Missile Defense Agency Copper Wire Bond Overview

To: 2018 NEPP Electronics Technology Workshop

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Bottom Line Up Front

• The Department of Defense is continuing to identify and assess the risks associated with using copper bond wire parts in defense systems.

• Screening processes should be in place to identify all use of plastic encapsulated microcircuits (PEM) with copper wire bonds in each system.

• Test and evaluation processes for PEMs must be updated to account for the differences between gold and copper bonding processes.

• Destructive Physical Analysis (DPA) is an effective method for detecting manufacturing process indicators and defects.
AEC-Q006 Appendix 1 Best Practices

• Inert environment around Cu wire
  - During wire storage
  - During free air ball formation
  - (Pd) Plated Cu wire

• Tighter controls/limits for wire pull/shear metrics
  - USL/UCL and LSL/LCL
  - Ball shear and wire pull near/over stitch
  - Production monitor using unmolded parts
  - Pull/shear after stress testing and careful decapsulation

• Capillary
  - More frequent replacement/maintenance
  - Designed specifically for Cu wire

• Thermosonic Bonding
  - Tighter parameters for frequency, temperature, force
  - Reliability data collection at bond recipe corners of Force and Frequency
Methods for Identifying Copper Wire Bond Parts

- Screening processes are necessary to properly identify manufacturer’s transition to copper wire bonds
  - Product change notifications
    - Assembly Material Change
    - Assembly Process Change
    - Manufacturing Location Change
  - Material declaration review
    - Most manufacturers call out the wire bond material
  - DPA
  - X-ray inspection
    - Experienced operators can distinguish the difference between Au and Cu wire bonds
Summary of Issues from PCNs

- PCN implementation dates
  - No PCN was issued if the part started as copper
  - Line delays and use of existing supplies

- Multiple Assembly Locations
  - Qualification
    - By Location
    - “Additional” assembly sets
      - Transition between gold and copper parts
  - Materials vary across assembly locations

- Retracted PCNs
  - Early identification
  - Continual monitoring
    - PCNs
    - Incoming devices
Copper Wire Identification Discrepancies

- Assembly site variations in bond wire
  - Four different assembly sites:
    - Two assembly sites only use gold bond wire
    - One assembly site uses only copper bond wire
    - One assembly site uses gold or copper bond wire
    ✓ Assembly site also has three options for wire size
- Different assembly sites can use different mold compounds, die attaches, bond wires, and die designs
  - Sometimes there are variations within the same facility
Qualification and Reliability Testing

• Reliability Monitor Data
  - Currently, most copper reliability data is a mix of copper and gold

• Qualification Data
  - PCN Qualification Data
    • Most readily available, but limited to one location
  - Typically done by package type, not to a specific part number
    • AEC-Q006, Rev. A qualification testing can be used
Methods to Limit the Impact of Copper Bond Wires

• Better Part Selection
  - Avoid Commercial (if possible)
    • Ask OCM (original component manufacturer) about gold options
    • “Old Gold”
      ✓ Known gold parts; date codes prior to copper implementation
  - Leveraging Automotive Options (AEC-Q006)
  - Military qualified standard parts
    - More expensive, requires less testing and screening
  - Defense Supply Center Columbus Vendor Item Drawings
    • V62 drawings are restricted to gold only

• Incoming Inspection
  - Mixed Reels
    • Review date codes & documentation
  - X-Ray
# Vendor Identification Information

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<tr>
<th>Vendor</th>
<th>Identification Method</th>
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<tr>
<td>Altera</td>
<td>Letter &quot;C&quot; at the end of the lot number</td>
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<td>Atmel</td>
<td>Adds a &quot;C&quot; to the orderable part number to specify copper only on sample parts. Production parts have no physical indicator</td>
</tr>
<tr>
<td>Central Semiconductor</td>
<td>No external visual indicator</td>
</tr>
<tr>
<td>Cypress</td>
<td>&quot;C&quot; on device packaging</td>
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<tr>
<td>Diodes Inc.</td>
<td>Indicator is not always available and varies according to the site of manufacture (may be a dash over the date code). Review the PCNs for additional guidance</td>
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<td>Exar</td>
<td>No external visual indicator</td>
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<tr>
<td>Freescale</td>
<td>No external visual indicator</td>
</tr>
<tr>
<td>IDT</td>
<td>&quot;Y&quot; suffix on lot number</td>
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<tr>
<td>International Rectifier</td>
<td>Underscore after lot code (XXXXP_)</td>
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<tr>
<td>Intersil</td>
<td>&quot;M&quot; site code = copper, &quot;H&quot; site code = gold</td>
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Conclusion

• The technical risks of using copper bond wires are still under evaluation and a concern for defense applications

• Copper bond wires are an emerging issue; updating requirements and assessing the risks should be a top priority industry wide

• Screening processes need to be in place to properly identify any use of copper wire bond devices

• DPA proved to be an expedient and statistically meaningful method for detecting/screening manufacturing process indicators, defects, and changes