

ULTRASONIC INSPECTION OF DIE ATTACH

1. PURPOSE. The purpose of this examination is to nondestructively detect unbonded regions and voids in the die attach material of semiconductor devices through the measure of acoustic continuity. It establishes methods and criteria for ultrasonic inspection of semiconductor devices.

- a. For certain die attach materials, a dramatic distinction between well-bonded and poorly bonded conditions may be difficult to achieve. This factor should be considered in relation to the design of each device when application of this test method is specified.
- b. The term "die attach interface" as used in this document refers to the entire area between the silicon die and the substrate to which it is bonded. This includes the interface between the die attach material and the die, the interface between the die attach material and the substrate, plus the die attach material itself.
- c. The term ultrasonic inspection as used in this document refers to high frequency ultrasonic visualization (imaging) which produces a gray scale output such as may be provided by ultrasonic scanning (US) or C-SCAN, scanning laser acoustic microscopy (SLAM), or C-mode scanning acoustic microscopy (C-SAM).

2. APPARATUS. The apparatus and materials for this test shall include:

- a. Ultrasonic imaging equipment with a test frequency sufficient to penetrate to the die attach interface. The test frequency and focal distance shall be adequate to detect voids as small as 0.0254 mm (0.001 inch) in diameter.
- b. Output device: A hard copy grey scale recording unit or other direct recording device (computer storage) shall be used to produce an image for analysis (manual or automated). The dynamic range of the output image shall be at least sixteen discernible colors or levels of grey. The image shall be large enough to be viewed at 10X or lower magnification.
- c. Ultrasonic detector: Shall be capable of detecting an acoustic signal which enters the back or bottom of the package and is reflected by or transmitted through the die attach interface. The reflected mode of imaging shall be used where the opening of a sealed, hermetic device is undesirable.

3. PROCEDURE. The ultrasonic generator, receiver, and line scan recorder settings (when used) shall be selected or adjusted as necessary to obtain satisfactory images and achieve maximum image details within the sensitivity requirements for the device or defect features the test is directed toward. In the case of reflection mode or transmission mode images, care must be exercised to insure that the ultrasound penetrates and is sensitive to the entire die attach interface.

3.1 Mounting and views. The devices shall be mounted in the holding tank 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 provided the fixtures do not block the view from the ultrasonic transducer to any portion of the body of the device. The coupling fluid in the holding tank shall be distilled water or other suitable noncorrosive liquid. The devices shall remain in the coupling fluid for as short a time as possible. Subsequent to the ultrasound inspection, proper cleaning and drying of the samples are required.

3.1.1 Views. All devices, shall have one view made with the acoustic signal penetrating the device in a direction perpendicular to the plane of the die attach, and for which there is acoustic continuity from the case exterior surface to the die attach interface (generally, the Y1 direction with the die attach parallel to the XZ plane). For devices with no sealed air gap above the active surface of the semiconductor element (unlidded devices), a view made with the acoustic signal directed from or through the active surface of the semiconductor element to the die attach interface may be specified.

3.2 Recording and marking. The acoustic image shall be printed by equipment using dry electrosensitive paper and with a resolution of 150 data elements per inch nominal. The image shall be identified by unambiguously marking the paper on which the image is printed with the following information:

- a. Device manufacturer's name or code identification number.
- b. Device type or part number.
- c. Production lot number or date code or inspection lot number.
- d. Ultrasonic image view number and date.
- e. Device serial or cross reference numbers, where applicable.
- f. Ultrasonic laboratory identification, if other than device manufacturer.

3.2.1 Nonprint techniques, when specified. The use of other than paper recording techniques is permitted if permanent records are not required and the equipment is capable of producing results of equal quality when compared to printed recording techniques, and all requirements of this method are complied with, except those pertaining to the actual recording.

3.2.2 Serialized devices. When device serialization is required, each device shall be readily identified by a serial number. They shall be imaged in consecutive, increasing serial order. When a device is missing, the blank space shall contain the serial number or other marking to readily identify and correlate ultrasonic image 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 large physical spacing of the devices.

3.2.3 Calibration. When specified, at least one open lid device of the same type and construction should be available to set up the visualization instruments. The device may be a scrap, nonoperational device which will be used to identify internal landmarks and insure the equipment is properly operating.

3.3 Tests. Acoustic frequency gate settings, receiver attenuation, and other equipment settings shall be selected to achieve resolution of 0.0254 mm (0.001 inch) in major dimension, optimize the signal reflected from the die attach interface, and to demark image features with as great a contrast as possible. Ultrasonic images shall be made for each view required.

3.4 Operating personnel. Personnel who will perform ultrasonic inspection shall have training in ultrasonic imaging procedures and techniques so that defects revealed by this method can be validly interpreted and compared with applicable standards. The following minimum vision requirements shall apply for visual acuity of personnel inspecting images:

- a. Distant vision shall equal at least 20/30 in both eyes, corrected or uncorrected.
- b. Near vision shall be such that the operator can read Jaeger type number 2 at a distance of 16 inches, corrected or uncorrected.
- c. Vision tests shall be performed by an oculist, optometrist, or other professionally recognized personnel at least once a year. Personnel authorized to conduct ultrasonic imaging tests shall be required to pass the vision tests specified in 3.4a and 3.4b.

3.5 Interpretation of ultrasonic images. Ultrasonic images shall be inspected to determine that each device conforms to this standard and defective devices shall be rejected. Interpretation of the image shall be made under moderate light level conditions without a glare on the recording paper's surface. The image shall be viewed at a magnification between 1X and 10X.

3.6 Reports of records.

3.6.1 Reports of inspection. For class level S devices, or when specified for other device class levels, the manufacturer shall furnish inspection reports with each shipment of devices. The report shall describe the results of the ultrasonic inspection, and list the purchase order number or equivalent identification, the part number, the date code, the quantity inspected, the quantity rejected, and the date of test. For each rejected device, the part number, the serial number when applicable, and the cause for rejection shall be listed.

3.6.2 Acoustic micrograph and report retention. When specified, the manufacturer shall retain a set of the ultrasonic images and a copy of the inspection report. These shall be retained for the period specified.

3.7 Examination and acceptance criteria. In the examination of devices, the following aspects shall be considered unacceptable die mounting, and devices that exhibit any of the following defects shall be rejected.

Voids: When imaging devices ultrasonically, certain types of mounting material may not give true representation of voids. When such devices are inspected, the mounting shall be noted on the inspection report.

- a. Contact area voids in excess of 50 percent of the total intended contact area.
- \* b. A single void which exceeds 10 percent of the intended contact area, or a single corner void in excess of 10 percent of the total intended contact area (see figure 2030-1).
- c. When the image is divided into four equal quadrants by bisecting both pairs of opposite edges, any quadrant exhibiting contact area voids in excess of 70 percent of the intended quadrant contact area (see figure 2030-1).

In case of dispute, the percent of voiding shall be determined by actual measurement from the image.

4. SUMMARY. The following details shall be specified in the applicable acquisition document:

- a. Number of views, if other than indicated in 3.1.1.
- b. Marking, if other than indicated in 3.2 and marking of samples to indicate they have been ultrasonically imaged, if required.
- c. Defects to be sought in the samples and criteria for acceptance or rejection, if other than indicated in 3.7.
- d. Image and report retention, if applicable (see 3.6.2).
- e. Test reports when required for class level B devices.

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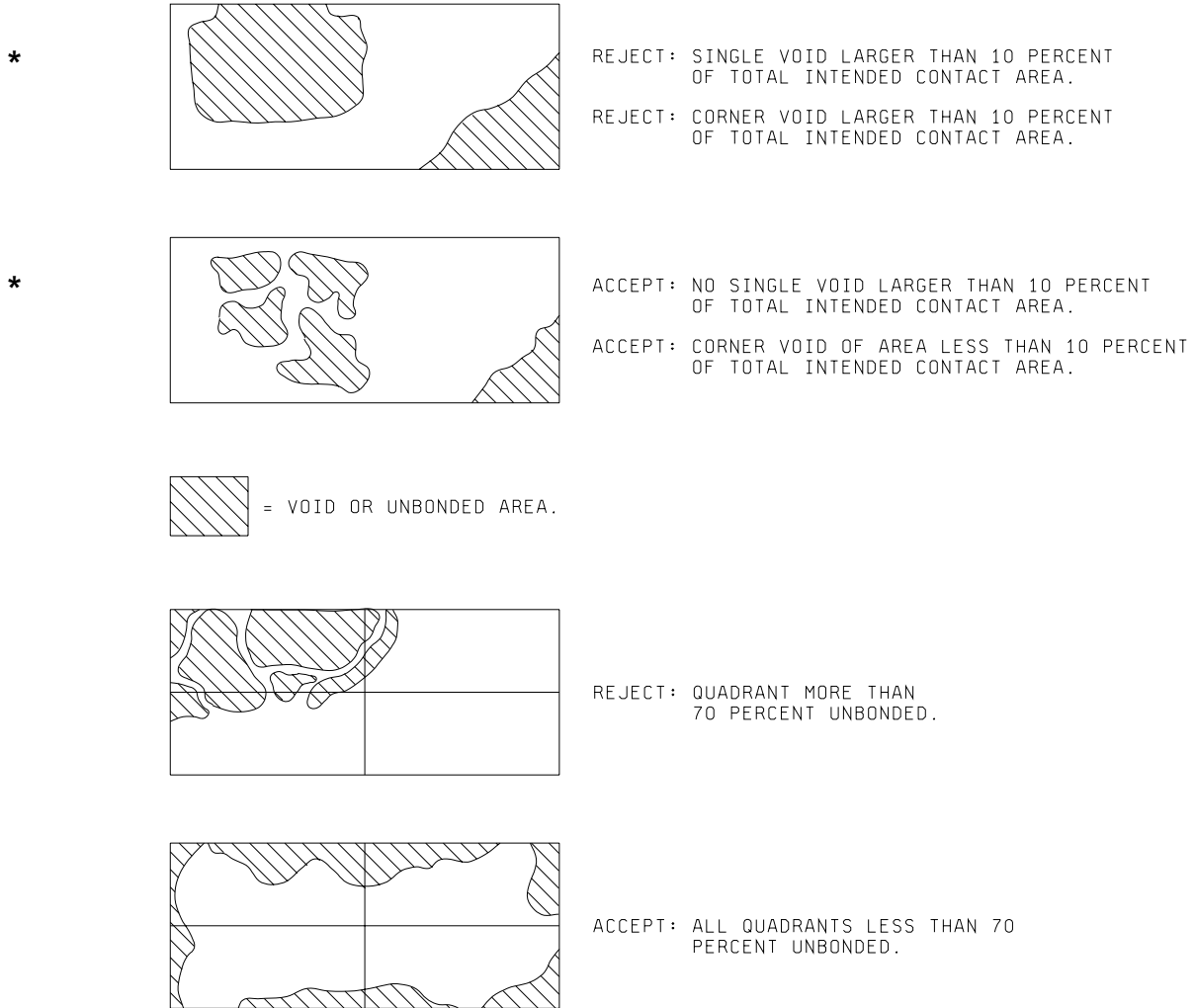


FIGURE 2030-1. Void criteria.