BS EN 61161:2013

BSI Standards Publication

Ultrasonics — Power measurement — Radiation force balances and performance requirements

National foreword

This British Standard is the UK implementation of EN 61161:2013. It is identical to IEC 61161:2013. It supersedes BS EN 61161:2007, which will be withdrawn on 6 March 2016.

The UK participation in its preparation was entrusted to Technical Committee EPL/87, Ultrasonics.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2013

ISBN 978 0 580 71712 3

ICS 17.140.50

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 May 2013.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61161

April 2013

ICS 17.140.50

Supersedes EN 61161:2007

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)

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-03-06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	-

CONTENTS

INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms and definitions 7
4 List of symbols 9
5 Requirements for radiation force balances 9
5.1 General 9
5.2 Target type 10
5.2.1 General 10
5.2.2 Absorbing target 10
5.2.3 Reflecting target 10
5.3 Target diameter 11
5.4 Balance/force measuring system 11
5.5 System tank 11
5.6 Target support structures 11
5.7 Transducer positioning 11
5.8 Anti-streaming foils 11
5.9 Transducer coupling 12
5.10 Calibration 12
6 Requirements for measuring conditions 12
6.1 Lateral target position 12
6.2 Transducer/target separation 12
6.3 Water 12
6.4 Water contact 13
6.5 Environmental conditions 13
6.6 Thermal drifts 13
7 Measurement uncertainty 13
7.1 General 13
7.2 Balance system including target suspension 13
7.3 Linearity and resolution of the balance system 13
7.4 Extrapolation to the moment of switching the ultrasonic transducer 14
7.5 Target imperfections 14
7.6 Reflecting target geometry 14
7.7 Lateral absorbers in the case of reflecting target measurements 14
7.8 Target misalignment 14
7.9 Ultrasonic transducer misalignment 14
7.10 Water temperature 14
7.11 Ultrasonic attenuation and acoustic streaming 14
7.12 Foil properties 14
7.13 Finite target size 15
7.14 Plane-wave assumption 15
7.15 Scanning influence 15
7.16 Environmental influences 15
7.17 Excitation voltage measurement 15
7.18 Ultrasonic transducer temperature 15

7.19 Nonlinearity 15
7.20 Acceleration due to gravity 15
7.21 Other sources 16
Annex A (informative) Additional information on various aspects of radiation force measurements 17
Annex B (informative) Basic formulae 30
Annex C (informative) Other methods of ultrasonic power measurement 36
Annex D (informative) Propagation medium and degassing 37
Annex E (informative) Radiation force measurement with diverging ultrasonic beams 38
Annex F (informative) Limitations associated with the balance arrangements 42
Bibliography 46

Figure 1 – Section through an absorbing target 16
Figure 2 – Linearity check: balance readout as a function of the input quantity 16
Figure E.1 – Piston result (oscillating curve) for P/cF as a function of ka 39
Figure E.2 – P/cF as a function of ka for four different pseudo-trapezoidal amplitude distributions 39
Figure E.3 – Ratio of the radiation conductance G as obtained using a convex-conical reflecting target to an absorbing target versus the value of ka [29] 41
Figure F.1 – Arrangement A 42
Figure F.2 – Arrangement B, with convex-conical reflecting target 43
Figure F.3 – Arrangement B, with absorbing target 43
Figure F.4 – Arrangement C, with absorbing target 43
Figure F.5 – Arrangement E, with absorbing (a) or concave-conical reflecting (b) target 43
Figure F.6 – Arrangement F, with convex-conical reflecting target 44
Figure F.7 – Arrangement F with absorbing target 44

Table F.1 – Advantages and disadvantages of different arrangements 45

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.