APEX Technical Conference 2011

Head-on-Pillow II

Detection of Head-on-Pillow Defects Using 5DX Method

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Agenda

- Introduction to Head-in-Pillow (HiP) Inspection
- Different method of inspecting and verifying HiP defect
- 5DX inspection method and algorithm
- Example of different 5DX algorithms
- Summary

Detecting Head-in-Pillow Joint

- Head-in-Pillow (HiP) defect is predominantly found in hidden joints such as BGA that could not be effectively detected using optical inspection.
- Various methods have been used, either destructive or non-destructive, with different levels of success.
- Destructive methods such as, dye-and-pry or cross-sectioning are inefficient, as they destroy the PCBA and is also very time consuming.
- Non-destructive methods such as x-ray and sometimes with the aid of side view microscope to inspect for HiP solder joint.
- 5DX Automated X-Ray is one of the most efficient tools being utilized in the industry even though HiP X-Ray profile is not easily recognizable.
- This presentation will show how some manufacturers detect HiP efficiently by using Agilent 5DX (Automated X-Ray Inspection) during production run. The suspect HiP joints from the 5DX validation report are then analyzed using a manual high-resolution 2D X-Ray inspection machine.

Testing for Head-in-Pillow Joint

- **X-Ray (2DX and Automated X-Ray)**
  - Using Manual 2D X-Ray is time consuming in looking for HiP defect
  - 5DX X-Ray can automatically inspect once the signature is programmed – trade-off between higher false call rate and defect escape lower it's efficiency
- **ICT/JTAG**
  - ICT (In circuit Test) and JTAG are electrical test that detect open in connection
  - JTAG with aid in ICT if pins are not accessible
  - HiP that has intermittence electrical contact will cause escape
- **Functional Test/Burn-in**
  - System Burn-in test incorporate system test and burn-in stress will stress the joint and cause the joint to open while testing
  - Burn-in test is most efficient to detect HiP but it is costlier to detect solder joint defect at this station

Verifying Head-in-Pillow Joint Defect

- **Destructive Method**
  - Dye-and-pry
    - This is a quick and easy method to verify HiP defect especially when the defect joint is in the inner row and defect pin number cannot be easily identified.
  - Cross Sectioning
    - Cross Sectioning will show lack of solder fusing between the solderball and the solder paste. This is another way to confirm HiP, but defect pin number has to be identified before cross-sectioning.
- **Non-Destructive Method**
  - Side View Microscope
    - Side view microscope will see HiP defect on the outer row of the BGA. It is limited to outer row of solder joint when microscope can access.
  - 2D X-Ray
    - 2D X-ray can see inner rows of solder joint. It's ability to see HiP increases if the machine has a higher resolution, high contrast, and tilting of the joint capability. It is also helpful if the joint is not obscured by other components.

Inspection for HiP in Production

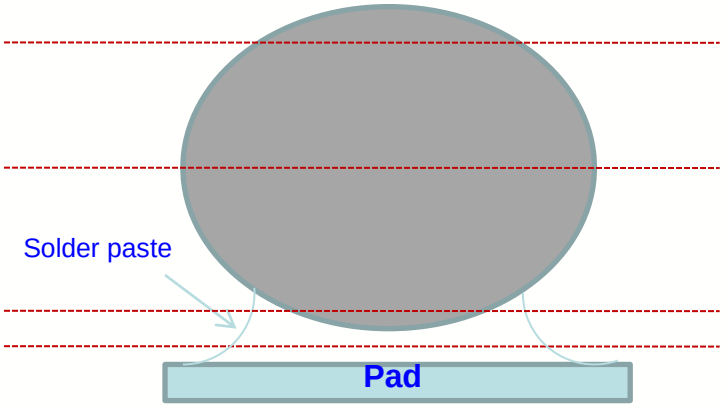
- **Method of inspecting for HiP in production using 5DX to screen and 2D X-ray to verify**
  - 5DX to screen for HiP Signature on all BGA automatically
  - 2D X-ray to verify HiP by knowing HiP Signature

5DX Slice Height Setup

Slice # 2 = Component Top Solder ball

Slice # 1 = Midball

Slice # 3 = Between Pad and Solder ball
Slice # 4 = Between Pad and Solder ball



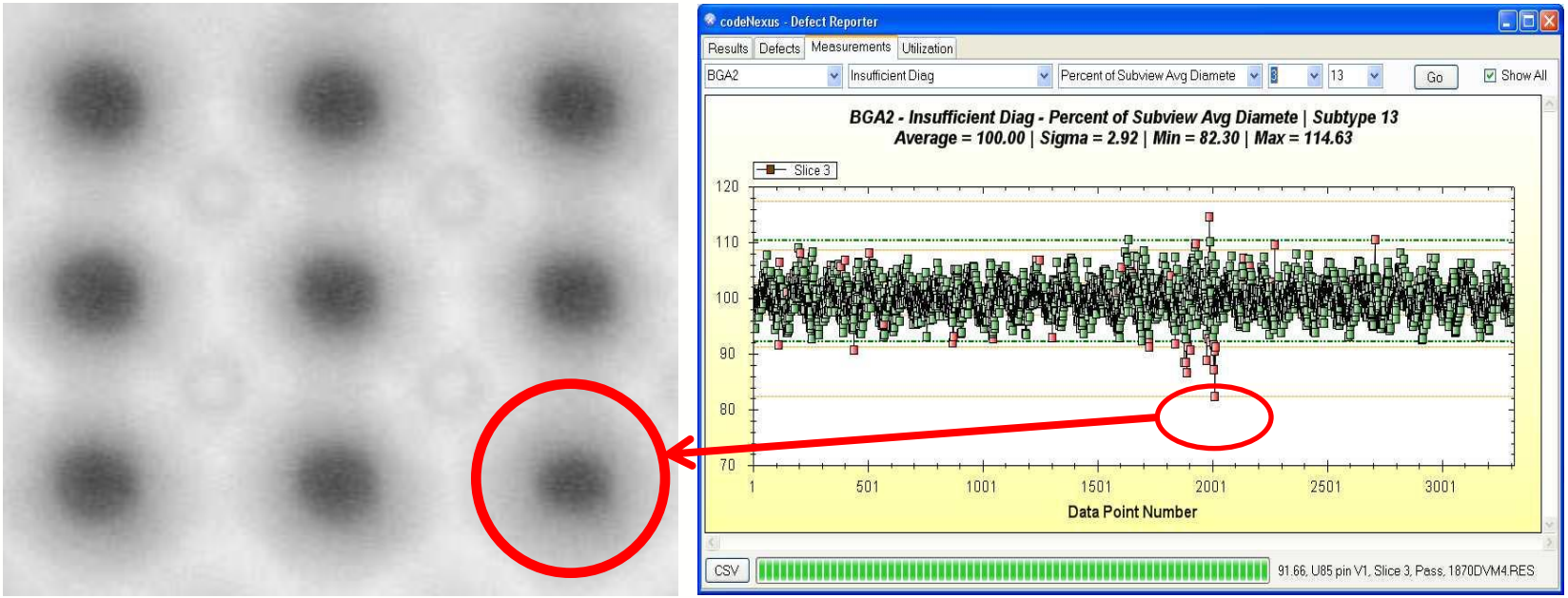
5DX Inspect Algorithms

- **BGA2 Algorithm Utilized**
  - BGA2 Insufficient - Measure Diameter, Thickness & Diameter Outlier
  - BGA2 Open Outlier - Measure Outlier Sensitivity Value
  - BGA2 Open Eclipse - Measure Open Signal Ratio

Types of 5DX Algorithm Detecting HiP

❑ BGA2 Insufficient Outlier Algorithm

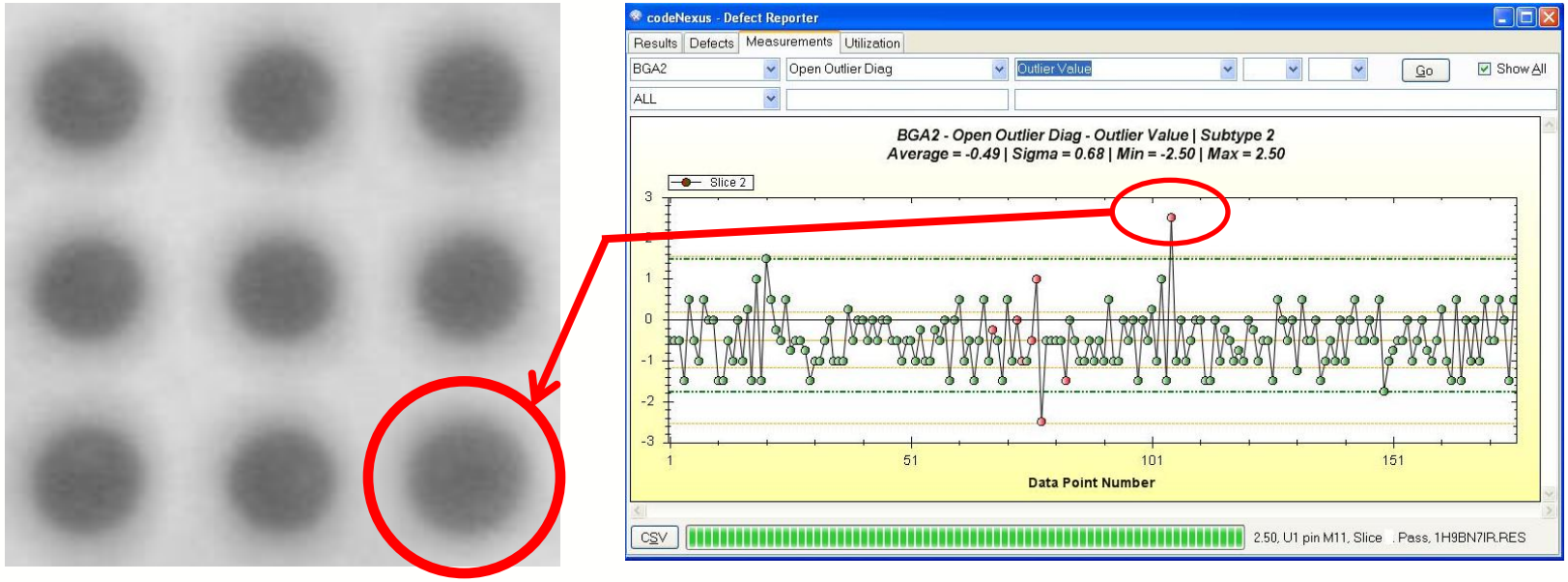
BGA2 Insufficient Outlier algorithm is effective in detecting HiP that has a smaller ball diameter profile at pad level slice.



Types of 5DX Algorithm Detecting HiP

❑ BGA2 Open Outlier Algorithm

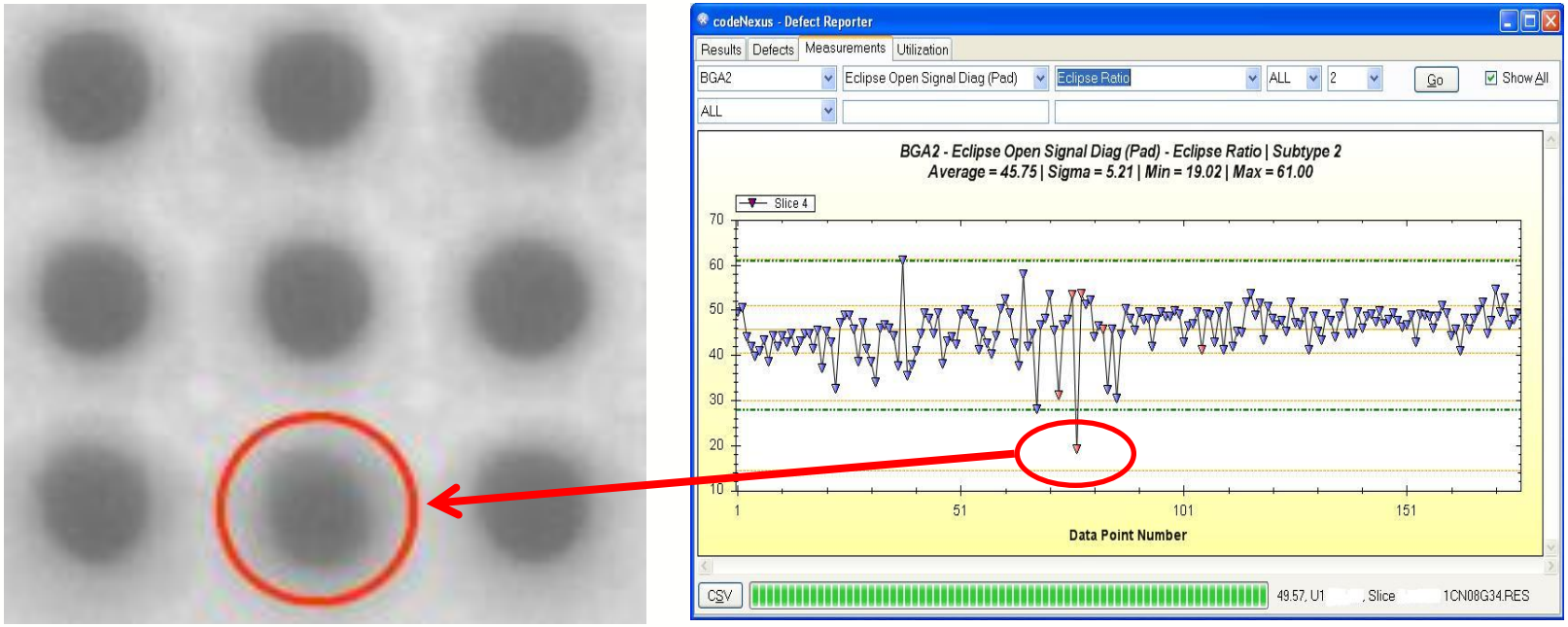
BGA2 Open Outlier algorithm is effective in detecting HiP that has a larger ball diameter profile at pad level slice.



Types of 5DX Algorithm Detecting HiP

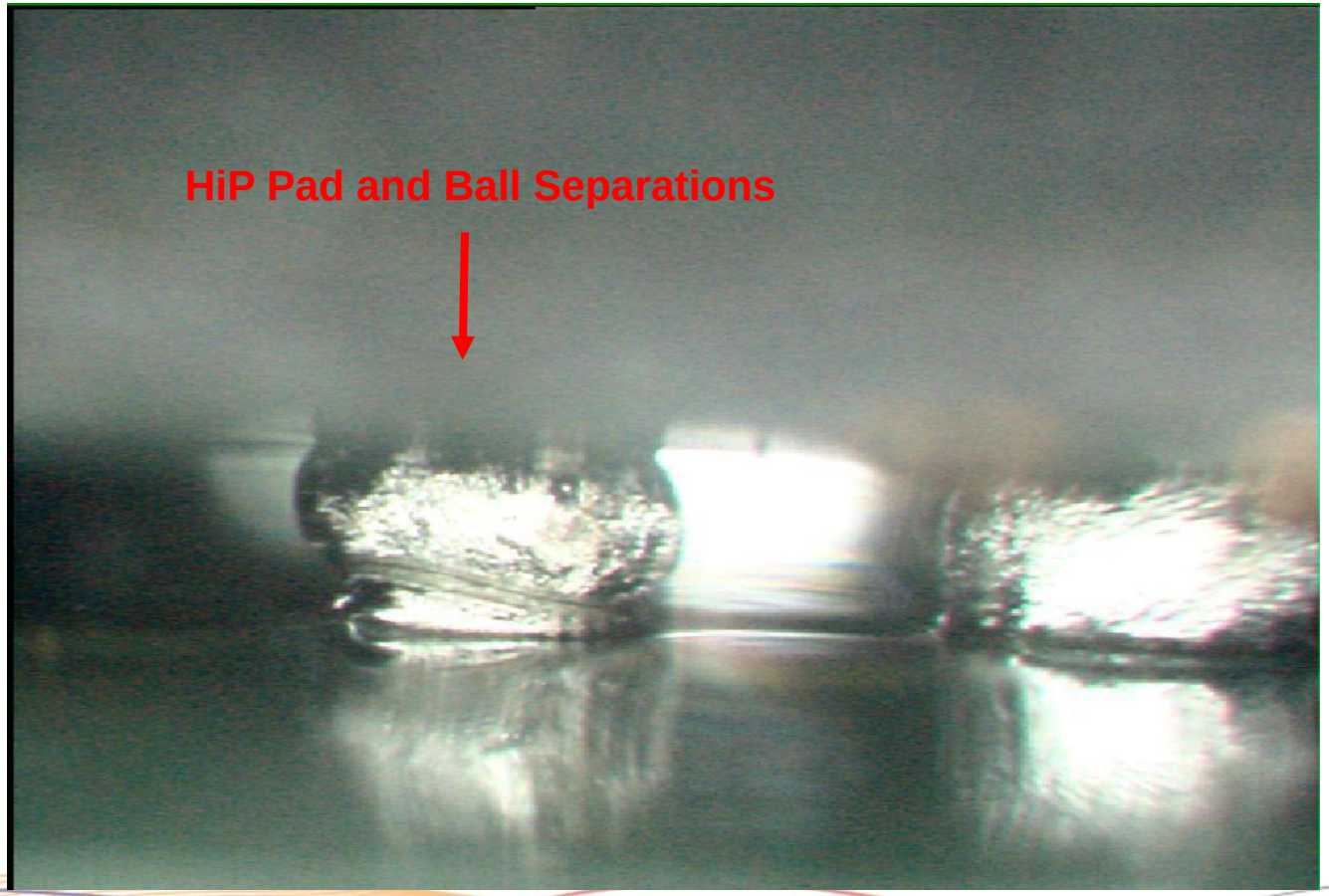
❑ BGA2 Eclipse Open Signal Algorithm

BGA2 Eclipse Open Signal algorithm is effective in detecting HiP that has an eclipse profile at pad slice or midball slice.



Verifying HiP using Side View Microscope

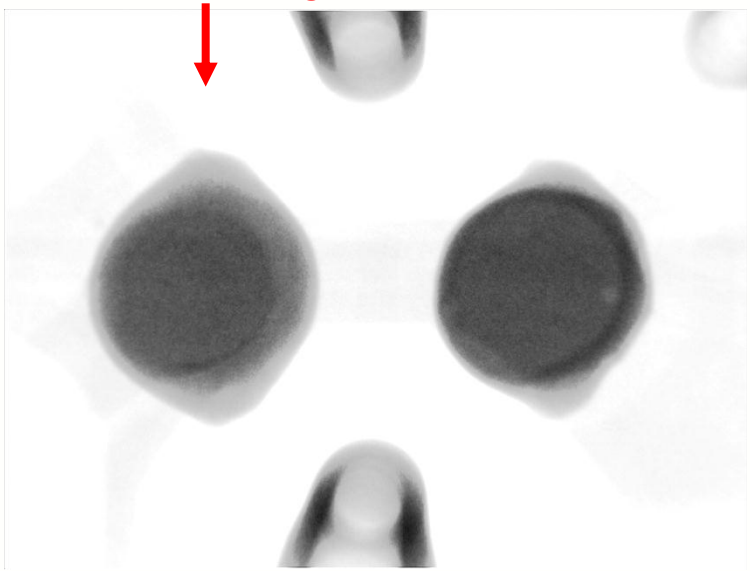
- Using a side view microscope to verify HiP suspected joints
  - Easier way to verify outer row of BGA joints



2D X-ray Signature

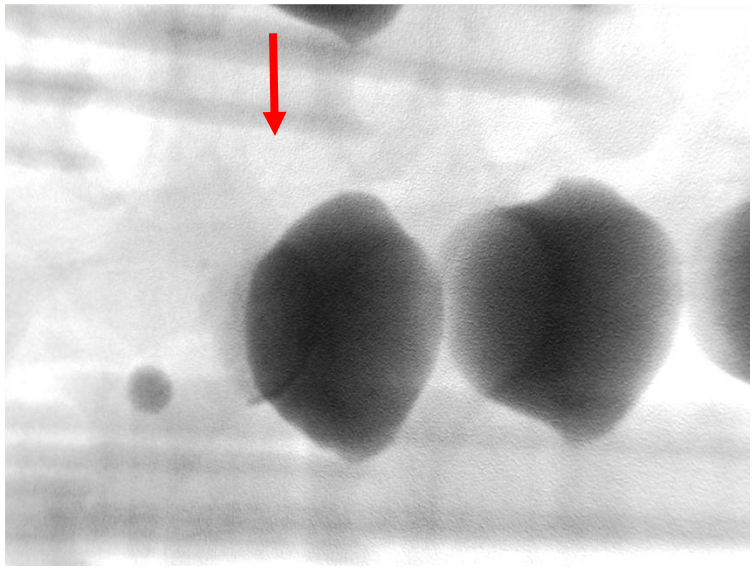
- Using a manual high resolution X-Ray to verify suspected inner joints
  - With tilt function on the X-Ray, detect joint to pad separation

HiP Darker Pad Signature



Front View

HiP Pad and Ball Separations



View from an angle

Summary

Base on our experience, HiP defect comes in various shapes and forms. Some of the HiP looks like an ordinary open joint, while others have an eclipse profile. The tough ones to detect are those that look like an absolutely good solder joint.

Although the HiP detection rate on the 5DX AXI averages about 70%, this system is currently by far the most efficient tool in the industry to screen for such defects. After the flagged joints are verified at the 5DX repair station, the remaining marginal or questionable joints are sent to a high resolution manual 2D x-ray machine for failure analysis.

Questions and Answers

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