Designation: E801 – 16

Standard Practice for Controlling Quality of Radiographic Examination of Electronic Devices[1]

This standard is issued under the fixed designation E801; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This practice relates to the radiographic examination of electronic devices for internal discontinuities, extraneous material, missing components, crimped or broken wires, and defective solder joints in cavities, in the encapsulating materials, or the boards. Requirements expressed in this practice are intended to control the quality and repeatability of the radiographic images and are not intended for controlling the acceptability or quality of the electronic devices imaged.

NOTE 1—Refer to the following publications for pertinent information on methodology and safety and protection: Guides E94 and E1000, and "General Safety Standard for Installation Using Non-Medical X Ray and Sealed Gamma Ray Sources, Energies Up to 10 MeV Equipment Design and Use," *Handbook No. 114*.[2]

1.2 If a nondestructive testing agency as described in Practice E543 is used to perform the examination, the testing agency should meet the requirements of Practice E543.

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:*[3]

E94 Guide for Radiographic Examination

E543 Specification for Agencies Performing Nondestructive Testing

E1000 Guide for Radioscopy

E1255 Practice for Radioscopy

E1316 Terminology for Nondestructive Examinations

3. Terminology

3.1 *Definitions*—Refer to Terminology E1316, Section D.

4. Direction of Radiation

4.1 When not otherwise specified, the direction of the central beam of radiation shall be as perpendicular (±5 %) as possible to the surface of the film or detector.

5. Image Quality Indicators (IQI's)

5.1 The quality of all levels of radiographic examination shall be determined by IQI's conforming to the following specifications:

5.1.1 The IQI's shall be fabricated of clear acrylic plastic with steel covers, lead spheres, gold or tungsten wires, and lead numbers. The steel covers serve as shims.

5.1.1.1 The IQI's shall conform to the requirements of Fig. 1.

5.1.1.2 The IQI's shall be permanently identified with the appropriate IQI number as shown in Fig. 1. The number shall be affixed by mounting a 0.125-in. (3.18-mm) tall lead number on the flat bottom of a 0.250-in. (6.35-mm) diameter hole. The identification number shall be located as shown in Fig. 1 and shall be of sufficient contrast to be clearly discernible in the radiographic image.

5.1.1.3 Each semiconductor IQI will have a serial number permanently etched or engraved on it. Each serial number will be traceable to the calibration image supplied by the manufacturer. The manufacturer shall radiograph the IQI with lead markers identifying the serial number. See Fig. 2.

6. Application of the Image Quality Indicator (IQI)

6.1 The application of the IQI's shall be made in such a manner as to simulate as closely as possible the device being examined. To accomplish this objective, a set of eight IQI's is provided. These provide a range of cover thickness (of steel shim stock) that is radiographically equivalent to the range of devices from glass diodes or plastic-encapsulated circuits (number one) to large power or hybrid circuit devices (number eight). Wire size increases with shim stock thickness because

[1] This practice 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) Method.

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[2] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

[3] 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.

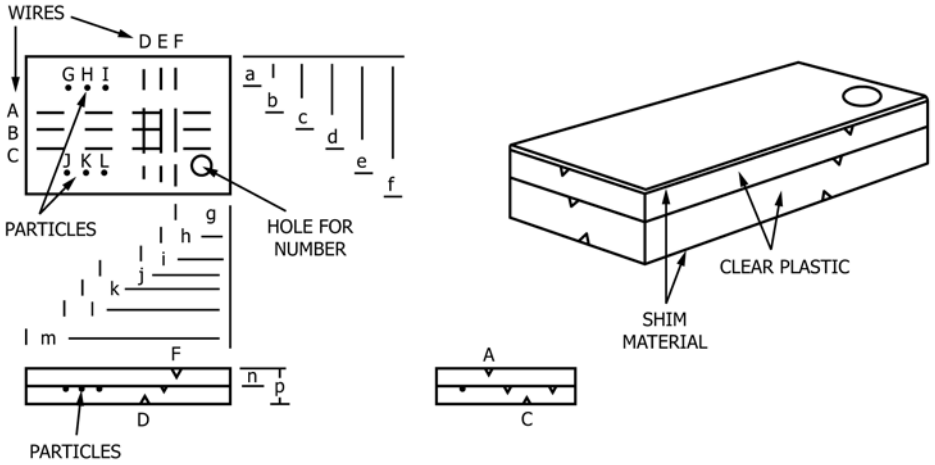


FIG. 1 Image Quality Indicator for Electron Devices

Dimensions, in. (mm)

a.	0.187 (4.750)	f.	1.00 (25.40)	k.	1.125 (28.575)
b.	0.375 (9.525)	g.	0.375 (9.525)	l.	1.313 (33.350)
c.	0.500 (12.700)	h.	0.500 (12.700)	m.	1.50 (38.10)
d.	0.625 (15.875)	i.	0.625 (15.875)	n.	0.125 (3.175)
e.	0.813 (20.650)	j.	0.938 (23.825)	p.	0.250 (6.350)

Particle Diameter, in. (mm)

G. 0.015(0.381)
H. 0.010(0.254)
I. 0.008(0.203)
J. 0.006(0.152)
K. 0.004(0.102)
L. 0.002(0.051)

Shim and Wire Specifications

IQI Number	Shim Thickness, in. (mm)	Wire Diameters, in. (mm)					
		A	B	C	D	E	F
1	0	0.002	0.001	0.0005	0.0005	0.001	0.002
	0	(0.051)	(0.025)	(0.0127)	(0.0127)	(0.025)	(0051)
2	0.002	0.002	0.001	0.0005	0.0005	0.001	0.002
	(0.051)	(0.051)	(0.025)	(0.0127)	(0.0127)	(0.025)	(0.051)
3	0.005	0.002	0.001	0.0005	0.0005	0.001	0.002
	(0.127)	(0.051)	(0.025)	(0.0127)	(0.0127)	(0.025)	(0.051)
4	0.007	0.002	0.001	0.0005	0.0005	0.001	0.002
	0.178	(0.051)	(0.025)	(0.0127)	(0.0127)	(0.025)	(0.051)
5	0.010	0.003	0.002	0.001	0.001	0.002	0.003
	(0.254)	(0.076)	(0.051)	(0.025)	(0.025)	(0.051)	(0.076)
6	0.015	0.003	0.002	0.001	0.001	0.002	0.003
	(0.381)	(0.076)	(0.051)	(0.025)	(0.025)	(0.051)	(0.076)
7	0.025	0.005	0.003	0.002	0.002	0.003	0.005
	(0.635)	(0.127)	(0.076)	(0.051)	(0.051)	(0.076)	(0.127)
8	0.035	0.005	0.003	0.002	0.002	0.003	0.005
	(0.889)	(0.127)	(0.076)	(0.051)	(0.051)	(0.076)	(0.127)

NOTE 1—Use additional layers of shim material as required. The layers shall be 1 by 1.625 in. (25.4 by 41.275 mm). The additional shim material shall be identified by the placement of lead numbers which denote the thickness immediately adjacent to the IQI during exposure, or as an alternative, documented on the radiographic technique.

NOTE 2—Tolerance is ±0.001 in. (0.025 mm) where dimensions are 0.000 and ±0.003 in. (0.076 mm) where dimensions are 0.00.

NOTE 3—Bond materials together with cyanoacrylic or equivalent fast-drying epoxy.

NOTE 4—Particle holes are 0.031 in. (0.787 mm) nominal diameter.

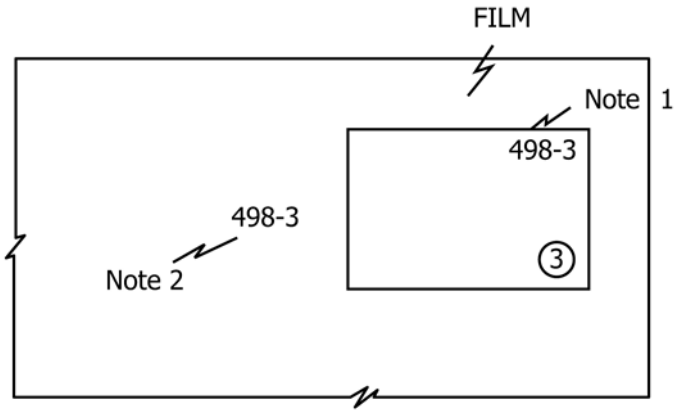
NOTE 5—Tolerance on particle diameter is + 0.0003 in. (0.0076 mm).

NOTE 6—Wire grooves are 0.007 in. (0.178 mm) depth with 90° inclusive angle.

NOTE 7—The number hole is 0.25 in. (0.635 mm) nominal diameter and 0.125 in. (0.318 mm) deep.

FIG. 1 Image Quality Indicator for Electron Devices

higher power devices that have thicker coverings normally use larger interconnecting wires than small signal devices that use thin coverings. Particle size is normally independent of device type, so these remain constant.



NOTE 1—Permanently etched or engraved serial number.
NOTE 2—⅛ in. lead markers corresponding to serial number.

FIG. 2 Arrangement of IQI and Lead Serial Number for Calibration Image

6.2 The IQI used shall be the one with a radiographic density or grey level nearest to that of the electronic device being examined. The radiographic density or grey level is measured on an area of the IQI image that contains no wire or particle images. It shall be measured using a calibrated densitometer in the case of film, or by pixel grey level value in the case of radioscopic examination. When necessary to meet the requirements of 8.1.1, additional shim stock shall be used. The shim(s) shall be of the same type of steel as in the IQI and shall be placed under the IQI. The additional shim(s) shall exceed the IQI outside dimensions by at least 0.125 in. (3.18 mm) on at least one side. The thickness of the shims shall be noted with lead numerals placed adjacent to the shimmed IQI or documented on the radiographic technique.

NOTE 2—Radiographic film densities shall be measured with a calibrated densitometer. When films are exposed simultaneously in one film holder, density variations should be determined on the single or combined films, depending on the manner in which they are read and interpreted. Radiographic film density shall be in the range of 1.0 to 3.5, unless otherwise specified.

6.3 The image distortion shall not exceed 10 % unless a higher or lower percentage is agreed upon between the purchaser and the supplier. Measurements for computation of image distortion shall be made in the grid formed by the crossing wires.

6.3.1 Determine percent image distortion (Note 3) as follows:

$$D = [(S_M - S_A)/S_A] \times 100$$

where:

D = percent distortion,
S_M = wire spacing as measured on the radiograph, and
S_A = actual wire spacing.

NOTE 3—Distortion may be positive or negative.

6.4 Particles *G* through *L* shall be visible in the image when IQI's 1 through 7 are used and particles *G* through *K* shall be visible in the image when IQI number 8 is used.

6.4.1 If shims are required, the number and size of particles that can be resolved shall be agreed on between the purchaser and the supplier.

7. Positioning of IQI's

7.1 The IQI's shall be placed so that the plane of the IQI is normal to the radiation beam.

7.1.1 The IQI's used for each exposure or field of view shall be positioned at the outer edges of the film or field of view but not impeding the area of interest being examined.

8. Number of IQI's

8.1 Two IQI's shall be used for each radiograph as shown in Fig. 3. The IQI's shall be located at diagonally opposite corners of the film as shown in Fig. 3. In radioscopic examinations, IQI qualification is required at least once during examination of similar parts. The procedure for radioscopic IQI qualification shall be established to subject the IQI's to the same image magnification and distortion as the parts will be subjected to during inspection and the procedure shall be documented on the radioscopic scan plan/technique.

8.1.1 The radiographic density or grey level of the IQI's shall bracket the radiographic density or grey level of the devices being examined. Additional shim(s) may be used as described in 6.2 to achieve this requirement.

9. Part Identification

9.1 In radiography, the image of identification markers for the coordination of the part with the film shall appear on the film, so as not to interfere with the interpretation of the radiograph and so that it is evident that the complete part order was obtained. These marker positions shall coincide with the part serial number.

9.2 In radioscopy, the image header for each part image shall include a part serial number for traceability and to ensure that the complete part order was obtained.

10. Identification of the Image

10.1 In both radiography and radioscopy, a system of positive identification of the image shall be provided in addition to Section 9. Any or all of the following may appear: the name of the examining laboratory, the date, the part number, the serial number, the date code, the view, and whether original or subsequent exposure.

11. Multiple-Film Techniques

11.1 Film techniques with two or more films of equal or different speeds in the same holder will be permitted, provided that the appropriate wires and particles in the IQI for a specific area are demonstrated.

12. Non-Film Techniques

12.1 The use of non-film imaging techniques will be permitted, provided that the applicable IQI wires and particles are demonstrated in the resultant image.

13. Image Quality

13.1 The radiographic image shall be free of blemishes that interfere with its interpretation.

14. Source-Film Distance

14.1 Any source-film distance will be satisfactory provided that the required IQI quality level is attained.

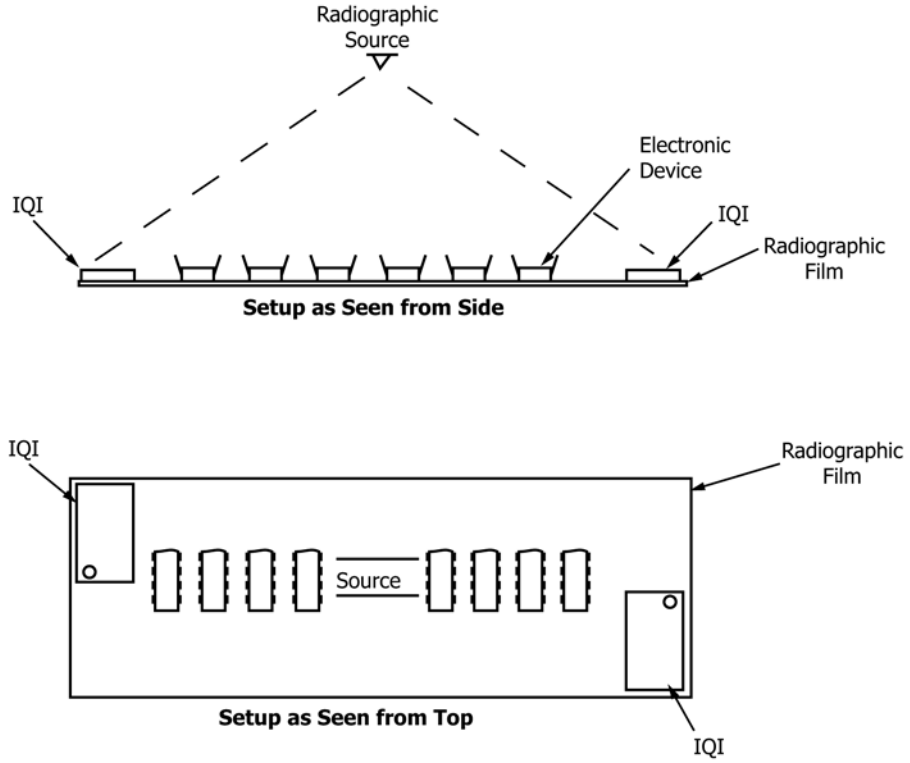


FIG. 3 Typical Image Quality Indicator Arrangement for Electronic Device

15. Records

15.1 Complete records of the radiographic technique or scan plan details, or both, shall be maintained by the examining laboratory.

15.2 A calibration image shall be made by exposing the individual semiconductor IQI at the proper distance from the focal spot. The IQI shall be centered in the beam during this exposure. The certificate shall show the actual dimensions of the grids formed by the cross wires and the parallel variances within the grid. It shall also state the actual size of each particle.

16. Keywords

16.1 electronic devices; IQI's; radiography; radioscopy; shim; wire