Inspection of Hidden Solder Connections

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Inspection of Hidden Solder Connections

- Introduction
- “Hidden” Solder Joint Types and Resulting Inspection Challenges
- Traditional Inspection Methods
- New Inspection Methods Available
- Conclusion
Introduction

• The assembly process determines joint integrity, not inspection!!!!!!
• PWB solder joint miniaturization
• New inspection challenges
• Traditional inspection methods may not be sufficient for solder joint assessment
• What are the inspection alternatives????? What is the latest and greatest available?????
“Hidden” Solder Joint Types and Resulting Inspection Challenges

- What’s a hidden solder joint?
- Surface mount components
  - All types of BGA (Micro BGA, PBGA, CBGA, CCGA)
  - J-leads
  - CSP
- Densely populated through hole components
  - Backplane connectors
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Traditional Inspection Methods (Industry Standards)

• Microscope inspection

Pros
  - Partial view of solder joint parallel to PWB edges

Cons
  - Extensive board handling increasing the possibility for damage
  - Results are subjective
  - Unable to view multiple rows of joints and unable to view between component gaps
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Traditional Inspection Methods (Industry Standards)

• Cross sectional analysis

Pros
- Able to view solder joint integrity, presence of cracks and microstructure condition can be determined
- Ability to view multiple rows through additional sections
- Z-axis or planar views possible

Cons
- Destructive test, not practical for process inspection
- Labor intensive
- Two dimensional aspect only
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Traditional Cross Section Inspection Of BGA Joints
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Traditional Cross Section Inspection Of a BGA Joint
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Traditional Inspection Methods (Industry Standards)

- Electrical testing

**Pros**

- 100% assembly verification
- Simple, pass or fail (either it works or it doesn’t)

**Cons**

- Does not reflect certain anomalous solder joint conditions (i.e. cold joints, partial cracks, voiding, etc.)
- Solder joint contamination may be overlooked
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Traditional Inspection Methods (Industry Standards)

- X-ray inspection

**Pros**
- Provides an internal view all solder joints in a non-destructive fashion

**Cons**
- 1:1 ratio of x direction views (tilt views are possible)
- Difficult to assess solder joints of a fully populated PWB, many obstructions could be present
- Film interpretation = labor intensive
- Unable to distinguish cold joints, fine cracks, flux contamination, etc.
New Inspection Methods Available

- 90° prism assisted microscope inspection

**Pros**

- Easy to use and systems are relatively inexpensive at 25 to 30K
- Minimizes PWB handling
- Can view one full side of periphery BGA solder joints. Able to view for BGA solder joint cracks
- Able to inspect between components with gaps as tight as 35 mils and component height gaps as small as 2 mils.
- Ability to view multiple BGA rows or J-leads to view solder joint profiles
- Able to detect the presence of non-metallic contamination such as flux
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New Inspection Methods Available
• 90° prism assisted microscope inspection

Cons
- Labor intensive
- Subjective and requires interpretation
- 100% inspection not possible
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90° Microscope Visual Inspection Of BGA Joint

Fine Crack after stress cycling
90° Microscope Visual Inspection of BGA 3rd Row

BGA SCOPE

crack at 3rd row inside BGA package
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90° Microscope Visual Inspection of J-Leads

J LEAD CRACK
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New Inspection Methods Available

- Real time microfocus x-ray and integrated BGA inspection software

**Pros**

- Relatively easy to use
- Real time x-ray views observable on a monitor. Can manipulate sample during the inspection process
- Can view solder joints in great detail, resolution as great as 0.0001 inches and magnifications can range from 1x to 1300x
- Image analysis software program that can eliminate operator judgement with simple pass or fail criteria
New Inspection Methods Available

- Real time microfocus x-ray and integrated BGA inspection software

**Cons**

- Labor intensive and not practical for 100% inspection if components obstruct BGA analysis system

- BGA analysis system only useful if the x-ray detector is parallel to the PWB. PWB tilt renders the program useless

- Unable to detect non-metallic contamination such as flux
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Real Time Microfocus X-ray Inspection
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Real Time Microfocus X-ray Inspection
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Real Time Microfocus X-ray Inspection
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Real Time Microfocus X-ray with BGA Inspection Software
New Inspection Methods Available

- **X-ray laminography**

**Pros**

- Views solder joints in unobstructed planar (z-axis) sections or “slices”
- 100% inspection
- Pass/fail criteria can be established prior to inspection and interpretation is not required
- Three dimensional solder joint digital reconstruction can be determined for solder volume and characteristics
- Inspection process is fast. HP claim of over 10K solder joints PWB top and bottom side in less than 10 minutes
New Inspection Methods Available

- X-ray laminography

Cons
- Initially very labor intensive with programming. 5-7 days of skilled labor for PWB Gerber (graphics) data interface
- Resolution of images is poor
- Slice size are between 4 to 6 mils, therefore joint cracking could not be detected
- Expensive purchase, ~540K. Alternative, service is offered at ~2K a day
- Too much information produced
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X-ray Laminography Inspection Will Show a Planar “Slice” View of BGA Solder Joints
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X-ray Laminography Inspection Will Show a Planar “Slice” View of BGA Solder Joints
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X-ray Laminography Inspection Showing a Planar “Slice” View of BGA Solder Joints
Conclusion

- Process control is of the utmost importance!
- Visual and real time x-ray examinations should not be used for 100% inspection to verify process control
- 90° inspection, cross section, and real time x-ray should be used for qualification and failure analysis purposes
- X-ray laminography can be used for 100% inspection. Is the initial cost worth the volumes of data?
- Combination of 100% electrical and lot sampling inspection - appropriate method to be determined by the customer