FINAL
DRAFT

INTERNATIONAL
STANDARD

**ISO/FDIS
22232-1**

ISO/TC **135**/SC **3**

Secretariat: DIN

Voting begins on:
2020-04-08

Voting terminates on:
2020-06-03

Non-destructive testing — Characterization and verification of ultrasonic test equipment —

Part 1: Instruments

Essais non destructifs — Caractérisation et vérification de l'appareillage de contrôle par ultrasons —

Partie 1: Appareils

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/FDIS 22232-1:2020(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 3, *Ultrasonic testing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 138, *Non-destructive testing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This document was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 3, *Ultrasonic testing*.

A list of all parts in the ISO 22232 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Non-destructive testing — Characterization and verification of ultrasonic test equipment —

Part 1: Instruments

1 Scope

This document specifies methods and acceptance criteria within the frequency range of 0,5 MHz to 15 MHz, for assessing the electrical performance of digital ultrasonic instruments for pulse operation using A-scan display, for manual ultrasonic non-destructive testing with single- or dual-transducer probes. This document is also applicable for multi-channel instruments. This document can partly be applicable to ultrasonic instruments in automated systems, but other tests can be needed to ensure satisfactory performance.

This document excludes ultrasonic instruments for continuous waves.

This document also excludes ultrasonic phased array instruments, see e. g. ISO 18563-1. If a phased array instrument has dedicated connectors for single- or dual-transducer probes this document is applicable for these channels.

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.

ISO 5577, *Non-destructive testing — Ultrasonic testing — Vocabulary*

ISO/IEC 17050-1, *Conformity assessment — Supplier's declaration of conformity — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
analogue output
output from the ultrasonic instrument which gives a d.c. voltage nominally proportional to the amplitude of the largest received signal within a monitor gate

3.2
cross talk during transmission
amount of signal transfer from the transmitter output to the receiver input during the transmission pulse, with the ultrasonic instrument set for separate transmitter-receiver operation (dual-transducer probe)

3.3
dead time after transmitter pulse
time interval following the start of the transmitter pulse during which the amplifier is unable to respond to incoming signals, when using the pulse-echo technique, because of saturation by the transmitter pulse

3.4
digital output
output from the ultrasonic instrument which gives a low or high value depending if a signal is below or above a monitor gate threshold

3.5
digitisation sampling error
error introduced into the displayed amplitude of an input signal by the periodic nature of measurements taken by an analogue-to-digital converter

3.6
equivalent input noise
measure of the electronic noise level observed on the ultrasonic instrument screen, and defined by the input signal level, measured at the receiver input terminals, that would give the same level on the screen if the amplifier itself were noiseless

3.7
external attenuator
standard attenuator calibrated to a traceable source used to test the ultrasonic instrument

3.8
fall time
<analogue output> time it takes the proportional gate output to fall from 90 % to 10 % of its peak value

3.9
switched monitor gate signal hold time
time for which the switched output from a monitor gate remains above 50 % of its maximum output following a signal in the monitor gate which is above the threshold

3.10
hold time
<analogue output> time for which the *analogue output* (3.1) is above 50 % of its maximum output following a signal in the monitor gate

3.11
linearity of analogue output
measure of how close the voltage output from the proportional gate is to being directly proportional to the input signal amplitude

3.12
mid-gain position
ultrasonic instrument gain setting which is half way between the maximum and minimum gains

EXAMPLE For an ultrasonic instrument with a maximum gain of 100 dB and a minimum gain of 0 dB, the mid-gain position would be 50 dB.

Note 1 to entry: Mid-gain position is measured in decibels.

3.13
receiver input impedance
characterisation of the internal impedance of the receiver as a parallel resistance and capacitance

3.14
response time
time over which a signal has to be detected by an ultrasonic instrument before it is displayed at 90 % of its peak amplitude

3.15
temporal resolution
minimum time interval over which two pulses are resolved by a drop in amplitude of 6 dB

3.16
switching hysteresis
difference in amplitude between the signal which turns on and the signal which turns off a monitor gate

4 Symbols

Symbol	Unit	Meaning
A_o, A_n	dB	Attenuator settings used during tests
C_{max}	pF	Parallel capacity of receiver at the maximum gain
C_{min}	pF	Parallel capacity of receiver at the minimum gain
D_S	dB	Cross talk during transmission
Δf_g	Hz	Frequency bandwidth measured at the proportional gate output
f_{go}	Hz	Centre frequency measured at the proportional gate output
f_{gu}	Hz	Upper frequency limit at −3 dB, measured at the proportional gate output
f_{gl}	Hz	Lower frequency limit at −3 dB, measured at the proportional gate output
f_{gmax}	Hz	Frequency with the maximum amplitude in the frequency spectrum measured at the proportional gate output
f_0	Hz	Centre frequency
f_u	Hz	Upper frequency limit at −3 dB
f_l	Hz	Lower frequency limit at −3 dB
f_{max}	Hz	Frequency with the maximum amplitude in the frequency spectrum
Δf	Hz	Frequency bandwidth
G_D	dB	Dynamic range
I_{max}	A	Amplitude of the maximum current that can be driven by the proportional gate output
N	—	Number of measurements taken
n_{ein}	$V/\sqrt{Hz}$	Equivalent input noise
R_l	Ω	Termination resistor
R_{max}	Ω	Input resistance of receiver at the maximum gain
R_{min}	Ω	Input resistance of receiver at the minimum gain
S	dB	Attenuator setting
ΔT	s	Time increment
t_A	s	Temporal resolution
t_d	s	Pulse duration
T_{final}	s	Time to the end of a distance-amplitude curve
T_0	s	Time to the start of a distance-amplitude curve
t_m	s	Measured rise time
t_r	s	Transmitter pulse rise time from an amplitude of 10 % to 90 % of the peak amplitude
t_s	s	Oscilloscope rise time
V_E	V	Input voltage at the receiver
V_{ein}	V	Equivalent input noise voltage
V_{in}	V	Input voltage
V_l	V	Proportional gate output voltage with load resistor
V_{max}	V	Maximum input voltage of the receiver
V_{min}	V	Minimum input voltage of the receiver

Symbol	Unit	Meaning
V_o	V	Proportional gate output voltage with no load resistor
V_{50}	V	Voltage amplitude of the transmitter pulse with a 50 Ω loading of the transmitter
V_{75}	Ω	Voltage amplitude of the transmitter pulse with a 75 Ω loading of the transmitter
Z_o	Ω	Output impedance of transmitter
Z_A	Ω	Output impedance of analogue output

5 General requirements of conformity

An ultrasonic instrument complies with this document if it fulfils all of the following requirements:

a) the ultrasonic instrument shall comply with Clause 7 within the frequency range of 0,5 MHz to 15 MHz;

b) a declaration of conformity according to ISO/IEC 17050-1 shall be available, issued by either the manufacturer operating a certified quality management system (e.g. in accordance with ISO 9001) or by an organization operating an accredited test laboratory (e.g. in accordance with ISO/IEC 17025);

c) the ultrasonic instrument shall be clearly marked to identify the manufacturer, and carry a unique serial number or show a permanent reference number from which information can be traced to the data sheet;

d) a manufacturer's technical specification corresponding to the ultrasonic instrument shall be available, which defines the performance criteria in accordance with Clause 6.

6 Manufacturer's technical specification for ultrasonic instruments

The manufacturer's technical specification for an ultrasonic instrument shall contain, as a minimum, the information listed in Table 1. The actual values quoted for the parameters listed in this clause shall be the results obtained from the tests described in Clause 7, with tolerances given as indicated.

Where applicable, these details should also include sampling rates used, effect of pulse repetition frequency or display range on the sampling rate and response time. In addition, the principles of any algorithm used to process data for display shall be described and the version of any software installed shall be quoted.

Table 1 — Technical characteristics to be shown in the instrument's technical specification

Information	Type of information	Remarks
General features		
Size	OI	Width (mm) × height (mm) × depth (mm)
Weight	OI	At an operational stage including all batteries
Type(s) of power supply	OI	—
Type(s) of instrument sockets	OI	—
Battery operational time	M	At fully charged new batteries
Number and type of batteries	OI	—
Stability against temperature	M	—
Key M measurement OI other information		

Table 1 *(continued)*

Information	Type of information	Remarks
Stability after warm-up time	M	—
Stability against voltage variations	M	—
Temperature and voltage (mains and/or batteries) ranges in which the instrument operates in accordance with the technical specification (operation and storage)	OI	When a warm-up time is necessary, its duration shall be stated
Form of indication given when a low battery voltage takes the ultrasonic instrument performance outside of the specification	OI	—
Pulse repetition frequencies (PRFs)	M	Minimum and maximum values
Maximum power consumption	OI	W
Protection grade	OI	—
Environment	OI	For example: restriction of hazardous substances (RoHS), explosive atmosphere (ATEX), vibration, humidity
Multi-channel configuration	OI	Number of channels controlled simultaneously (parallel operation) and number of available channels (multiplexed operation)
Extension of the number of channels by interconnection of instruments	OI	—
Available measurement units	OI	For example: mm, inches, %, dB, V
Display		
Screen size and resolution	OI	—
Range of sound velocities	OI	—
Time base delay range	OI	—
List of available views	OI	—
Screen refresh rate for A-scan presentations	OI	—
Maximum digitization frequency without processing	OI	—
Digitization frequency with processing	OI	For example: interpolation
Digitizer vertical resolution	OI	In bits
Highest digitized frequency	OI	—
Time base deviation	M	—
Response time	M	—
Inputs/outputs		
Signal unrectified output (i.e. radio frequency, RF) and/or rectified available on the output socket	OI	—
Number and characteristics of logic and analogue control outputs	OI	Including the wiring diagram
Number and characteristics of encoder inputs	OI	Including the wiring diagram
Power input	OI	AC, DC, voltage range, power (W)
Key M measurement OI other information		

Table 1 *(continued)*

Information	Type of information	Remarks
Available power supply for external devices	OI	Voltage, power
Synchronization input/output	OI	—
Transmitter		
Shape of transmitter pulse and, where applicable, polarity	OI	i.e. rectangular, unipolar, bipolar, arbitrary pulse
Transmitter voltage, pulse rise time, fall time and duration	M	—
Output impedance	M	—
Possibility to apply different voltages on each channel	OI	—
Maximum power available per transmitter	OI	—
Receiver		
Characteristics of the gain control, i.e. range in decibels, value of increments	OI	—
Characteristics of the logarithmic amplifier	OI	—
Input voltage at full screen height (FSH)	OI	—
Maximum input voltage	M	V_{max} measured in 8.9.4.1
Linearity of vertical display	M	—
Frequency response	M	—
Dead time after transmitter pulse	M	—
Equivalent input noise	M	$\frac{nV}{\sqrt{Hz}}$
Dynamic range	M	—
Input impedance	M	—
Time-corrected gain (TCG)	M	—
Possibility to apply different gain values on each channel	OI	
Cross talk between transmitter and receiver	M	—
Gain linearity	M	—
Data acquisition		
Transfer rate between the instruments and the external storage unit	OI	Including type of interface
Maximum number of A-scans stored per second	OI	A-scan characteristics shall be stated
Maximum number of C-scans stored per second	OI	C-scan characteristics shall be stated
Maximum number of samples per A-scan	OI	—
Gates		
Number of gates	OI	—
Threshold operation	OI	For example: coincidence or anti-coincidence
Measurement mode	OI	For example: threshold, max amplitude, zero crossing

Key

M measurement

OI other information