Part Qualification/Upscreen:

The customer had a series of environmental processes to which their devices needed to be qualified. A nondestructive method of evaluating the devices for any changes caused by each qualification step was desired.

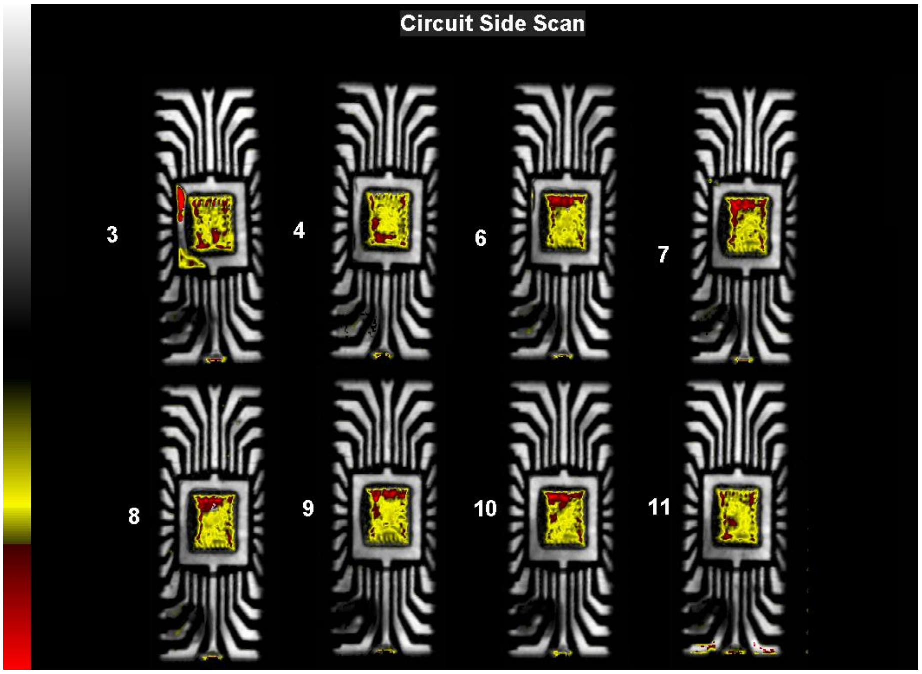
Package: Plastic-encapsulated 28-pin SOIC

Solution:
Scanning acoustic microscopy was performed using both a reflective (C-mode) scan and a through-transmission mode scan following each qualification step.

Summary:

Increased delamination was observed in all parts following one of the qualification process steps. The delamination did not meet the referenced specification, NASA PEM-INST-001.

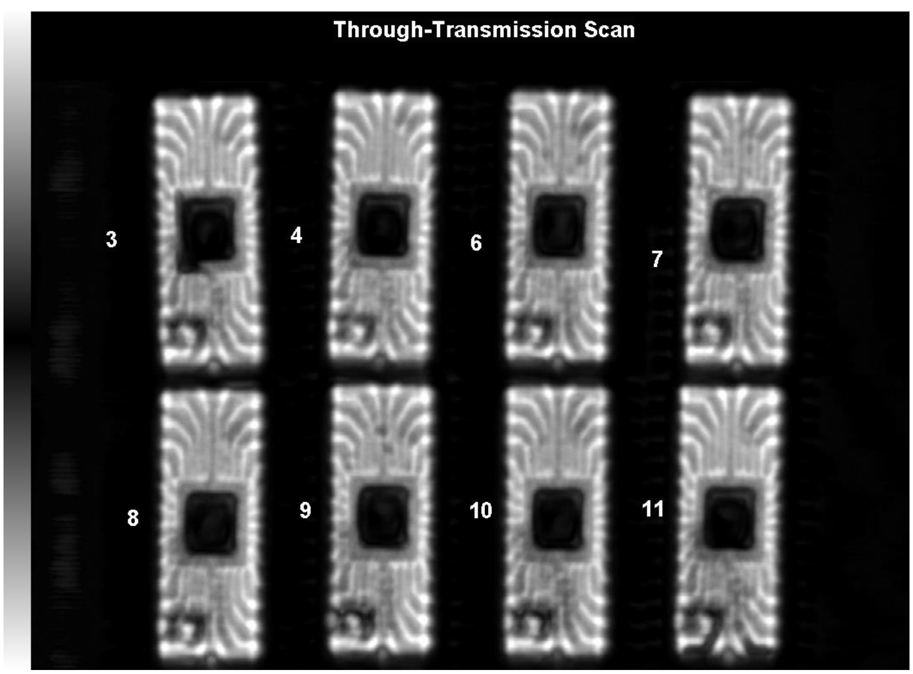
Image 1



Baseline C-mode scan showing the mold compound bond to the die surface, paddle, and lead fingers. The red/yellow appearance of the die in each device is suggestive of delamination. Further investigation using a B-mode scan, or virtual cross-section, showed this appearance to be the result of a die coat present between the mold compound and the die surface. Most die coat materials tend to reflect the ultrasound in a manner similar to a delamination or other air gap, resulting in the red/yellow appearance in this instance. However, the B-mode scan clearly shows the rounded shape that is characteristic of a die coat (see image 5).

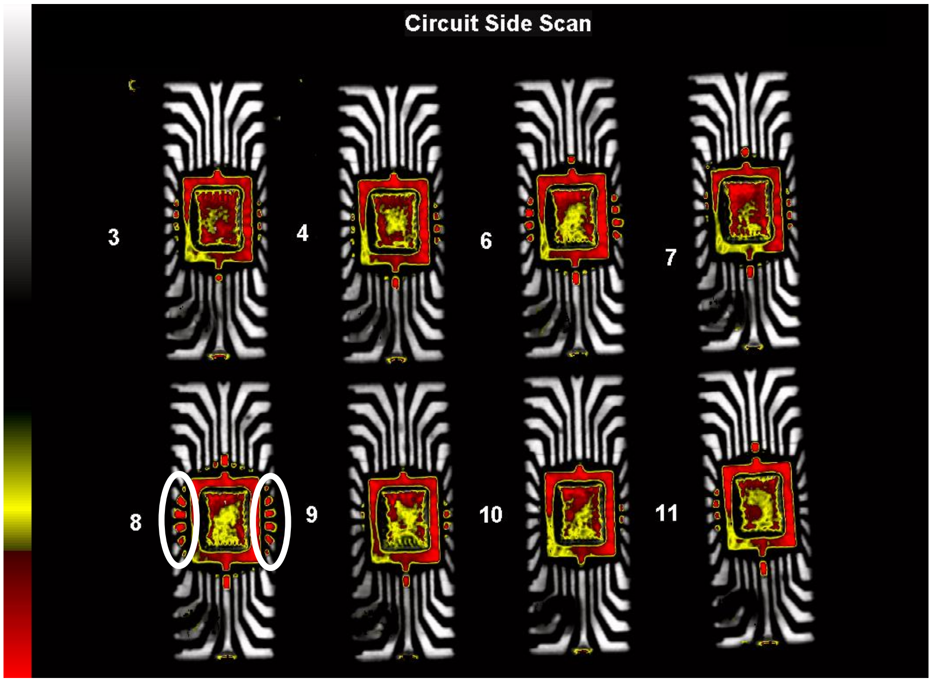
Red and yellow areas visible on the paddle in S/N 3 represent delamination between the mold compound and the paddle surface. Delamination is identified by its characteristic waveform (see image 6).

Image 2



Baseline through-transmission mode image. This imaging mode does not isolate a specific layer within the component but displays the degree to which ultrasound is transmitted through the device, using a gray-scale. Darker areas transmit little or none of the sound wave, suggesting the presence of an air gap such as a crack, delamination or void. Lighter areas transmit ultrasound through the entire thickness of the device. The dark areas in image 2 correspond to the red/yellow areas in image 1.

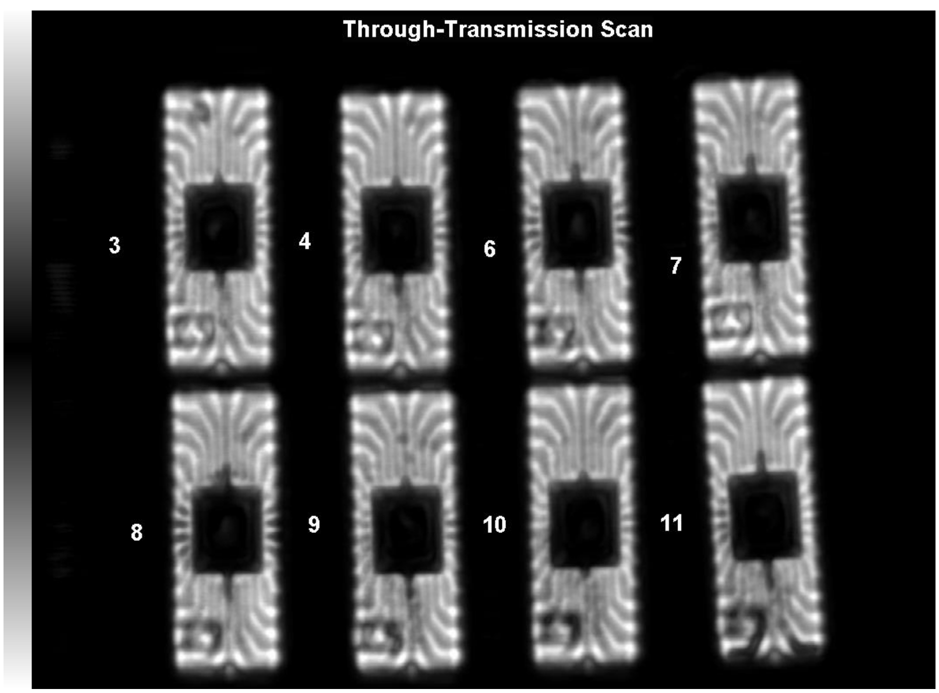
Image 3



Post-process C-mode image. Increased delamination is visible at the paddle and, in some instance, the lead fingers. Since the lead finger delamination is located in wirebonded areas (see circled regions in S/N 8, for example), the delamination does not meet the criteria outlined in NASA PEM-INST-001, which was the referenced specification for this analysis.

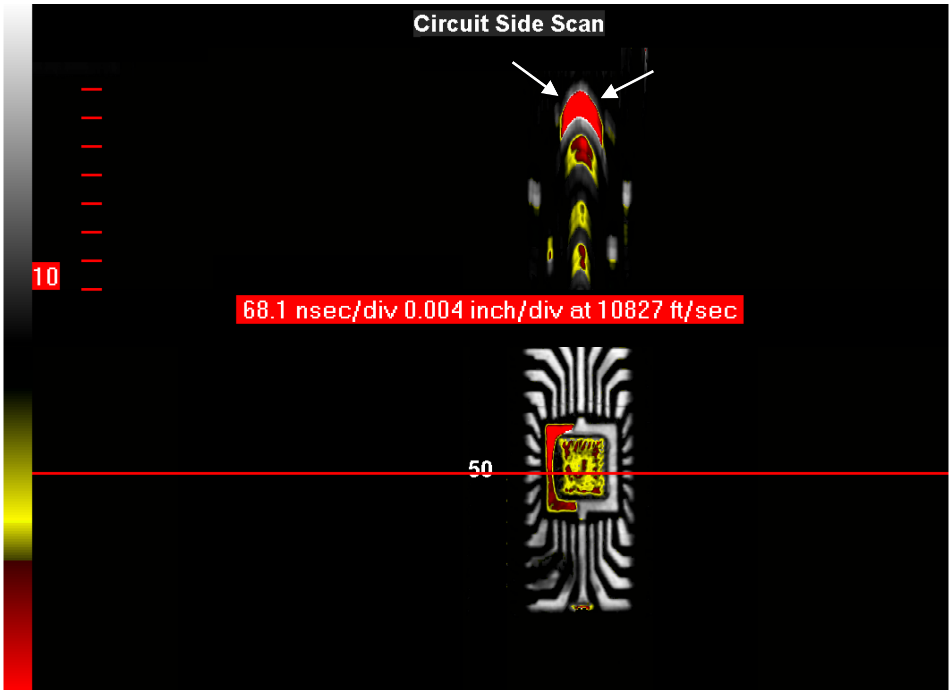
The increased paddle delamination is considered a reliability concern by this specification, since the delamination affects more than half of the paddle area.

Image 4



Post-process through-transmission mode image. The newly observed areas of delamination identified in image 3 appear dark in this image.

Image 5

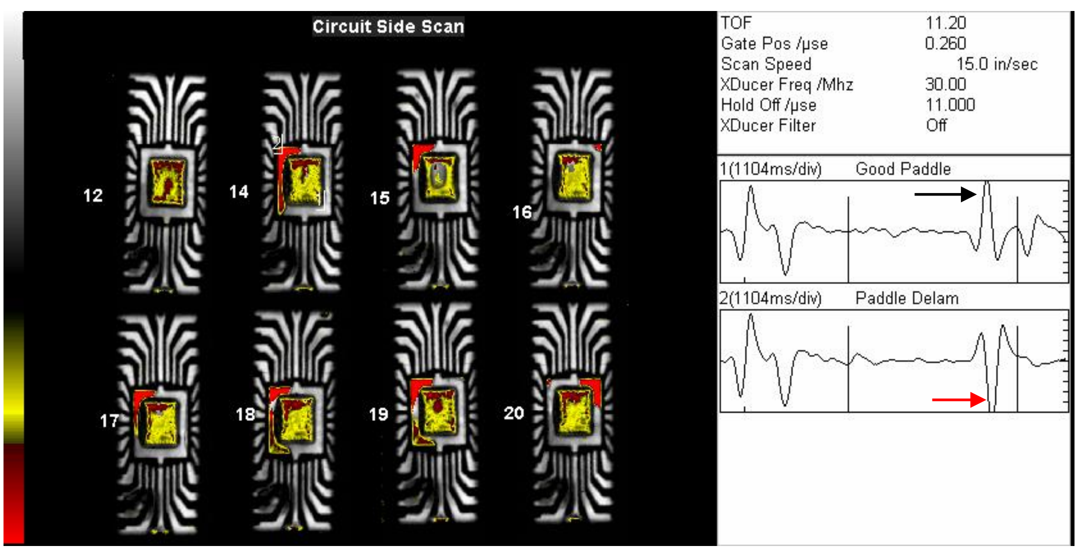


B-scan (virtual cross-section)

The lower half of the image shows the original pre-process C-mode scan. The red, horizontal line identifies the plane of the virtual cross-section.

The upper half of the image is the virtual cross-section. The rounded appearance of the die surface (identified by the arrows) is characteristic of a die coating.

Image 6

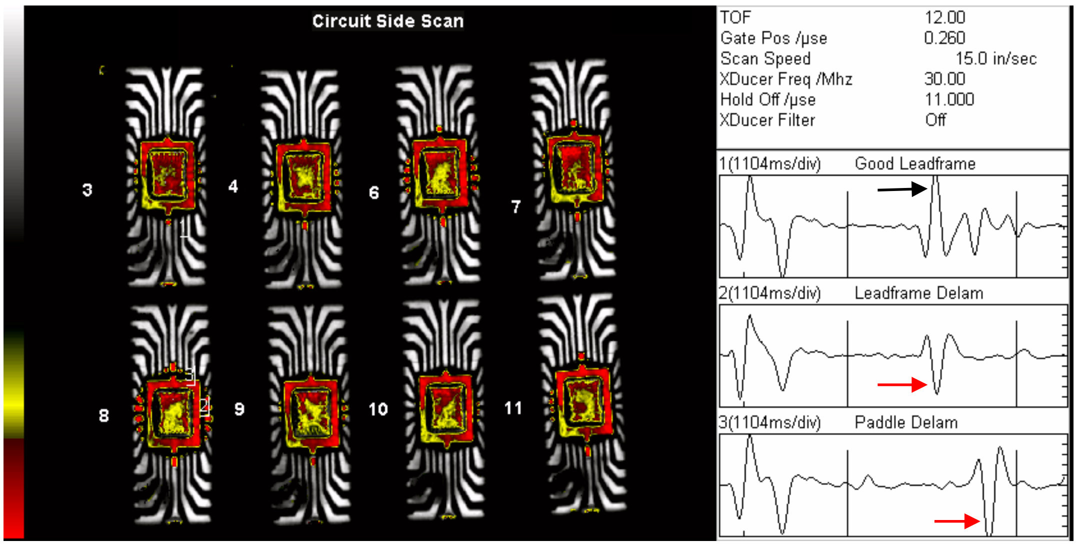


A-scans (echo waveforms) from the pre-process inspection.

Waveform 1 shows a good area of the paddle. The positive-polarity echo (see black arrow) is characteristic of a good bond between the mold compound and the paddle surface.

Waveform 2 shows a delaminated area of the paddle. The negative-polarity echo (see red arrow) is characteristic of a delamination between the mold compound and the paddle surface.

Image 7



A-scans (echo waveforms) from the post-process inspection.

Waveform 1 shows a good lead finger. The positive-polarity echo indicates a good bond between the mold compound and the lead finger.

Waveform 2 shows a delaminated lead finger. The negative-polarity echo indicates a delamination between the mold compound and the lead finger.

Waveform 3 shows the paddle. The entire paddle surface is delaminated as indicated by the negative-polarity echo.