasonic beam in one of three types: **collimated, convergent or divergent**

**3.12  
collimated**

beam for which the **active area coefficient**,  $Q$ , obeys the following inequality:

$$-0,05 \text{ cm}^{-1} \leq Q \leq 0,1 \text{ cm}^{-1}$$

**3.13  
convergent**

beam for which the **active area coefficient**,  $Q$ , obeys the following inequality:

$$Q < -0,05 \text{ cm}^{-1}$$

**3.14  
divergent**

beam for which the **active area coefficient**,  $Q$ , obeys the following inequality:

$$Q > 0,1 \text{ cm}^{-1}$$

**3.15  
continuous wave**

wave in which the ratio  $p_p / \sqrt{2} p_{rms}$ , at any point in the **far field** on the **beam alignment axis**, is less than or equal to 1,05, where  $p_p$  is the **temporal-peak acoustic pressure** and  $p_{rms}$  is the **r.m.s. acoustic pressure**

**3.16  
duty factor**

ratio of the pulse duration to the pulse repetition period

NOTE Definition adopted from IEC 60469-1, 5.3.2.4.

### 3.17 effective intensity

$I_e$   
intensity given by  $I_e = P/A_{ER}$  where  $P$  is the **output power** and  $A_{ER}$  is the **effective radiating area**

NOTE **Effective intensity** is expressed in watt per centimetre squared ( $W/cm^2$ ).

### 3.18 absolute maximum effective intensity

value of the effective intensity corresponding to the absolute maximum rated output power and the absolute minimum effective radiating area from the equipment

### 3.19 effective radiating area

$A_{ER}$   
**beam cross-sectional area** determined at a distance of 0,3 cm from the front of the **treatment head**,  $A_{BCS}(0,3)$ , multiplied by a dimensionless factor,  $F_{ac}$ , given by:

$$F_{ac} = 1,354 \quad (2)$$

NOTE 1 The conversion factor  $F_{ac}$  is used here in order to derive the area close to the **treatment head** which contains 100 % of the **total mean square acoustic pressure**. The origin of the value of  $F_{ac}$  is described in Annex E and bibliographic references [3] and [4].

NOTE 2 Beam cross-sectional area is expressed in centimetre squared ( $cm^2$ ).

### 3.20 absolute minimum effective radiating area effective radiating area minus the 95 % confidence overall uncertainty in the effective radiating area

### 3.21 end-of-cable loaded sensitivity end-of-cable loaded sensitivity of a hydrophone (or hydrophone-assembly)

$M_L(f)$   
ratio of the instantaneous voltage at the end of any integral cable or output connector of a **hydrophone** or **hydrophone-assembly**, when connected to a specified **electric load impedance**, to the **instantaneous acoustic pressure** in the undisturbed free field of a plane wave in the position of the reference centre of the **hydrophone** if the **hydrophone** were removed

NOTE 1 **End-of-cable loaded sensitivity** is expressed in volts per pascal (V/Pa).

NOTE 2 Definition adopted from IEC 62127-3.

### 3.22 far field

acoustic (sound) field at distances from an **ultrasonic transducer** where the values of the **instantaneous acoustic pressure** and particle velocity are substantially in phase [see also IEC 60050-801, 801-03-30]

NOTE 1 Definition adopted from IEC 62127-1.

NOTE 2 For the purposes of this standard, the far field is at a distance greater than  $A_{ERN}/(\pi\lambda)$  where  $A_{ERN}$  is the nominal value of the effective radiating area of the treatment head and  $\lambda$  is the wavelength of the ultrasound corresponding to the acoustic working frequency. This differs from IEC 62127-1.

### 3.23 hydrophone

transducer that produces electrical signals in response to waterborne acoustic signals

NOTE Definition adopted from IEC 60050-801, 801-32-26 (1994).

**3.24**  
**instantaneous acoustic pressure**  
 **$p(t)$**

pressure minus the ambient pressure at a particular instant in time and at a particular point in an acoustic field (see also IEC 60050-801, 801-01-19)

NOTE 1 **Instantaneous acoustic pressure** is expressed in pascal (Pa).

NOTE 2 Definition adopted from IEC 60050-801, 801-21-19 (1994).

**3.25**  
**active area coefficient**  
 **$Q$**

quotient of the **active area gradient**,  $m$ , and the **beam cross-sectional area** at 0,3 cm from the face of the **treatment head**,  $A_{BCS}(0,3)$

NOTE **Active area coefficient** is expressed in per centimetre ( $\text{cm}^{-1}$ ).

**3.26**  
**active area gradient**  
 **$m$**

gradient of the line connecting the **beam cross-sectional area** at 0,3 cm from the face of the **treatment head**,  $A_{BCS}(0,3)$ , and the **beam cross-sectional area** at the position of the last axial maximum acoustic pressure,  $A_{BCS}(Z_N)$ , versus distance

NOTE **Active area gradient** is expressed in centimetre (cm).

**3.27**  
**mean square acoustic pressure**

mean square of the **instantaneous acoustic pressure** at a particular point in the acoustic field. The mean is taken over an integral number of **acoustic repetition periods**

NOTE 1 In practice, the mean value is often derived from rms measurements.

NOTE 2 **Mean square acoustic pressure** is expressed in pascal squared ( $\text{Pa}^2$ ).

**3.28**  
**total mean square acoustic pressure**  
 **$pms_t$**

sum of the **mean square acoustic pressure** values, each with a specified incremental area, in a specified plane over specified limits of summation

NOTE **Total mean square acoustic pressure** is expressed in pascal squared ( $\text{Pa}^2$ ).

**3.29**  
**modulation waveform**

temporal envelope waveform of the **amplitude modulated wave** at the point of **peak r.m.s. acoustic pressure** on the **beam alignment axis** and displayed over a period sufficiently long to include all significant acoustic information in the **amplitude modulated wave**

**3.30**  
**output power**  
 **$P$**

time-average ultrasonic power emitted by a **treatment head of ultrasonic physiotherapy equipment** into an approximately free field under specified conditions in a specified medium, preferably in water

NOTE 1 Definition adopted from IEC 61161:2006.

NOTE 2 **Output power** is expressed in watt (W).