IEC TS 62736

Edition 2.0 2023-01

TECHNICAL SPECIFICATION

colour inside

Ultrasonics – Pulse-echo scanners – Simple methods for periodic testing to verify stability of an imaging system's elementary performance

IEC TS 62736:2023-01(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC TS 62736

Edition 2.0 2023-01

TECHNICAL SPECIFICATION

colour inside

Ultrasonics – Pulse-echo scanners – Simple methods for periodic testing to verify stability of an imaging system's elementary performance

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 17.140.50

ISBN 978-2-8322-6345-7

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ULTRASONICS – PULSE-ECHO SCANNERS –

Simple methods for periodic testing to verify stability of an imaging system's elementary performance

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 can 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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
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 might be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TS 62736 has been prepared by IEC technical committee 87: Ultrasonics. It is a Technical Specification.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

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

a) expansion of the applicable types of transducers and the frequency range of application;
b) extension of test protocols and image assessments, including for **very-low-echo spheres**;
c) revision of **phantom** designs and their acoustic properties, consistent with the second edition of IEC TS 62791;
d) inclusion of luminance tests for system-image display consistency at scanner and remote monitors;

e) addition of special considerations for 3D-imaging transducers (Annex D) and workbook examples (Annex E).

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
87/777/DTS	87/791/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are defined in greater detail at www.iec.ch/standardsdev/publications.

Terms **in bold** in the text are defined in Clause 3.

Symbols and formulae are in *Times New Roman italic*.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

An ultrasonic pulse-echo scanner produces images of tissue in a scan plane by sweeping a narrow, pulsed beam of ultrasound through the section of interest and detecting the echoes generated by reflection at tissue boundaries and by scattering within tissues. Various transducer types are employed to operate in a transmit/receive mode to generate/detect the ultrasonic signals. Ultrasonic scanners are widely used in medical practice to produce images of soft-tissue organs throughout the human body. As ultrasound systems are usually employed under rigorous time restrictions and in diverse environments to help make decisions that are often critical to patients' wellbeing, it is important that the systems perform consistently at the level initially provided and accepted in initial tests, for example, those of IEC TS 62791, IEC 61391-1, 61391-2, and IEC 62563-2. This document provides methods to verify the stability of an imaging system's elementary performance.

This document is deemed necessary because substandard ultrasound-system performance is often accepted or remains undetected in the absence of unequivocal and documented tests. The most common of the failures, in all but the oldest systems nearing retirement, are sub-performance of a transducer-array element or lens or of a cable or electronic channel. There is approximately a 14 % transducer-failure rate and a 10 % system-failure rate per year on first testing [1],[2],[3],[4],[5],[5],[7],[8],[9],[10],[11],[12][1]. Sensitive image uniformity tests for these transducer- and channel-failures are presented here for use daily to monthly (Level 1), annually (Level 2) and biennially (Level 3).

This common occurrence of suboptimal diagnostic examinations has created an urgent need to standardize quality-assurance (**QA**) and performance-evaluation procedures to promote improved efficacy of diagnostic examinations through widespread use of effective **QA** procedures and to dispel myths as to their utility. Proposers believe, however, that existing national and international standards and guides [1],[3],[12],[13],[14] specify or recommend too many tests and inappropriate tests for detecting and discriminating the common flaws in diagnostic ultrasound systems during routine **QA**. These practices include tests, such as spatial resolution, which are low-yield and belong in performance-evaluation procedures, rather than **QA**.

Modern flat-panel display technology is more stable than, and generally far superior to, earlier cathode ray tube (CRT) displays. However, these displays can still exhibit luminance drift, as well as problems such as defective pixels. They still need to be evaluated periodically.

Detection of failures by these recommended pulse-echo tests will probably also detect most failures affecting the operation of other modes, such as colour-flow, harmonic-, elasticity- and compound-imaging. The failures might be more pronounced in these other modes and the fraction of failures in other modes detected by these tests has not been reported.

Image-uniformity **QA** is applicable to transducers operating in the wide 1 MHz to 40 MHz frequency range, as the requirements for phantoms are not stringent for this test. The other tests could be made applicable up to 40 MHz [15],[16] when the depth of penetration measurement is allowed to be relative, rather than absolute, and phantom stability is verified.

NOTE Phantom manufacturers are encouraged to extend the frequency range to which phantoms are specified to enable relative depth-of-penetration tests of systems operating at fundamental and harmonic frequencies above 23 MHz.

System-manufacturing and repair companies, as well as those performing more complete **performance evaluation** for acceptance, replacement, or research might well employ other or additional tests that are not within the scope of this document. More complete tests than those included in the three levels for periodic testing and for assessment at times of particular importance or concern are specified in IEC 61391-1, IEC 61391-2 and IEC TS 62791. These more complete tests are categorized as **performance evaluation**, rather than **quality**

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

assurance or frequent periodic testing. It is possible that good, automated analysis of the high-contrast sphere tests will reduce both the need for optional tests listed here, and for most, more complete **performance evaluation**. Full assessment of distance-measurement accuracy might still be required if automated, 3D distance measurement calibration is not added to the high-contrast sphere tests.

Uniformity tests of transducers not readily amenable to transducer-element testing by the simple image-uniformity procedures specified here (for example, phased-array and 2D-array transducers) are not included in the scope. They are usually evaluated well by careful performance of the high-contrast sphere tests. System manufacturers are encouraged to provide pulsing patterns of the transducer elements to allow testing of individual elements or small-enough groups of elements to enable users to detect significant element failure or to provide access to another implemented and explained element-test programme.

ULTRASONICS – PULSE-ECHO SCANNERS –

Simple methods for periodic testing to verify stability of an imaging system's elementary performance

1 Scope

This document, which is a Technical Specification, specifies requirements and methods for periodic testing of the quality of diagnostic medical ultrasound systems using reflection-mode (pulse-echo) imaging. Image measurement and interpretation workstations are included.

NOTE Usually, "periodic testing" is referred to as "quality control (QC)" or **quality assurance (QA)**.

This document includes minimum sets of such tests intended for frequent users of medical ultrasound systems, for **quality assurance** professionals in their organizations, or those hired from other quality-control and/or service-provider organizations. The procedures are for a wide range of more common diagnostic ultrasound systems, currently operating from 1 MHz to 40 MHz, although available phantoms meet the specifications only from 1 MHz to 23 MHz.

The tests are defined in three levels, with the simplest and most cost-effective performed most frequently:

Level 1 comprises five quick tests/observations to be performed daily to monthly by those normally operating the systems.

Level 2 includes one necessary test for all systems in addition to those of Level 1, two Level 1 tests performed more rigorously, two tests that are for special situations or equipment, and one that is just optional, included because it is highly developed. Level 2 tests are performed annually by those with meaningful **quality assurance** training.

Level 3 extends the two special situations tests to all systems, adds one optional test and includes a periodic review of the QA programme.

Frequent distance-measurement accuracy tests are recommended in this document only for certain classes of position encoding that are not now known to be highly stable and without bias. **QA** in all dimensions is recommended in this document as the first test for such systems.

The test methodology is applicable for transducers operating in the 1 MHz to 23 MHz frequency range. The types of transducers used with these scanners include

a) electronic phased arrays,

b) linear arrays,

c) convex arrays,

d) mechanical transducers,

e) two-dimensional arrays operated in a 2D imaging mode,

f) transducers operating in 3D imaging mode for a limited number of sets of reconstructed 2D images, and

g) three-dimensional scanning transducers based on a combination of the above types.

All tests on scanners considered here evaluate basic pulse-echo techniques and might detect most failures in other modes. Dedicated Doppler systems, or other systems for detection of blood motion, are excluded from this scope as specialized equipment is required to test them. Such test equipment can be specific to the intended application of the Doppler system.

This document includes definition of terms and specifies methods for measuring the **maximum relative depth of penetration** of real-time ultrasound B-MODE scanners, though this penetration measure is listed as less frequently applied.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-802, *International Electrotechnical Vocabulary – Part 802: Ultrasonics* (available at <http://www.electropedia.org>)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-802 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
quality assurance
QA
regularly performed procedures to ensure consistent performance

Note 1 to entry: Quality control is a part of quality assurance. Another term used is quality maintenance.

3.2
performance evaluation
set of tests performed to assess specific absolute performance of the object tested

Note 1 to entry: Typical times for ultrasound system **performance evaluation** are at pre-purchase evaluation, new and repaired system acceptance testing, according to IEC 61391-1 and IEC 61391-2 and [1],[17],[18],[19],[20],[21],[22], and at times of performance difficulties and end-of-useful-life evaluations. Level 3 **QA** tests include many of those recommended for such **performance evaluation**.

3.3
phantom
device designed to mimic some aspects of the human body for the purposes of testing or training

3.4
addressable patch
smallest addressable group of transducer elements

3.5
pixel value
integer value of a processed signal level or integer values of processed colour levels, provided to the display for a given pixel

Note 1 to entry: In a grey-scale display the **pixel value** is converted to a luminance by some, usually monotonic, function. The set of integer values representing the grey scale runs from 0 (black) to (2^M − 1) (white), where M is a positive integer, commonly called the bit depth. Thus, if M = 8, the largest **pixel value** in the set is 255.

[SOURCE: IEC TS 62791:2022, 3.6]