**PRODUCT / PROCESS CHANGE NOTIFICATION**

**PCN-000434**

**Date:** 12 February, 2018

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**Part Number(s) Affected:**

| GN2403BIBE3, GN2403SBIBE3, GN2404BIBE3,  
| GN2407BIBE3, GN2407SBIBE3, GN2408BIBE3,  
| GN2409BIBE3, GN2410FBIBE3, GN2410BIBE3,  
| GN2411BIBE3, GN2412BIBE3, GN2415BIBE3,  
| GT1704-IBE3, GT1706-IBE3  

**Customer Part Number(s) Affected:**

- N/A

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**Description, Purpose and Effect of Change:**

**Purpose of Change:**

Semtech’s Assembly Subcontractor, Amkor Technology Taiwan Ltd, has issued a final change notice: PCN171130 “Semtech LG/Dicing Saw Improvement”. The proposed change is to optimize process at Laser Grooving and Wafer Saw to minimize risk of sidewall crack and topside chip out occurrence.

1. Laser grooving improvement by:
   - Increasing keep-out-zone from seal ring to side wall >5um (decreasing laser groove kerf width)
   - Optimizing overall shape/profile of the groove – Wide beam Laser Grooving
   - Decreasing overall EPA (energy density per area) – Wide beam Laser Grooving

2. Wafer saw improvement (Z1 blade):
   - Blade grit concentration reduction
   - Blade thickness reduction to accommodate resizing of laser grooving kerf width

**Description of Laser Grooving Change:**

Wide (Multi) Beam is a method in laser grooving that allows for reduction of total applied energy by decreasing the amount of passes required with similar results as “V” beam method:

- This process allows better kerf properties and more clearance from seal ring. This minimizes risk for top side chipping or ILD layer delamination.
- This also allows better Z1 sawing and consistent kerf to achieve >5um keep out zone.

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**Change Classification**

- Major
- Minor

**Impact to Form, Fit, Function**

- Yes
- No

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PRODUCT / PROCESS CHANGE NOTIFICATION  
PCN-000434  
Date: 12 February, 2018  

<table>
<thead>
<tr>
<th>Impact to Data Sheet</th>
<th>☑ Yes</th>
<th>☑ No</th>
<th>New Revision or Date</th>
<th>☑ N/A</th>
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</thead>
</table>

**Impact to Performance, Characteristics or Reliability:**

The changes to the process are intended to improve the reliability of the product by preventing the sidewall cracking and topside chip out.

<table>
<thead>
<tr>
<th>Implementation Date</th>
<th>1st April 2018</th>
<th>Work Week</th>
<th>WW13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last Time Ship (LTS) Of unchanged product</td>
<td>30th April 2018</td>
<td>Affecting Lot No. / Serial No. (SN)</td>
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</tr>
<tr>
<td>Sample Availability</td>
<td>2nd March 2018</td>
<td>Qualification Report Availability</td>
<td>2nd Jan 2018</td>
</tr>
</tbody>
</table>

**Supporting Documents for Change Validation/Attachments:**

- Amkor PCN Changes

**Issuing Authority**

Semtech Business Unit: Signal Integrity Products

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FOR FURTHER INFORMATION & WORLDWIDE SALES COVERAGE:  [http://www.semtech.com/contact/index.html#support](http://www.semtech.com/contact/index.html#support)
Amkor GN2411 PCN Change
Initial PCN Improvement Actions

Changes were made at Laser Grooving/Wafer Saw to prevent sidewall crack and topside chip out.

– Increasing keep-out-zone from the seal ring by decreasing the laser groove kerf width to 52um (+/- 3um).
– Optimizing the overall shape/profile of the groove – Wide beam Laser Grooving
– Decreasing the overall EPA (energy density per area) – Enable Z1 blade area optimization
– Z1 Blade thickness/grit concentration reduction to enable LG clearance >5um

<table>
<thead>
<tr>
<th>Leg</th>
<th>Condition</th>
<th>SS</th>
<th>LG</th>
<th>Saw</th>
<th>Assembly</th>
<th>Setup</th>
<th>Workmanship/OS/X-section</th>
<th>MSL3A+HAST96</th>
<th>MSL3A+TCT300,TC500</th>
<th>IR5X</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Proposed PCN/POR</td>
<td>150</td>
<td>Proposed PCN</td>
<td>Proposed PCN</td>
<td>Standard</td>
<td>5</td>
<td>10</td>
<td>min 45</td>
<td>min 45</td>
<td>min 45</td>
</tr>
<tr>
<td>2</td>
<td>Proposed POR + Power</td>
<td>150</td>
<td>Proposed PCN 0.5W</td>
<td>Proposed PCN</td>
<td>Standard</td>
<td>5</td>
<td>10</td>
<td>min 45</td>
<td>min 45</td>
<td>min 45</td>
</tr>
<tr>
<td>3</td>
<td>Proposed POR + Misaligned Groove</td>
<td>150</td>
<td>Proposed PCN 0.5W</td>
<td>Proposed PCN</td>
<td>Standard</td>
<td>5</td>
<td>10</td>
<td>min 45</td>
<td>min 45</td>
<td>min 45</td>
</tr>
</tbody>
</table>
PCN Engineering Flow

Process flow carried out to ensure improvements meet quality expectations:

1. Establish LG recipe with 52um kerf requirements.
2. Ensure laser grooving and mechanical sawing recipe meet targets below:
   - Total EPA (energy density per area): <=1.2 J/mm²
   - LG kerf width: Target +/−3μm
   - Minimum keep out zone from dummy bar: > 5μm
   - LG depth compromises of below targets:
     ✓ Non TEG location: Target 15+/-3um
     ✓ TEG location: Target 12+/-3um
     ✓ Maximum Porosity depth: < 25 um
     ✓ Bottom width at 10um depth: >30um

<table>
<thead>
<tr>
<th>Item</th>
<th>L/G Depth</th>
<th>L/G Kerf width</th>
<th>LG to dummy bar</th>
<th>Bottom width</th>
<th>Laser Profile pattern</th>
<th>X-section (10x10μm)</th>
<th>X-section (LG All)</th>
<th>Porosity depth</th>
<th>Side wall inspection</th>
<th>Visual inspection</th>
<th>Heat affect zone check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor</td>
<td>&gt;10um</td>
<td>Target 23 um</td>
<td>&gt;5μm</td>
<td>30μm bottom width &gt;30μm</td>
<td>2x</td>
<td>2x</td>
<td>&lt;25 um</td>
<td>No delam</td>
<td>No crack/delam</td>
<td>As above</td>
<td>No delam</td>
</tr>
<tr>
<td>Tool</td>
<td>Laser profiler</td>
<td>Laser profiler</td>
<td>Laser profiler</td>
<td>Laser profiler</td>
<td>X-section</td>
<td>X-section</td>
<td>Data and SEM</td>
<td>IR</td>
<td>OM/SEM</td>
<td>50X magnification</td>
<td>FIB</td>
</tr>
</tbody>
</table>

PCN Engineering Flow Diagram:
- Step 1: To separate the wafer to quarter
- Step 2: To use different LG parameter for each quarter wafer
- Step 2.1: Report to be submitted for FA
- Step 2.2: Report to use the PPM specs and train the assembly
- Step 3: To use different LG parameter for each quarter wafer

Flowchart:
- Load the wafer on the machine
- Go to manual mode for WS
- Pitch programming for channel 1
- Cut position adjust for 0 offset before cut for leg 1
- Stop and adjust cut position for leg 2
- Cut 5 lines on leg 2 configuration
- Stop and adjust cut position for Leg 2
- Cut 7 lines on Leg 1 configuration
- Cut 5 lines on Leg 1 configuration
- Stop and adjust cut position for Leg 3
- Cut 5 lines on leg 3 configuration
- Stop and adjust cut position for Leg 4
- Cut 5 lines on Leg 4 configuration
- Adjust cut position to center and continue cutting channel 1
- Proceed manual cut of Channel 2
- Adjust pitch and theta for channel 2
- Manual reposition of wafer to Channel 2
Final PCN Process – Before/After

<table>
<thead>
<tr>
<th>Process</th>
<th>Item</th>
<th>Original Configuration</th>
<th>Proposed POR/PCN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser Grooving</td>
<td>Kerf width</td>
<td>55um</td>
<td>52um</td>
</tr>
<tr>
<td></td>
<td>Depth</td>
<td>&gt;10um</td>
<td>&gt;10um</td>
</tr>
<tr>
<td></td>
<td>Bottom Width</td>
<td>No Monitoring</td>
<td>&gt;30um at 10um depth</td>
</tr>
<tr>
<td></td>
<td># of laser pass</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Power</td>
<td>1.6W - 3W</td>
<td>2.5W - 4W</td>
</tr>
<tr>
<td></td>
<td>Freq</td>
<td>100Hz to 150Hz</td>
<td>40Hz to 200Hz</td>
</tr>
<tr>
<td></td>
<td>beam width</td>
<td>10um</td>
<td>10um - 50um</td>
</tr>
<tr>
<td></td>
<td>beam length</td>
<td>10um</td>
<td>10um</td>
</tr>
<tr>
<td></td>
<td>Cut Length</td>
<td>300mm</td>
<td>300mm</td>
</tr>
<tr>
<td></td>
<td>EPA (J/mm2) each pass</td>
<td>0.71 - 1.00</td>
<td>0.25 - 0.40</td>
</tr>
<tr>
<td>Wafer Saw</td>
<td>Z1 Blade</td>
<td>ZH05 SD3500</td>
<td>ZH05 SD2000</td>
</tr>
<tr>
<td></td>
<td>Z1 Blade Thickness</td>
<td>38um-43um</td>
<td>38um-40um</td>
</tr>
<tr>
<td></td>
<td>Z2 blade Thickness</td>
<td>30um-35um</td>
<td>30um-35um</td>
</tr>
<tr>
<td></td>
<td>Z1 % Cut</td>
<td>20% - 30%</td>
<td>20% - 30%</td>
</tr>
<tr>
<td></td>
<td>Auto Blade dressing Frequency</td>
<td>Change Blade</td>
<td>every 45 lines</td>
</tr>
</tbody>
</table>

- Less kerf width with improved Z1 blade thickness
- Less total laser energy minimizing risk of side wall damage
- Reduced chipping with increased blade dressing
Before/After Changes – Kerf Width

Action: Reduce Laser Grooving kerf width from ~55um to 52um providing safety margin away from die side wall/dummy bar

Before

- Laser Grooving Width: >55um
- Z1 Blade: HCFE
- Z2 Blade: HEFD
- Centering: +/- 3um

After

- Laser Grooving Width: 52um
- Z1 Blade: ZH05
- Z2 Blade: HEFD
- Centering: +/- 3um
Before/After Changes – LG Profile

Action: Optimizing laser groove profile from V groove to U Groove (wide beam) to reduce stress on side wall.

Before

V-Shaped Profile

- V shape profile is widely used in high volume production laser grooving standards.
- Risk of blade to hit sidewall at certain stress points and initiate Si sidewall cracking towards the active layers

After

U-Groove/Wide Beam method in laser grooving allows for the reduction of total applied energy by decreasing the amount of passes required. Less risk of defects.
- The wide kerf/clearance allows Z1 blade to saw thru without risk of damaging side wall.
- This profile maintain the below targets:
  - Laser Width – overall laser width target +/-3um
  - Laser Depth – low K layers are properly remove
  - KOZ (Keep out zone) between seal ring to laser edge sufficient to prevent possible metal redeposition/heat dissipation
  - Porosity width should be less than 25um
Before/After Changes – Quality Gate

Action: Increase quality gatings to meet Laser Groove and sawing standards

Before

- LG Kerf Check: 10 lines
- Wafer Saw Kerf Check: 10 lines
- Auto dressing: New blade only

After

- LG Kerf Check: 5 lines
- Wafer Saw Kerf Check: 5 lines
- Auto dressing: every 45 lines
- LG kerf/width using profiler for every new setup
- 100% AOI
- IR inspection after UF curing process: Sampling

KERF CHECK (SAW/LG)
PCN REL Results – Quantity Mapping

- Passed 100% REL (MSL3A /HAST96hrs/TC500) with zero chipping.
- Kerf profile all units >5um width from side wall.
- Z1 blade effectiveness zero chipping with CPK >1.67
# REL Results - Inspection

<table>
<thead>
<tr>
<th>SEM Tilt Side view</th>
<th>SEM Top view</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image 1" /></td>
<td><img src="image2.png" alt="Image 2" /></td>
</tr>
<tr>
<td><img src="image3.png" alt="Image 3" /></td>
<td><img src="image4.png" alt="Image 4" /></td>
</tr>
<tr>
<td><img src="image5.png" alt="Image 5" /></td>
<td><img src="image6.png" alt="Image 6" /></td>
</tr>
<tr>
<td><img src="image7.png" alt="Image 7" /></td>
<td><img src="image8.png" alt="Image 8" /></td>
</tr>
<tr>
<td><img src="image9.png" alt="Image 9" /></td>
<td><img src="image10.png" alt="Image 10" /></td>
</tr>
</tbody>
</table>

## SEM Side view – Porosity Depth

| ![Image 11](image11.png) | ![Image 12](image12.png) |
| ![Image 13](image13.png) | ![Image 14](image14.png) |
| ![Image 15](image15.png) | ![Image 16](image16.png) |
| ![Image 17](image17.png) | ![Image 18](image18.png) |
Validation Run

**Action:** Validation lot build with PCN process. Results for full build below:

<table>
<thead>
<tr>
<th>Device</th>
<th>GN2411BIE3</th>
</tr>
</thead>
<tbody>
<tr>
<td>MO Lot No.</td>
<td>FC7440062 (PCN)</td>
</tr>
<tr>
<td>Wafer Lot No.</td>
<td>PF6A47.00</td>
</tr>
<tr>
<td>Act. QTY</td>
<td>4518</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Items</th>
<th>In</th>
<th>Out</th>
<th>Yield%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invoice</td>
<td>4518</td>
<td>4518</td>
<td>100%</td>
</tr>
<tr>
<td>2nd Opt</td>
<td>4518</td>
<td>4402</td>
<td>97.43%</td>
</tr>
<tr>
<td>Die Attach</td>
<td>4402</td>
<td>4402</td>
<td>100%</td>
</tr>
<tr>
<td>D/A Flux Clean</td>
<td>4402</td>
<td>4402</td>
<td>100%</td>
</tr>
<tr>
<td>Underfill Dispensing</td>
<td>4402</td>
<td>4402</td>
<td>100%</td>
</tr>
<tr>
<td>3rd Opt</td>
<td>4402</td>
<td>4398</td>
<td>99.91%</td>
</tr>
<tr>
<td>Laser Mark</td>
<td>4398</td>
<td>4398</td>
<td>100%</td>
</tr>
<tr>
<td>Ball Attach</td>
<td>4398</td>
<td>4398</td>
<td>100%</td>
</tr>
<tr>
<td>FVI</td>
<td>4398</td>
<td>4396</td>
<td>99.95%</td>
</tr>
<tr>
<td>Packing</td>
<td>4396</td>
<td>4396</td>
<td>100%</td>
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</table>

**Final Yield:** 97.29%

**Action:** Final Test result for Post REL

<table>
<thead>
<tr>
<th>DeviceNo</th>
<th>CustomerLotNo</th>
<th>TestQty</th>
<th>PassQty</th>
<th>FailQty</th>
<th>Bin1</th>
<th>Bin2</th>
<th>Bin3</th>
<th>Bin4</th>
<th>Bin5</th>
<th>Bin6</th>
<th>Bin7</th>
<th>Bin8</th>
<th>Final Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>GN2411BI BE3-01</td>
<td>163117.1</td>
<td>500</td>
<td>500</td>
<td>0</td>
<td>500</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

No chipping defects found from AOI

No chipping defects found from IR

Cosmetic defects
PCN Summary

- PCN results meets package requirements with no change in form/fit/function. Risk on chipping significantly reduced.

- Wide Beam LG Dicing PCN met all condition below:
  - Laser Width (criteria: 55um +/-3)
  - Minimum keep out zone from outer seal ring > 5um
  - Bottom width at 10um depth : >30um
  - LG depth: Non TEG location Target 15+/-3um, TEG location :
    Target 12+/-3um
  - Z1 Blade: ZH05 SD2000N1 50

- All lots (PCN/Validation) passed MSL3A /HAST96hrs /TC500. FA inspection indicate no risk of chipping.

- Inspection gating has been improved to include 100% AOI and IR inspection.

- Semtech is ready for Mass Production on current PCN process.