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# **RADIOGRAPHIC INSPECTION OF ELECTRONIC COMPONENTS**

## **ESCC Basic Specification No. 20900**

|         |              |
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## 1. SCOPE

### 1.1 GENERAL

This specification describes the equipment and procedures to be used for the internal inspection of electronic components by radiographic means. When radiographic inspection is called for in an ESCC specification, it shall be used in conjunction with the relevant Ancillary ESCC Specification, numbered in the 209XXXX series, wherein the specific accept/reject criteria are prescribed (see Ancillary Specifications).

#### NOTES:

1. This type of inspection is not intended as an alternative to pre- and post- assembly visual examination.
2. For certain component types, the opacity of the construction materials may effectively prevent radiographic identification of certain types of defects or materials from some or all possible viewing angles. This factor should be considered in relation to the design of the component when the application of this test method is specified.

### 1.2 ALTERNATIVE STANDARDS

Where the configuration of a particular component is not in accordance with the examples shown in an Ancillary Specification, or where current in-house inspection drawings or standards (accepted in the PID) are to be used, it shall be the Manufacturer's responsibility to obtain the formal interpretation of the ESCC Executive, concerning any deviation.

## 2. EQUIPMENT AND MATERIALS

The equipment and materials for this test shall include:-

- (a) Radiographic equipment with a sufficient energy level to penetrate the component. The focal distance shall be adequate to maintain a sharply defined image of an object with a major dimension of 0.0254mm.
- (b) Radiographic film: Very fine grain industrial X-ray film grade, either single or double emulsion.
- (c) Radiographic viewer: Capable of 0.0254mm resolution in major dimension.
- (d) Holding fixtures: Capable of holding component in the required positions without interfering with the accuracy or ease of image interpretation of all specified defects, or damaging component.
- (e) Film holder: A 1.6mm minimum lead-topped table or lead-backed film holder to prevent back-scatter of radiation.
- (f) Penetrameters: Suitable penetrameters as quality references for the radiographs.

## 3. PROCEDURE

### 3.1 GENERAL

The X-ray exposure factors, voltage, milli-ampere setting and time settings shall be selected or adjusted as necessary to obtain satisfactory exposures and achieve maximum image details of defect features within the sensitivity limitations of the component.

The X-ray voltage shall be the lowest consistent with these requirements, but shall in no case exceed 150 kV.

### 3.2 MOUNTING

Components shall be mounted in the holding fixture so that they are not damaged or contaminated and are in the proper plane as specified. The components may be mounted in any type of fixture and masking with lead diaphragms or barium clay may be used to isolate multiple specimens. The fixtures or masking materials shall not block the view from the X-ray source to the film of any portion of the body of the component.

### 3.3 PENETRAMETERS

As a quality reference, penetrameters shall be employed in all radiographic testing. The penetrameter image shall meet the following requirements:-

- (a) Penetrameter wires shall be visible on each radiograph.
- (b) Penetrameters shall be selected to give a radiographic density within  $\pm 10\%$  of the density of the area of interest of the component under inspection.
- (c) Penetrameters shall be placed in diagonal corners on the source side of the film. The plane of the penetrameters shall be normal to the radiation beam. When 35mm film strip is used, the penetrameter shall be placed in a position normally occupied by a component and a penetrameter image shall be made (exposed) for every 50 components or every 40cm of film, whichever is more convenient.
- (d) Distortion of any penetrameter shall not exceed 10%.
- (e) The spacing between wires of a penetrameter shall not be distorted by more than 10%. The percentage of distortion as used in this specification is defined as follows:-

$$\frac{S_0 - S_1}{S_0} \times 100, \text{ where}$$

S<sub>0</sub>= actual wire spacing.

S<sub>1</sub>= Wire spacing as it appears on the X-ray film.

A suitable range of penetrameters is shown in Figure 1 and Table 1. Equivalent penetrameters, to give an image of similar quality, may be used.

### 3.4 POSITIONING OF COMPONENTS

Components shall be radiographed in consecutive serial number order, when applicable. When a component is missing, the blank space shall contain either the serial number or an X-ray opaque object to assist in the accurate correlation of X-ray data.

Components shall be aligned in rows, starting with the lowest serial number in the top left-hand corner, continuing to the right, then forming a second row from left to right and so on. A clearance distance on the processed film of not less than 6.0mm shall be provided between the outer perimeters of all components, components and penetrameters, and components or penetrameters and the edge of the film.

### 3.5 VIEWS

The directions of radiographic exposure shall be as prescribed for the component in the relevant Ancillary Specification.

### 3.6 FILM AND MARKING

The radiograph film shall be in film holder backed with a minimum 1.6mm of lead, or the holder shall be placed on a lead-topped table. The film shall be identified such that the following information may be referenced to the radiograph:-

- (a) Component Manufacturer's name or code.
- (b) Component type or part number.
- (c) Production lot number or date code or inspection lot number.
- (d) Radiographic film view number and date.
- (e) Component serial numbers or cross-reference numbers, when applicable.
- (f) X-ray laboratory identification.

### 3.7 NON-FILM TECHNIQUES

When specified, the use of non-film techniques is permitted if permanent records are not required. The equipment shall be capable of producing results of equal quality when compared with film techniques. All requirements of this specification shall be complied with, except those pertaining to the actual film.

### 3.8 TESTS

The X-ray exposure factor shall be selected to achieve resolution of 0.0254mm major dimension, and a film density between 1 and 2 in the area of interest of the image.

Radiographs shall be made for each specified view.

### 3.9 PROCESSING

The radiographic film Manufacturer's recommended procedure shall be used to develop the exposed film and the film shall be processed so that it is free of processing defects such as fingerprints, scratches, fogging, chemical spots, blemishes, etc.

### 3.10 OPERATING PERSONNEL

The radiographic examination shall be carried out by the component Manufacturer. Personnel who will perform radiographic inspection shall be properly trained in the radiographic procedures and techniques so that defects revealed by this method can be validly interpreted and compared with applicable standards.

## 4. INTERPRETATION OF RADIOGRAPHS

Utilising the equipment specified herein, radiographs shall be inspected to determine that each component conforms to the applicable standard and the relevant criteria. Defective components shall be rejected. Interpretation of the radiograph shall be made under low light level conditions without glare on the radiograph viewing surface. The radiographs shall be examined on a suitable illuminator with variable intensity or on a viewer suitable for radiographic inspection on projection-type viewing equipment. The radiograph shall be viewed at a magnification between x6 and x25. Viewing masks may be used when necessary.

## 5. REPORTS AND RECORDS

### 5.1 REPORTS OF INSPECTION

When specified in the appropriate ESCC specification, the manufacturer shall furnish inspection reports with each component delivery lot. The report shall describe the results of the radiographic inspection and list the following:-

- (a) Purchase Order number or equivalent identification.
- (b) Component type or part number.

- (c) Date code.
- (d) Quantity inspected, with serial numbers, when applicable.
- (e) Quantity rejected, with serial numbers, when applicable
- (f) Date of inspection.

For each rejected component, the type or part number, serial number when applicable and cause for rejection shall be listed.

## 5.2 RADIOGRAPHS

When specified in the appropriate ESCC specification, the Manufacturer shall furnish photographic reproductions of each radiograph relevant to a component delivery lot.

## 5.3 RETENTION OF REPORT AND RADIOGRAPHS

The Manufacturer shall retain one set of the radiographs and a copy of the inspection report relevant to a component delivery lot for a minimum period of 3 years.

## 6. EXAMINATION AND ACCEPTANCE CRITERIA

The detailed examination/inspection requirements for a component and the accept/reject criteria shall be as specified in the relevant Ancillary Specification.

## 7. ANCILLARY SPECIFICATIONS

The following Ancillary Specifications in the ESCC 209XXXX series have been issued for use in conjunction with this specification:-

- ESCC No. 2093000, Radiographic Inspection of Capacitors.
- ESCC No. 2093501, Radiographic Inspection of Quartz Crystal Units.
- ESCC No. 2093502, Radiographic Inspection of Surface Acoustic Wave (SAW) Devices.
- ESCC No. 2094000, Radiographic Inspection of Resistors.
- ESCC No. 2095000, Radiographic Inspection of Discrete Semiconductors (1).
- ESCC No. 2099000, Radiographic Inspection of Integrated Circuits.

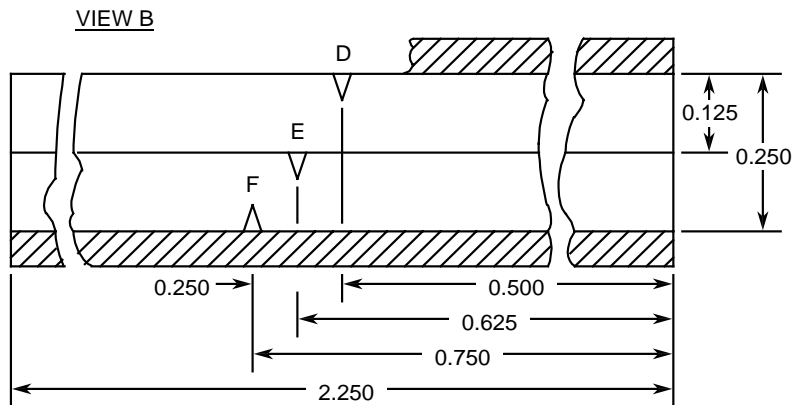
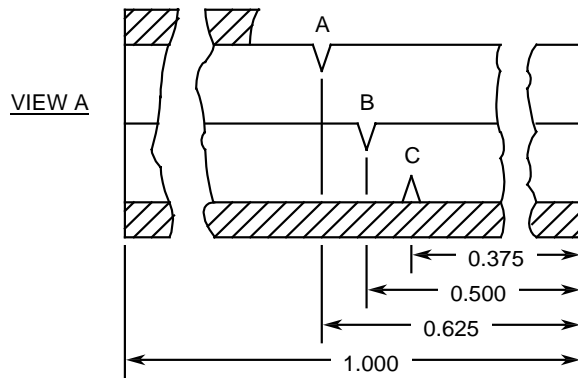
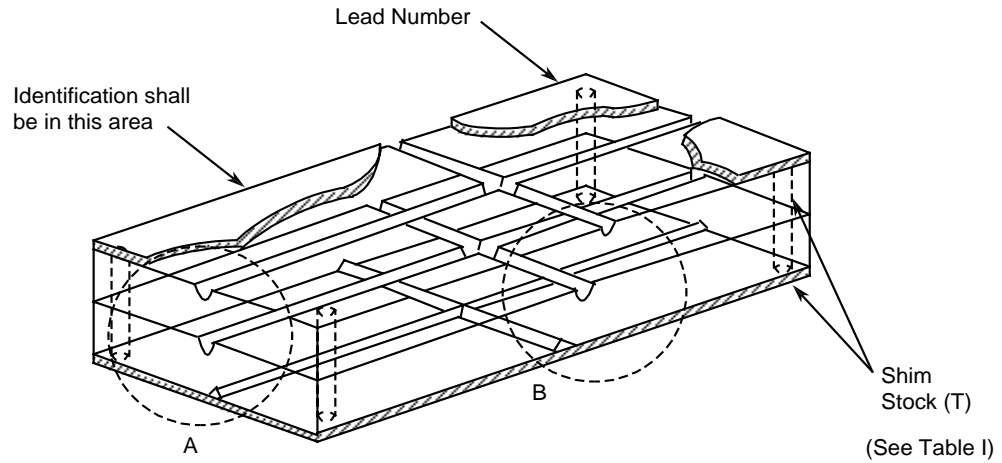
### NOTES:

1. For Discrete Microwave Semiconductor Devices (ESCC Generic Specification No. 5010), no individual ancillary specification for Radiographic Inspection exists. ESCC No. 2095000 should be used to the extent applicable.



8. FIGURES

8.1 FIGURE 1: PENETRAMETER



**NOTES:**

1. All dimensions are in inches.
2. Except for grooves and wires, dimensional tolerances shall be  $\pm 0.005$  inch.
3. For the purpose of this specification, metric dimensions shall be in accordance with the conversion detailed in Table 2.

**9. TABLES**

**9.1 TABLE 1: TYPES OF PENETRAMETER**

| Penetrameter Number | Shim Stock Thickness T (Inches) | Wire Size (Inches) |       |        |        |       |       |
|---------------------|---------------------------------|--------------------|-------|--------|--------|-------|-------|
|                     |                                 | A                  | B     | C      | D      | E     | F     |
| 1                   | 0.005                           | 0.002              | 0.001 | 0.0005 | 0.0005 | 0.001 | 0.002 |
| 2                   | 0.007                           | 0.002              | 0.001 | 0.0005 | 0.0005 | 0.001 | 0.002 |
| 3                   | 0.010                           | 0.003              | 0.002 | 0.001  | 0.001  | 0.002 | 0.003 |
| 4                   | 0.015                           | 0.003              | .002  | 0.001  | 0.001  | 0.002 | 0.003 |
| 5                   | 0.025                           | 0.005              | 0.003 | 0.002  | 0.002  | 0.003 | 0.005 |
| 6                   | 0.035                           | 0.005              | 0.003 | 0.002  | 0.002  | 0.003 | 0.005 |

**NOTES:**

1. Shim stock shall be made of steel.
2. Wires shall be made of tungsten, except for penetrameters used with relays, in which case, copper wires shall be utilised.
3. Groove details are not critical. Wire shall be flush or below plastic and located as shown.
4. Centre sections shall be made of clear plastic of low X-ray density.
5. All materials shall be bonded with clear-type cement.
6. Plastic cement shall have a low X-ray density.
7. Dimensions, except grooves and wires, shall be  $\pm 0.005$  inch.
8. In addition to bonding the penetrameter sections, assemblies may be fastened within 0.250 inch of each corner; bottom face to be flush.
9. Fastener shall not interfere with the end-use of the penetrameter.
10. For the purpose of this specification, metric dimensions shall be in accordance with the conversion detailed in Table 2.

**9.2 TABLE 2: METRIC CONVERSION**

| inches | mm    | inches | microns |
|--------|-------|--------|---------|
| 1.000  | 25.40 | 0.035  | 889     |
| 0.750  | 19.05 | 0.025  | 635     |
| 0.625  | 15.88 | 0.015  | 381     |
| 0.500  | 12.70 | 0.010  | 254     |
| 0.375  | 9.52  | 0.007  | 178     |
| 0.250  | 6.35  | 0.005  | 127     |
| 0.125  | 3.17  | 0.003  | 77      |
|        |       | 0.002  | 55      |
|        |       | 0.001  | 25      |
|        |       | 0.0005 | 13      |