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Standard Guide for Measuring Some Electronic Characteristics of Ultrasonic Testing Instruments¹

This standard is issued under the fixed designation E1324; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This guide describes procedures for electronically measuring the following performance-related characteristics of some sections of ultrasonic instruments:

1.1.1 Power Supply Section:

line regulation,
battery discharge time, and
battery charge time.

1.1.2 Pulser Section:

pulse shape,
pulse amplitude,
pulse rise time, pulse length, and
pulse frequency spectrum.

1.1.3 Receiver Section:

vertical linearity,
frequency response,
noise and sensitivity, and
dB controls.

1.1.4 Time Base Section:

horizontal linearity, and
clock (pulse repetition rate).

1.1.5 Gate/Alarm Section:

delay and width,
resolution,
alarm level,
gain uniformity,
analog output, and
back echo gate.

1.2 This guide complements Practice E317 and is not intended for evaluating the performance characteristics of ultrasonic testing instruments on the inspection/production line.

NOTE 1—No access to internal circuitry is required.

1.3 Units—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are

mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

E317 Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Testing Instruments and Systems without the Use of Electronic Measurement Instruments
E1316 Terminology for Nondestructive Examinations

2.2 ISO Standards:³

ISO 10012 Measurement Management Systems—Requirements for Measurement Processes and Measuring Equipment
ISO 17025 General Requirements for the Competence of Testing and Calibration Laboratories

2.3 Other Standard:⁴

IEEE Std. 100, IEEE Standard Dictionary of Electrical and Electronics Terms

3. Summary of Guide

3.1 The electronic performance of each section is measured by identifying that portion of the electrical circuit of the

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.

⁴ Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331

*A Summary of Changes section appears at the end of this standard

instrument which comprises the section, applying the recommended stimulus or load, or both, and performing the required measurements using commercially available electronic test equipment. These data are then summarized in tabular or graphical form as performance-related values which can be compared with corresponding values of other ultrasonic testing instruments or of values for the same instrument obtained earlier (see Section 12 for a suggested reporting format).

3.2 The following describes the sections of the ultrasonic instrument and their interrelations during measurement:

3.2.1 *Power Supply Section*—The power supply section is that portion of the total instrument circuitry which supplies the regulated DC voltages required to power all other sections of the ultrasonic instrument, including the high voltage (that is, pulser and display voltage) circuitry.

3.2.2 *Pulser Section*—The pulser section is that portion of the total instrument circuitry which generates the electrical pulse used to energize the ultrasonic search unit. The pulser section may also include the pulse-shape modification controls such as pulse length, damping, or tuning controls.

3.2.3 *Receiver Section*—The receiver section is that portion of the total instrument circuitry which amplifies, or modifies, or both, the radio frequency (RF) pulses received from the ultrasonic search unit. This includes the RF amplifiers, detectors, video amplifiers, suppression and filtering, and the display vertical deflection circuits. Some instruments may not contain all of these circuits.

3.2.3.1 *Time Variable Gain (TVG)*, (alternatively referred to as Distance Amplitude Correction (DAC), Time Controlled Gain (TCG), etc.) and reject or threshold, while part of the receiver section, should be turned off while making measurements unless otherwise specified by the user.

3.2.4 *Gate/Alarm Section*—This section monitors the signals in the receiver section to detect the presence or absence of significant indications. The gate may include attenuation or gain controls. This section is considered separate from the receiver section for the purposes of this guide. The alarm signal may be audible, a voltage proportional to the indication amplitude, or a mark on voltage or current sensitive paper or some combination of these.

3.2.5 *Time Base Section*—The time base section provides the linear horizontal sweep, or baseline. It includes the horizontal deflection circuits and the clock and delay circuits that control repetition rate and positioning of signals on the baseline.

4. Significance and Use

4.1 The recommended measurement procedures described in this guide are intended to provide performance-related measurements that can be reproduced under the specified test conditions using commercially available test instrumentation. These measurements indicate capabilities of sections of the ultrasonic testing instrument independent of specific transducers or examination conditions. Measurements are made from normally available connectors or test points so that no access to internal circuitry is required. Further, this guide is not intended for service, calibration, or maintenance of circuitry for which the manufacturer's instructions are available. It is intended

primarily for pulse echo flaw detection instruments operating in the nominal frequency range of 100 kHz to 25 MHz, but the procedures are applicable to measurements on instruments utilizing significantly higher frequency components.

4.2 These procedures can be applied to the evaluation of any pulse-echo ultrasonic testing instrument which can be described as a combination of the electronic sections discussed in this guide.

NOTE 2—These procedures are not intended to preclude the use or application of equipment for which some or all of the measurement techniques of this document are not applicable.

4.3 An ultrasonic testing instrument that cannot be completely described as a combination of the electronic sections discussed in this practice can be partially evaluated. Each portion of the ultrasonic testing instrument that is evaluated must fit the description for the corresponding section.

4.4 This guide is meant to be used by electronic personnel to evaluate the electronic system components and not the ultrasonic system characteristics.

5. Apparatus

5.1 *Ultrasonic Instrument*—Any electronic instrument comprised of a power supply, pulser, clock, receiver, and a sweep and display section to generate, receive, and display electrical signals related to ultrasonic waves for examination purposes.

NOTE 3—Some ultrasonic instruments do not include a cathode ray tube display. Some sections of this guide may not apply to these instruments, or may be applicable only with modifications. Such modifications should be made only by personnel competent in electronics.

5.2 *Voltmeter*—Any instrument(s) capable of measuring the AC line and DC battery voltages required for 7.1 or 7.2.

5.3 *Variable Transformer*—An autotransformer or other device capable of supplying variable AC power to the ultrasonic instrument over the full range of voltages and waveforms specified by the manufacturer.

5.4 *Pulser Load*—Unless otherwise requested by the using parties, the pulser load should be a 50 Ω noninductive resistor, preferably mounted in a shielded coaxial assembly. The resistor must be able to withstand the maximum peak pulser voltage. The impedance of the resistor should be checked at the anticipated operating frequency to ensure that it is noninductive. Other impedances may be used if specified.

5.5 *Spectrum Analyzer*—Any spectrum analyzer (and probe assembly, if required) that is capable of analyzing the electrical pulse from the pulser module and displaying the frequency components of the pulse as described in 8.3. A recording of the display (photograph or chart recorder) is desirable.

5.6 *Probe*—A wide band high input impedance (≥ 10 k Ω) attenuating (100 $\times$ or 50 $\times$) probe to reduce the pulse amplitude, as delivered to the oscilloscope and the spectrum analyzer, to a level that (a) will not harm the equipment and (b) will allow for frequency and time analysis without significantly altering the pulse shape. The probe output impedance should match the input impedance of the measurement instrument. (If the impedance is high, a terminating resistance may be required at the input to match the output impedance of the probe.) The