Designation: E 1161 – 03

Standard Test Method for Radiologic Examination of Semiconductors and Electronic Components[1]

This standard is issued under the fixed designation E 1161; 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 test method provides a standard procedure for nondestructive radiographic examination of semiconductor devices, electronic components, and the materials used for construction of these items. This test method covers the radiographic examination of these items for possible defective conditions such as extraneous material within the sealed case, improper internal connections, voids in materials used for element mounting, or the sealing glass, or physical damage.

1.2 The quality level and acceptance criteria for the specimens being examined shall be specified in the detail drawing, purchase order or contract.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 94 Guide for Radiographic Examination[2]

E 431 Guide to Interpretation of Radiographs of Semiconductors and Related Devices[2]

E 543 Practice for Agencies Performing Nondestructive Testing[2]

E 801 Practice for Controlling Quality of Radiological Examination of Electronic Devices[2]

E 1255 Practice for Radioscopy[2]

E 1316 Terminology for Nondestructive Examinations[2]

2.2 *ASNT Standard:*[3]

ANSI/ASNT CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel

SNT-TC-1A Personnel Qualification and Certification

2.3 *AIA Documents:*

NAS-410 Certification and Qualification of Nondestructive Test Personnel[4]

2.4 *Federal Standard:*

FED-STD-595 Color (Requirements for Individual Color Chits)[5]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, see Terminology E 1316.

4. Significance and Use

4.1 This test method is useful for determination of voiding in semiconductor element to header mounting material, glass seal, and lid seal areas. It is also useful for examination of the internal cavities of devices for extraneous material, wire dress, and bond placement for unattached elements.

5. Basis of Application

5.1 The following items are subject to contractual agreement between the parties using or referencing this standard.

5.1.1 *Personnel Qualification*—If specified in the contractual agreement, personnel performing examinations to this standard shall be qualified in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, NAS-410, or a similar document and certified by the employer or certifying agency, as applicable. The practice or standard used and its applicable revision shall be identified in the contractual agreement between the using parties.

5.1.2 *Qualification of Nondestructive Testing Agencies*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Practice E 543. The applicable edition of Practice E 543 shall be specified in the contractual agreement.

5.1.3 *Surface Preparation*—The pre-examination surface preparation criteria shall be as specified in the contractual agreement.

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[1] This test method is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.01 on Radiology (X and Gamma) Methods.

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[2] *Annual Book of ASTM Standards*, Vol 03.03.

[3] Available from the American Society for Nondestructive Testing, 1711 Arlingate Plaza, P.O. Box 28518, Columbus, OH 43228.

[4] Aerospace Industries Association (AIA), 1050 Eye St., NW, Washington, DC 20005.

[5] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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5.1.4 *Timing of Examination*—The timing of examination shall be as specified in the contractual agreement.

5.1.5 *Extent of Examination*—The extent of examination shall be in accordance with paragraph 9.2.1.1 or 9.2.1.2 unless otherwise specified.

5.1.6 *Reporting Criteria/Acceptance Criteria*—Reporting criteria for the examination results shall be as specified in the contractual agreement. Since acceptance criteria (for example, for reference radiographs) are not specified in this standard, they shall be specified in the contractual agreement.

5.1.7 *Reexamination of Repaired/Reworked Items*—Reexamination of repaired/reworked items is not addressed in this standard and if required shall be specified in the contractual agreement.

6. Apparatus

6.1 *Radiation Source*—Only X-radiation generating equipment shall be used. It shall provide the proper quality level and film density when used in accordance with this test method.

6.1.1 *Focal Spot*—The focal spot size shall be such that the resolution specified in 9.4 can be achieved.

6.2 *Radiographic Viewer*, capable of resolving a flaw of 0.025 mm at a density of 1.0 to 2.0.

6.3 *Holding Fixtures*, capable of holding specimens in the required positions without interfering with the accuracy or ease of interpretation.

6.4 *Lead-Topped Tables*—Perform all semiconductor and electronic component radiographic examination on a lead-topped table. The lead shall be at least 1.5 mm thick.

6.5 *Film Holders*—Film holders and cassettes shall be light tight. They may be flexible vinyl, plastic, or other durable material.

6.6 *IQI's*, shall be in accordance with Practice E 801.

6.7 *Density Measurement Apparatus*—Use a densitometer capable of repeatable measurements within 0.02 density units and step wedge comparison films.

7. Materials

7.1 *Films*—Films used for radiographic examination of semiconductors and electronic components must be very fine grain. The grain must be fine enough to permit resolution of discontinuities that are 0.025 mm.

7.2 *Non-Film Techniques, When Specified*—The use of non-film techniques is permitted if agreed upon between purchaser and supplier and the equipment is capable of producing results of equal quality when compared with film techniques, and all requirements of this test method are complied with, except those pertaining to the actual film. Types of permanent records using non-film techniques if required are, for example, digital magnetic tape or disc, video tape, and photograph of video image.

8. Calibration

8.1 The step wedge comparison films used for densitometer calibration shall be currently calibrated with traceability to the National Institute of Standards and Technology.

9. Procedure

9.1 Select or adjust the X-ray exposure factors, voltage, milliampere setting, and time settings as necessary to obtain satisfactory exposures and image detail within the sensitivity requirements for the device or defect features toward which the radiographic examination is directed. The X-ray voltage shall be the lowest consistent with these requirements and shall not exceed 150kV.

9.2 *Mounting and Views*—Mount the devices in the holding fixture so that the devices are not damaged or contaminated and are in the proper plane as specified. The devices may be mounted in any type of fixture and masking with lead diaphragms or barium clay may be employed to isolate multiple devices. The fixtures or masking materials must not block the view from the X-ray source to the film of any portion of the body of the device that requires examination.

9.2.1 *Views*:

9.2.1.1 Take one view of flat packages, dual-in-line packages, and single-ended cylindrical devices, unless otherwise specified, with the X-rays penetrating in the *Y* direction as shown in Figs. 1 and 2. When more than one view is required, take the second and third views, as applicable, with the X-rays penetrating in the *Z* and *X* directions respectively. Position the die/cavity interface as close as possible to the film to avoid distortion.

9.2.1.2 Take one view of stud-mounted and cylindrical axial lead devices, unless otherwise specified, with the X-rays penetrating in the *X* direction as defined in Figs. 1 and 2. When more than one view is required, take the second and third views, as applicable, with the X-rays penetrating in the *Z* direction and at 45° between the *X* and *Z* directions. Position the die/cavity interface as close as possible to the film to avoid distortion.

9.3 *Radiographic Image Quality Indicators (IQI's)*—Each radiograph shall have at least two IQI's exposed with each view located (and properly identified) in opposite corners of the film. These IQI's shall be selected and used in accordance

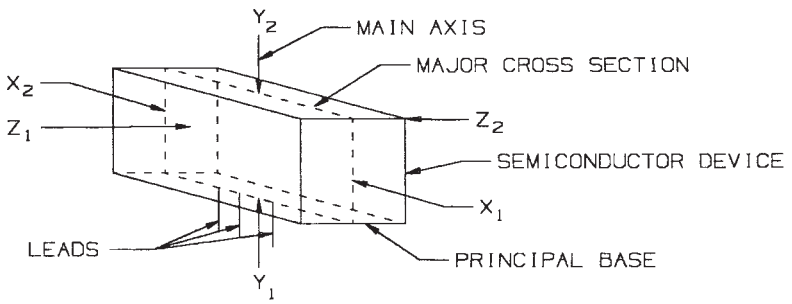

FIG. 1 Orientation of Noncylindrical Semiconductor Device to Direction of Accelerating Force

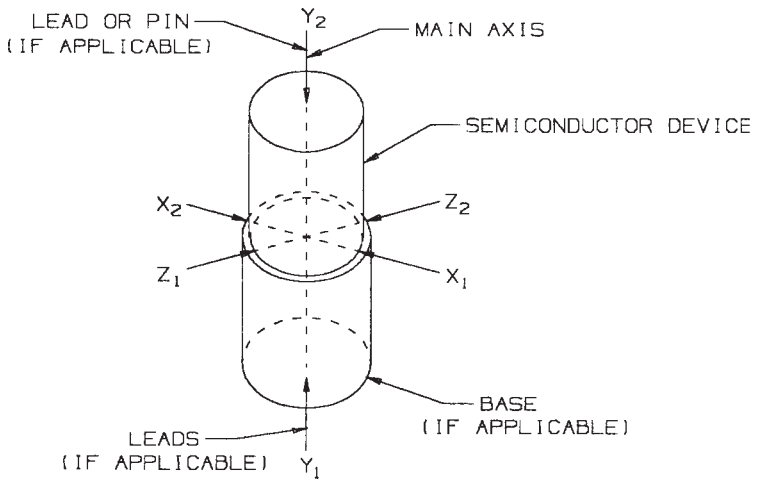

FIG. 2 Orientation of Cylindrical Semiconductor Device to Direction of Accelerating Force

with, and shall meet the requirements of, Practice E 801. For radioscopic images (where allowed) the additional requirements of Practice E 1255 shall be met.

9.4 *Film and Marking*—Place the radiographic film in a film holder on the lead-topped table. Identify the film using techniques that print the following information, photographically, on the radiograph:

9.4.1 *Marking*:

9.4.1.1 Device manufacturer's name or code identification number.

9.4.1.2 Device type or part number.

9.4.1.3 Production lot number or date code or examination lot number.

9.4.1.4 Radiographic film view number and date.

9.4.1.5 Device serial or cross-reference numbers, when applicable.

9.4.1.6 X-ray laboratory identification, if other than device manufacturer.

9.4.2 *Serialized Devices*—When device serialization is required, identify each device readily by a serial number. Radiograph in consecutive, increasing serial order. When a device is missing, the blank space shall contain either the serial number or other X-ray objects to readily identify and correlate X-ray data. When large skips occur within serialized devices, the serial number of the last device before the skip and the first device after the skip may be used in place of the multiple opaque objects.

9.4.3 *Special Device Marking*—When specified, identify the devices that have been X-rayed and found acceptable with a contrasting color dot on the external case. The dot shall be approximately 1.5 mm in diameter. The color selected from FED-STD-595 shall be any shade agreed upon between client and purchaser. Place the dot so that it is readily visible but does not obliterate other device marking.

9.5 *Examinations*—Select the X-ray exposure factors to achieve resolution of a flaw of 0.0254 mm, less than 10 % distortion, and a film density between 1 and 2 in the area of interest of the device image. Make radiographs for each view required.

9.6 *Processing*—Process the radiographic film in accordance with Guide E 94 unless otherwise specified, and process film so that it is free of processing defects such as fingerprints, scratches, fogging, chemical spots, blemishes, and the like.

9.7 *Interpretation of Radiographs*—Utilizing the equipment specified herein, inspect radiographs to determine that each device conforms to the criteria agreed upon by the seller and the buyer. Guide E 431 provides many useful illustrations which may aid in this interpretation. Interpretation of the radiograph shall be made under low light level conditions without glare on the radiographic viewing surface. Examine the radiographs on a suitable illuminator with variable intensity or on a viewer suitable for radiographic examination on projection-type viewing equipment. View the radiograph at a magnification between 6× and 25×. Viewing masks may be used when necessary. Any radiograph not clearly illustrating the features in the radiographic quality standards is not acceptable and another radiograph of the devices shall be taken.

10. Precision and Bias

10.1 The precision and bias of this test method are dependent upon the calibration of the film comparison step wedge and the use of appropriate paragraphs of Practice E 801.

11. Keywords

11.1 electronic devices; nondestructive testing; radiographic; radioscopy; semiconductors; X-Ray

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