SLOVENSKI STANDARD
SIST EN 61161:2013

01-julij-2013

Nadomešča:
SIST EN 61161:2008

Ultrazvok - Močnostne meritve - Ravnotežje sevalnih jakosti in tehnične zahteve

Ultrasonics - Power measurement - Radiation force balances and performance requirements

Ultraschall - Leistungsmessung - Schallfeldkraft-Waagen und Anforderungen an ihre Funktionseigenschaften

Ultrasons - Mesurage de puissance - Balances de forces de rayonnement et exigences de fonctionnement

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ICS:

17.140.50	Elektroakustika	Electroacoustics

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EN 61161

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English version

Ultrasonics - Power measurement - Radiation force balances and performance requirements

(IEC 61161:2013)

Ultrasons - Mesurage de puissance - Balances de forces de rayonnement et exigences de fonctionnement (CEI 61161:2013)

Ultraschall - Leistungsmessung - Schallfeldkraft-Waagen und Anforderungen an ihre Funktionseigenschaften (IEC 61161:2013)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 61161:2013 E

Foreword

The text of document 87/520/FDIS, future edition 3 of IEC 61161, prepared by IEC/TC 87 "Ultrasonics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61161:2013.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2013-12-06
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-03-06

This document supersedes EN 61161:2007.

EN 61161:2013 includes the following significant technical changes with respect to EN 61161:2007:

– whereas the second edition tacitly dealt with circular transducers only, the present edition as far as possible deals with both circular and rectangular transducers, Including a number of symbols for rectangular transducers;

– attention is paid to focused cases and the influence of scanning has been added;

– the method of calibrating the radiation force balance now depends on whether the set-up is used as a primary or as secondary measurement tool;

– Annex B (basic formulae) has been updated and in Annex C the buoyancy change method is mentioned (see also future EN 62555).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61161:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60601-2-5	NOTE	Harmonised as EN 60601-2-5.
IEC 61157	NOTE	Harmonised as EN 61157.
IEC 61846:1998	NOTE	Harmonised as EN 61846:1998 (not modified).
IEC 62127-1	NOTE	Harmonised as EN 62127-1.
IEC 62127-2	NOTE	Harmonised as EN 62127-2.
IEC 62127-3	NOTE	Harmonised as EN 62127-3.
IEC 62555 [1)]	NOTE	Harmonised as EN 62555 [1)].

[1)] At draft stage.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 61689	-	Ultrasonics - Physiotherapy systems - Field specifications and methods of measurement in the frequency range 0,5 MHz to 5 MHz	EN 61689	-

IEC 61161

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Ultrasonics – Power measurement – Radiation force balances and performance requirements

Ultrasons – Mesurage de puissance – Balances de forces de rayonnement et exigences de fonctionnement

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ULTRASONICS – POWER MEASUREMENT – RADIATION FORCE BALANCES AND PERFORMANCE REQUIREMENTS

FOREWORD

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International Standard IEC 61161 has been prepared by IEC technical committee 87: Ultrasonics.

This third edition cancels and replaces the second edition published in 2006. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

– whereas the second edition tacitly dealt with circular transducers only, the present edition as far as possible deals with both circular and rectangular transducers, including a number of symbols for rectangular transducers;
– attention is paid to focused cases and the influence of scanning has been added;
– the method of calibrating the radiation force balance now depends on whether the set-up is used as a primary or as secondary measurement tool;
– Annex B (basic formulae) has been updated and in Annex C the buoyancy change method is mentioned (see also future IEC 62555).

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

FDIS	Report on voting
87/520/FDIS	87/528/RVD

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.

NOTE The following print types are used:
- Requirements: in Arial 10 point
- Notes: in Arial 8 point
- Words in **bold** in the text are defined in Clause 3
- Symbols and formulae: *Times New Roman + Italic*.

The committee has decided that the contents of this publication will remain unchanged until the stability 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.

INTRODUCTION

A number of measuring methods exist for the determination of the total emitted power of ultrasonic transducers ([1], [2], [3][1], see also Annex C). The purpose of this International Standard is to establish standard methods of measurement of ultrasonic power in liquids in the lower megahertz frequency range based on the measurement of the radiation force using a gravimetric balance. The great advantage of radiation force measurements is that a value for the total radiated power is obtained without the need to integrate field data over the cross-section of the radiated sound beam. This standard identifies the sources of errors and describes a systematic step-by-step procedure to assess overall measurement uncertainty as well as the precautions that should be undertaken and uncertainties that should be taken into account while performing power measurements.

Basic safety requirements for ultrasonic physiotherapy devices are identified in IEC 60601-2-5 and make reference to IEC 61689, which specifies the need for acoustic power measurements with an uncertainty better than ± 15 % at a level of confidence of 95 %. Considering the usual degradation of accuracy in the practical application of this standard, reference measurement methods need to be established with uncertainties better than ± 7 %. Ultrasonic diagnostic device declaration requirements including acoustic power are specified in other IEC standards, as for example in IEC 61157.

The measurement of acoustic power accurately and repeatably using a radiation force balance as defined in this standard is influenced by a number of practical problems. As a guide to the user, additional information is provided in Annex A using the same section and clause numbering as the main body.

[1] Numbers in square brackets refer to the Bibliography.

ULTRASONICS – POWER MEASUREMENT – RADIATION FORCE BALANCES AND PERFORMANCE REQUIREMENTS

1 Scope

This International Standard

- specifies a method of determining the total emitted acoustic power of ultrasonic transducers based on the use of a radiation force balance;
- establishes general principles for the use of radiation force balances in which an obstacle (target) intercepts the sound field to be measured;
- establishes limitations of the radiation force method related to cavitation and temperature rise;
- establishes quantitative limitations of the radiation force method in relation to diverging and focused beams;
- provides information on estimating the acoustic power for diverging and focused beams using the radiation force method;
- provides information on assessment of overall measurement uncertainties.

This International Standard is applicable to:

- the measurement of ultrasonic power up to 1 W based on the use of a radiation force balance in the frequency range from 0,5 MHz to 25 MHz;
- the measurement of ultrasonic power up to 20 W based on the use of a radiation force balance in the frequency range 0,75 MHz to 5 MHz;

- the measurement of total ultrasonic power in well-collimated, diverging and focused ultrasonic fields;
- the use of radiation force balances of the gravimetric type or force feedback type.

(See also Clause A.1)

NOTE 1 A focused beam is converging in the pre-focal range and diverging beyond focus.

NOTE 2 Ultrasonic power measurement in the high intensity therapeutic ultrasound (HITU) range, i.e. beyond 1 W or 20 W, respectively, is dealt with in the future IEC 62555.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61689, *Ultrasonics – Physiotherapy systems – Field specifications and methods of measurement in the frequency range 0,5 MHz to 5 MHz*

3 Terms and definitions

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

3.1
acoustic streaming
bulk fluid motion initiated by a sound field

3.2
free field
sound field in a homogeneous isotropic medium whose boundaries exert a negligible effect on the sound waves

[SOURCE: IEC 60050-801:1994, definition 801-23-28, modified – the term no longer contains "sound"]

3.3
output power
P
time-average ultrasonic power emitted by an **ultrasonic transducer** into an approximately **free field** under specified conditions in a specified medium, preferably water

Note 1 to entry: **Output power** is expressed in watt (W).

3.4
radiation force
acoustic radiation force
F
time-average force acting on a body in a sound field and caused by the sound field, excluding the component due to **acoustic streaming**; or, more generally: time-average force (excluding the component due to **acoustic streaming**) in a sound field, appearing at the boundary surface between two media of different acoustic properties, or within a single attenuating medium

Note 1 to entry: **Radiation force, acoustic radiation force**, is expressed in newton (N).

3.5
radiation pressure
acoustic radiation pressure
radiation force per unit area

Note 1 to entry: This term is widely used in the literature. However, strictly speaking, the **radiation force** per unit area is a tensor quantity [4] and it should be referred to as the acoustic radiation stress tensor when a strict scientific terminology is to be used. The integral quantity "**acoustic radiation force**" is generally preferred in this International Standard. Whenever at some places, the term "**acoustic radiation pressure**" appears it is to be understood as the negative value of the normal radiation stress in the direction of the field axis.

Note 2 to entry: **Radiation pressure, acoustic radiation pressure,** is expressed in pascal (Pa).

3.6
target
device specially designed to intercept substantially all of the ultrasonic field and to serve as the object which is acted upon by the **radiation force**

3.7
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

3.8
radiation conductance
G
ratio of the acoustic **output power** and the squared RMS transducer input voltage

Note 1 to entry: It is used to characterize the electrical to acoustical transfer of **ultrasonic transducers**.

Note 2 to entry: **Radiation conductance** is expressed in siemens (S).

4 List of symbols

a	radius of a circular ultrasonic source transducer
b_x and b_y	half-dimensions of a rectangular ultrasonic source transducer in x and y direction, respectively (so that 2 b_x and 2 b_y are the transducer's side lengths)
c	speed of sound (usually in water)
d_x and d_y	geometrical focal lengths of a focusing **ultrasonic transducer** in the x-z and the y-z plane, respectively
d	geometrical focal length of a focusing **ultrasonic transducer** in the case of $d_x = d_y = d$
F	**radiation force** on a **target** in the direction of the incident ultrasonic wave
g	acceleration due to gravity
G	**radiation conductance**
h_d	half the diagonal of a rectangular transducer, $h_d = (b_x^2 + b_y^2)^{1/2}$
h_h	harmonic mean of b_x and b_y, $h_h = 2 / (1/b_x + 1/b_y)$
k	circular wavenumber, $k = 2\,\pi / \lambda$
P	**output power** of an **ultrasonic transducer**
s	normalized distance from a circular **ultrasonic transducer**, $s = z\,\lambda / a^2$
z	distance between an **ultrasonic transducer** and a **target**
α	amplitude attenuation coefficient of plane waves in a medium (usually water)
β_x and β_y	focus (half-)angles of a rectangular focusing **ultrasonic transducer** in the x-z and the y-z plane, respectively; $\beta_x = \arctan(b_x/d_x)$, $\beta_y = \arctan(b_y/d_y)$ if the transducer is planar and the focal lengths are counted from the planar transducer surface
γ	focus (half-)angle of a circular focusing **ultrasonic transducer**; $\gamma = \arcsin(a / d)$ if the transducer is spherically curved and the focal length is counted from the "bottom" of the "bowl"; $\gamma = \arctan(a / d)$ if the focal length is counted from the plane defined by the rim of the active part of the "bowl" or if the transducer is planar
θ	angle between the direction of the incident ultrasonic wave and the normal to a reflecting surface of a **target**
λ	ultrasonic wavelength in the sound-propagating medium (usually water)
ρ	(mass) density of the sound-propagating medium (usually water)

NOTE 1 The direction of the incident wave mentioned above under F and θ is understood to be the direction of the field axis, i.e., it is understood in a global sense rather than in a local sense.

NOTE 2 Strictly speaking, in the case of a focusing transducer, the focusing details and the transducer shape are independent of each other, i.e. a circular transducer, too, can have two different focus (half-)angles. With regard to ultrasound practice, however, this standard restricts to the two cases of a circular transducer with one focus (half-) angle and of a rectangular transducer with two focus (half-)angles (which can, of course, be equal to each other).

5 Requirements for radiation force balances

5.1 General

The **radiation force** balance shall consist of a **target** which is connected to a balance. The ultrasonic beam shall be directed vertically upwards or downwards or horizontally on the **target** and the **radiation force** exerted by the ultrasonic beam shall be measured by the