

Ultrasonics — Physiotherapy systems — Performance requirements and methods of measurement in the frequency range 0.5 MHz to 5 MHz

The European Standard EN 61689:1996 has the status of a
British Standard

ICS 11.040.60

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW



Document Sharing Hub

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee EPL/87, Ultrasonics, upon which the following bodies were represented:

- Association of British Health-Care Industries
- British Dental Association
- British Institute of Radiology
- British Medical Ultrasound Society
- British Society for Rheumatology
- Department of Health
- Institution of Electrical Engineers
- Institution of Physics and Engineering in Medicine and Biology
- National Physical Laboratory
- Institute of Laryngology and Otology

This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 May 1997

© BSI 09-1999

The following BSI references relate to the work on this standard:
Committee reference EPL/87
Draft for comment 93/203591 DC

ISBN 0 580 26676 1

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
National foreword	ii
Foreword	2
Text of EN 61689	5

National foreword

This British Standard has been prepared by Technical Committee EPL/87 and is the English language version of EN 61689:1996 *Ultrasonics — Physiotherapy systems — Performance requirements and methods of measurement in the frequency range 0.5 MHz to 5 MHz*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 1689:1996, published by the International Electrotechnical Commission (IEC).

Cross-references

Publication referred to	Corresponding British Standard
IEC 50 (801) 1994	BS 4727 <i>Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms</i> Part 3: <i>Terms particular to telecommunications and electronics</i> Group 08:1995 <i>Acoustics and electroacoustics</i>
IEC 469-1:1987	BS 5698 <i>Guide to pulse techniques and apparatus</i> Part 1:1989 <i>Pulse terms and definitions</i>
EN 60601-1:1990 (IEC 601-1:1988)	BS 5724 <i>Medical electrical equipment</i> Part 1:1989 <i>General requirements for safety</i> Part 2 <i>Particular requirements for safety</i>
HD 395.2.5 S1:1986 (IEC 601-2-5:1984)	Section 2.5:1985 <i>Specification for safety of ultrasonic therapy equipment</i>
IEC 866:1987	BS 7041:1989 <i>Specification for characteristics and calibration of hydrophones for operation in the frequency range 0.5 MHz to 15 MHz</i>
EN 61101:1993 (IEC 1101:1991)	BS EN 61101:1994 <i>Specification for absolute calibration of hydrophones using the planar scanning technique in the frequency range 0.5 MHz to 15 MHz</i>
EN 61102:1993 (IEC 1102:1991)	BS EN 61102:1994 <i>Specification for measurement and characterization of ultrasonic fields using hydrophones in the frequency range 0.5 MHz to 15 MHz</i>
EN 61161:1994 (IEC 1161:1992)	BS EN 61161:1995 <i>Specification for ultrasonic power measurement in liquids in the frequency range 0.5 MHz to 25 MHz</i>

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 43 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.

Descriptors: Ultrasound, physiotherapy systems, performance, measurements

English version

Ultrasonics — Physiotherapy systems
Performance requirements and methods of measurement
in the frequency range 0,5 MHz to 5 MHz

(IEC 1689:1996)

Ultrasons — Systèmes de physiothérapie
Prescriptions de performance et
méthodes de mesure dans la gamme de
fréquences de 0,5 MHz à 5 MHz
(CEI 1689:1996)

Ultraschall — Physiotherapiesysteme
Anforderungen an das Betriebsverhalten
und Meßverfahren im Frequenzbereich
von 0,5 MHz bis 5 MHz
(IEC 1689:1996)

This European Standard was approved by CENELEC on 1996-10-01. 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

Foreword

The text of document 87/91/FDIS, future edition 1 of IEC 1689, prepared by IEC TC 87, Ultrasonics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61689 on 1996-10-01.

This European Standard supersedes HD 87 S1:1977.

This European Standard should be read in conjunction with HD 395.2.5 S1:1986 (IEC 601-2-5).

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1997-07-01

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

In this standard, Annex A, Annex B and Annex ZA are normative and Annex C to Annex M are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 1689:1996 was approved by CENELEC as a European Standard without any modification.

Contents

	Page
Foreword	2
Introduction	5
1 Scope	5
2 Normative references	5
3 Definitions	6
4 List of symbols	12
5 Requirements for safety and performance declaration	13
6 Performance and safety requirements	13
6.1 Rated output power	13
6.2 Effective intensity	13
6.3 Beam non-uniformity ratio	13
7 Conditions of measurement and test equipment used	13
7.1 Test vessel	14
7.2 Hydrophone	14
7.3 RMS or peak signal measurement	14
8 Type testing reference procedures and measurements	15
8.1 Rated output power	15
8.2 Hydrophone measurements	15
8.3 Effective radiating area	16
8.4 Reference type testing parameters	17
8.5 Acceptance criteria for reference type testing	18
9 Routine measurement procedure	18
9.1 Rated output power	19
9.2 Beam cross-sectional area at z_p	19
9.3 Acceptance criteria for routine testing	20
10 Sampling and uncertainty determination	20
10.1 Reference type testing measurements	20
10.2 Routine measurements	20
10.3 Uncertainty determination	20
Annex A (normative) Raster scan measurement and analysis procedures	21
Annex B (normative) Diametrical or line scan measurement and analysis procedures	22
Annex C (informative) Rationale concerning the beam cross-sectional area definition	25
Annex D (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})	29
Annex E (informative) Rationale behind the use of a group of measurement planes	31

	Page		Page
Annex F (informative) Rationale behind using a limiting value for the beam non-uniformity ratio (R_{BN})	33	Figure F.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 $s = \lambda z / a^2$	35
Annex G (informative) Determining acoustic power through radiation force measurements	36		
Annex H (informative) The validity of low-power measurements of the beam cross-sectional area (A_{BCS})	38	Figure F.2 — Histogram of R_{BN} values for 37 treatment heads of various diameter and frequency	36
Annex J (informative) Influence of hydrophone effective diameter	38	Table B.1 — Constitution of the transformed array $[B]$ used for the analysis of half-line scans	24
Annex K (informative) Relationship between the effective radiating area (A_{ER}) and the effective radiating area determined using the FDA definition	40	Table G.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 1161	37
Annex L (informative) Guidance on uncertainty determination	41		
Annex M (informative) Bibliography	42	Table H.1 — Variation of the beam cross-sectional area $[A_{BCS}(z)]$ with the indicated output power from two transducers	38
Annex ZA (normative) Normative references to international publications with their corresponding European publications	43	Table J.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	39
Figure C.1 — Iso-pressure lines of a typical physiotherapy treatment head of small geometrical area ($ka = 17$)	26	Table K.1 — Comparison of values of the effective radiating area determined using the FDA method [7] (identified by the symbol ERA_{FDA}) with values for A_{ER} based on the methods specified in this standard	41
Figure C.2 — Plot of beam cross-sectional area against different limit values for a small variation in distance along the beam alignment axis, z	27		
Figure C.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	28		
Figure C.4 — Variation of the beam cross-sectional area (A_{BCS}) with distance from the face of the treatment head	28		
Figure C.5 — Variation of the normalized beam cross-sectional area (A_{BCS}) as a function of ka	29		
Figure D.1 — Conversion factor F_{ac} as a function of the ka product for ka product between 40 and 160	30		
Figure D.2 — Conversion factor F_{ac} as a function of the ka product for ka product between 16 and 40	31		
Figure E.1 — Variation of the beam cross-sectional area against measurement distance z for eight different treatment heads	32		
Figure E.2 — Variation of the beam cross-sectional area with measurement distance z for three transducers exhibiting high values of R_{BN}	33		

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.

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 circular transducer per **treatment head**, producing static beams perpendicular to the face of the **treatment head** in accordance with present practice.

This standard specifies:

- methods of measurement and characterization of the output performance of **ultrasonic physiotherapy equipment** based on reference testing methods;
- characteristics to be declared by manufacturers of **ultrasonic physiotherapy equipment** based on reference testing methods;
- requirements for performance and safety of the ultrasonic field generated by **ultrasonic physiotherapy equipment**;
- methods of measurement and characterization of the output performance of **ultrasonic physiotherapy equipment** based on routine testing methods;
- acceptance criteria for aspects of performance 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 normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents 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 normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(801):1994, *International Electrotechnical Vocabulary (IEV) — Chapter 801: Acoustics and electroacoustics*.

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

IEC 601-1:1988, *Medical electrical equipment — Part 1: General requirements for safety*.

IEC 601-2-5:1984, *Medical electrical equipment — Part 2: Particular requirements for the safety of ultrasonic therapy equipment*.

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*.

IEC 1101:1991, *The absolute calibration of hydrophones using the planar scanning technique in the frequency range 0,5 MHz to 15 MHz*.

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

IEC 1161:1992, *Ultrasonic power measurement in liquids in the frequency range 0,5 MHz to 25 MHz*.

3 Definitions

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

3.1

acoustic pulse waveform

temporal waveform of the **instantaneous acoustic pressure** at a specified position in the acoustic field and displayed over a period sufficiently long to include all significant information in a single pulse or tone burst (see 3.2 of IEC 1102)

3.2

acoustic repetition period

time interval between corresponding points of consecutive cycles for **continuous wave** ultrasound (see 3.3 of IEC 1102)

3.3

acoustic working frequency

frequency of an acoustic signal based on the observation of the output of a **hydrophone** placed in an acoustic field. The signal is analysed using the zero-crossing frequency technique (see 3.4.1 of IEC 1102)

3.4

amplitude modulated 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 greater than 1,05, where p_p is the **temporal-peak acoustic pressure** and p_{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 (see IEC 601-2-5)

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 $A_{ERN}/(\pi\lambda)$ where A_{ERN} is the nominal value of the **effective radiating area** of the **treatment head** and λ 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 $2A_{ERN}/(\pi\lambda)$ or $A_{ERN}/(3\pi\lambda)$ 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 $A_{ERN}/(\pi\lambda)$ 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 8.2.

see 3.5 of IEC 1102 in the case of plane surfaces

3.7

beam cross-sectional area

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**

Symbol: A_{BCS}

Unit: centimetre squared, cm^2

3.8

beam maximum intensity

product of the **beam non-uniformity ratio** and **rated output power** divided by the **effective radiating area**

Unit: watt per centimetre squared, W/cm^2

3.9

beam non-uniformity ratio

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:

$$R_{BN} = \frac{p_{\max}^2 A_{ER}}{pms_t a_0}$$

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_0 is the unit area for the raster scan.

Symbol: R_{BN}

Unit: dimensionless

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 **linear regression 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 **linear regression coefficient**, Q , obeys the following inequality:

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

3.14

divergent

beam for which the **linear regression coefficient**, Q , obeys the following inequality:

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

3.15

continuous wave

wave in which the ratio $p_p / \sqrt{2} p_{\text{rms}}$ 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**cylindrical asymmetry parameter**

parameter used to describe the cylindrical symmetry of a physiotherapy beam. The **cylindrical asymmetry parameter** is determined by analysing the data from either raster scans or diametrical scans in terms of eight equally angled half-line scans. The **cylindrical asymmetry parameter** is given by the percentage of the standard deviation of values of the **beam cross-sectional area** determined from these individual half line-scans, calculated relative to the mean value

Symbol: Φ

Unit: dimensionless

3.17**duty factor**

ratio of the **pulse duration** to the **pulse repetition period** (see 5.3.2.4 of IEC 469-1)

3.18**effective intensity**

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

Symbol: I_e

Unit: watt per centimetre squared, W/cm^2

3.19**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**

3.20**effective radiating area**

beam cross-sectional area extrapolated to the front face of the **treatment head**, $A_{BCS}(0)$, multiplied by a dimensionless factor, F_{ac} , given by:

$$F_{ac} = 2,58 - 0,0305 ka_1 \text{ for } ka_1 \leq 40$$

$$F_{ac} = 1,354 \text{ for } ka_1 > 40$$

where

k is the circular wave number per centimetre, cm^{-1} ;

a_1 is the effective radius of the **treatment head** in centimetres and is derived by solving for a in the equation:

$$\pi a^2 + [0,0305 k A_{BCS}(0)] a - 2,58 A_{BCS}(0) = 0$$

NOTE The conversion factor F_{ac} is used here in order to derive the area at the **treatment head** which contains 100 % of the total **mean square acoustic pressure**.

Symbol: A_{ER}

Unit: centimetre squared, cm^2

3.21**absolute minimum effective radiating area**

effective radiating area minus the 95 % confidence overall uncertainty in the **effective radiating area**

3.22**end-of-cable loaded sensitivity of a hydrophone**

ratio of the voltage at the end of any **integral** cable or connector of a **hydrophone**, when connected to any specified electrical input impedance, to the **instantaneous acoustic pressure** in the undisturbed free-field of a plane wave in the position of the acoustic centre of the **hydrophone** if the **hydrophone** were removed (see 3.14 of IEC 1102)

Symbol: M_L

Unit: volt per pascal, V/Pa

3.23**far field**

acoustic (sound) field at a distance from a **treatment head** where the values of the **instantaneous acoustic pressure** and particle velocity are substantially in phase [see 801-23-30 of IEC 50(801)]

for the purposes of this standard, the **far field** is at a distance greater than $A_{\text{ERN}}/(\pi\lambda)$ where A_{ERN} is the nominal value of the **effective radiating area** of the **treatment head** and λ is the wavelength of the **ultrasound** corresponding to the **acoustic working frequency** (see 3.16 of IEC 1102)

3.24**hydrophone**

transducer that produces electrical signals in response to waterborne acoustic signals (see also 801-32-26 of IEC 50(801), 3.4 of IEC 866 and 3.19 of IEC 1102)

3.25**instantaneous acoustic pressure**

at a particular point in the acoustic field, difference between the pressure existing at a particular instant in time and the ambient pressure [see 801-21-19 of IEC 50(801)]

Symbol: p

Unit: pascal, Pa

3.26**linear regression coefficient**

quotient of the **linear regression gradient**, m , and the **beam cross-sectional area** at the face of the **treatment head**, $A_{\text{BCS}}(0)$

Symbol: Q

Unit: per centimetre, cm^{-1}

3.27**linear regression gradient**

gradient of the linear regression fit of the **beam cross-sectional area** versus distance and determined at four specified measurement planes

Symbol: m

Unit: centimetre, cm

3.28**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 In practice, the mean value is often derived from peak or r.m.s. measurements.

Unit: pascal squared, Pa^2

3.29**total mean square acoustic pressure**

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

Symbol: pms_t

Unit: pascal squared, Pa^2

3.30**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**

3.31**output power**

time-average ultrasonic power radiated by a **treatment head of ultrasonic physiotherapy equipment** into an approximately free field under specified conditions in a specified medium, preferably in water (see **3.5** of IEC 1161)

Symbol: P

Unit: watt, W

3.32**rated output power**

maximum **output power** of the **ultrasonic physiotherapy equipment** at any of the allowed line voltages

Unit: watt, W

3.33**absolute maximum rated output power**

sum of the **rated output power**, the 95 % confidence overall uncertainty in the **rated output power**, and the maximum increase in the **rated output power** for a ± 10 % variation in the nominal line voltage

3.34**temporal-maximum output power**

in the case of an **amplitude modulated wave**, the **temporal-maximum output power** is given by:

$$P_{tm} = 1/2 \left[\frac{p_p}{p_{rms}} \right]^2 P$$

where

P is the actual **output power** under **amplitude modulated wave** conditions;

p_p is the **temporal-peak acoustic pressure**;

p_{rms} is the true **r.m.s. acoustic pressure**.

both p_p and p_{rms} are measured under **amplitude modulated wave** conditions and at a specified point on the **beam alignment axis**

Symbol: P_{tm}

Unit: watt, W

3.35**pulse duration**

time interval beginning at the first time the pressure amplitude exceeds a reference value and ending at the last time the pressure amplitude returns to that value. The reference value is equal to the sum of the minimum pressure amplitude and 10 % of the difference between the maximum and minimum pressure amplitude

Unit: second, s

NOTE This definition differs from that of **3.30** of IEC 1102 to account for incomplete modulation.

3.36**pulse repetition period**

absolute value of the time interval after which the same characteristics of a periodic waveform recur (see **5.3.2.1** of IEC 469-1)

3.37**pulse repetition rate**

inverse of the **pulse repetition period**. This is also equal to the repetition frequency of the modulated waveform

Unit: hertz, Hz

3.38**r.m.s. acoustic pressure**

root mean square (r.m.s.) of the **instantaneous acoustic pressure** at a particular point in an acoustic field. The mean is taken over an integral number of **acoustic repetition periods** (see **3.36** of IEC 1102)

Symbol: p_{rms}

Unit: pascal, Pa

3.39**maximum r.m.s. acoustic pressure**

maximum value of the **r.m.s. acoustic pressure** detected by a **hydrophone** over the entire acoustic field

Symbol: p_{max}

Unit: pascal, Pa

3.40**peak r.m.s. acoustic pressure**

maximum value of the **r.m.s. acoustic pressure** over a specified region, line or plane in an acoustic field

3.41**temporal-maximum intensity**

in the case of an **amplitude modulated wave**, the **temporal-maximum intensity** is given by:

$$I_{\text{m}} = \frac{P_{\text{tm}}}{A_{\text{ER}}}$$

where

P_{tm} is the **temporal-maximum output power**;

A_{ER} is the **effective radiating area**.

Symbol: I_{m}

Unit: watt per centimetre squared, W/cm^2

3.42**temporal-peak acoustic pressure**

maximum value of the modulus of the **instantaneous acoustic pressure** at a particular point in an acoustic field (see **3.54** of IEC 1102)

Symbol: p_{p}

Unit: pascal, Pa

3.43**treatment head**

assembly comprising one **ultrasonic transducer** and associated parts for local application of **ultrasound** to the patient (see IEC 601-2-5)

3.44**ultrasonic transducer**

device capable of converting electrical energy to mechanical energy within the ultrasonic frequency range and/or reciprocally of converting mechanical energy to electrical energy (see **3.58** of IEC 1102)

3.45**ultrasound**

acoustic oscillation whose frequency is above the high-frequency limit of audible sound (about 16 kHz) [see 801-21-04 of IEC 50(801)]

3.46**ultrasonic physiotherapy equipment; equipment**

equipment for the generation and application of **ultrasound** to a patient for therapeutic purposes (see IEC 601-2-5)