Reverse Costing Analysis

Galaxy S5 Fingerprint Sensor
Samsung/Synaptics

August 2014 – Version 1 – Written by Elena Barbarini

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Contact
• This full reverse costing study has been conducted to provide insight on technology data, manufacturing cost and selling price of the Samsung Galaxy S5 Fingerprint Sensor Assembly.

• For the first time Samsung integrates a fingerprint sensor in the Galaxy product line. The Fingerprint Sensor technology has been developed by Validity Inc. which, since November 2013 is part of Synaptics Inc., world leader in capacitive sensing human interface solutions for consumer electronics companies.

• Totally different from the iPhone 5S fingerprint and home button, Samsung’s fingerprint sensor works thanks to an innovative technology for capacitive sensing of ridge peaks and ridge valleys of a fingerprint on a swiped finger. The sensor senses the speed of the finger as it is swiped across the image sensor and recognize the fingerprint image.

• The fingerprint sensor of the Galaxy S5 is located above the home button and it has the dimension of 17.5x5.5 mm. The sensor is incorporated within a rectangular shaped housing composed of an aluminum ring and a stainless steel base. The sensor is protected by a white plastic cover.
Synthesis of the Physical Analysis

Fingerprint Button Assembly:
- Electronic components assembly: Surface mounted device (SMD)
- Fingerprint PCB sensor
- Fingerprint IC sensor
- Electrical connections and support: Flex PCB, 2 metal layers

Fingerprint PCB sensor
- Sensing Principle: capacitive
- Process: FR4, 4 metal layers, microvias
- Placement: soldered to the flex substrate

Fingerprint IC sensor
- Process: CMOS 0.13 µm 1P8M
- Electrical Connection: copper pillars
- Placement: flip chip to rigid PCB

Stainless steel base

Galaxy S5 Fingerprint sensor Assembly
Fingerprint Button disassembly

✓ Protective elastomer dimensions:

✓ Plastic support dimensions:

Fingerprint sensor disassembly steps
Packaging Cross-Section

Fingerprint Sensor Cross-section – optical view

- Al Ring thickness:
- Stainless Steel Base thickness:

Fingerprint Sensor Cross-section – SEM view
Sensing PCB Cross-Section

✓ MicroVias minimum dimension:

Rigid PCB Cross-Section – SEM View
The die marking includes:

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Synthesis of the main parts

Fingerprint button main parts:

- [List of components]

Fingerprint button cross-section – Optical View
• We perform the economic analysis of the Sensor IC Front-End & Back-End 0 with the IC Price+ tool.
• We perform the economic analysis of the Sensor rigid PCB with the PCB Price+ tool.
Sensor Front-End Cost

<table>
<thead>
<tr>
<th></th>
<th>Low Yield</th>
<th></th>
<th>Medium Yield</th>
<th></th>
<th>High Yield</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
<td>Breakdown</td>
</tr>
<tr>
<td>Raw Substrates (Si 300mm)</td>
<td>$90.08</td>
<td>2.1%</td>
<td>$90.08</td>
<td>2.1%</td>
<td>$90.08</td>
<td>2.1%</td>
</tr>
<tr>
<td>Clean Room</td>
<td>$80.06</td>
<td>1.9%</td>
<td>$80.06</td>
<td>1.9%</td>
<td>$80.06</td>
<td>1.9%</td>
</tr>
<tr>
<td>Equipment</td>
<td>$60.04</td>
<td>1.5%</td>
<td>$60.04</td>
<td>1.5%</td>
<td>$60.04</td>
<td>1.5%</td>
</tr>
<tr>
<td>Consumable</td>
<td>$50.03</td>
<td>1.2%</td>
<td>$50.03</td>
<td>1.2%</td>
<td>$50.03</td>
<td>1.2%</td>
</tr>
<tr>
<td>Labour</td>
<td>$40.02</td>
<td>1.0%</td>
<td>$40.02</td>
<td>1.0%</td>
<td>$40.02</td>
<td>1.0%</td>
</tr>
<tr>
<td>Yield losses</td>
<td>$30.01</td>
<td>0.7%</td>
<td>$30.01</td>
<td>0.7%</td>
<td>$30.01</td>
<td>0.7%</td>
</tr>
<tr>
<td><strong>Sensor Front-End Cost</strong></td>
<td>$20.01</td>
<td></td>
<td>$20.01</td>
<td></td>
<td>$20.01</td>
<td></td>
</tr>
<tr>
<td><strong>Sensor Front-End Price</strong></td>
<td>$10.01</td>
<td></td>
<td>$10.01</td>
<td></td>
<td>$10.01</td>
<td></td>
</tr>
</tbody>
</table>

- The cost for the sensor ranges from according to yield variations.
- The largest portion of the manufacturing cost is due to the
- We estimate a which results in a ranging from . This corresponds to the selling price to Synaptics.
## Sensor Die Cost

<table>
<thead>
<tr>
<th></th>
<th>Low Yield</th>
<th></th>
<th>Medium Yield</th>
<th></th>
<th>High Yield</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
<td>Breakdown</td>
</tr>
<tr>
<td>Sensor Wafer Cost</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Nb of potential dies per wafer</td>
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<td></td>
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<tr>
<td>Nb of good dies per wafer</td>
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<tr>
<td>Front-End Cost</td>
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<tr>
<td>Probe Test Cost</td>
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<tr>
<td>Backgrinding Cost</td>
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<tr>
<td>Bumping Cost</td>
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<td></td>
<td></td>
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<tr>
<td>Dicing Cost</td>
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<td></td>
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<tr>
<td>Yield losses Cost</td>
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<td></td>
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<tr>
<td><strong>Sensor Die Cost</strong></td>
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<tr>
<td>Synaptics Gross Profit</td>
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<tr>
<td><strong>Sensor Die Price</strong></td>
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</tr>
</tbody>
</table>

- The number of **good dies per wafer** is estimated to ranges from **```** according to yield variations, which results in a **die cost** ranging from **```**

- We estimate a gross margin of **```** for Synaptics, which results in a **front-end price** ranging from **```** This corresponds to the selling price to Samsung.
Sensor rigid PCB Cost

<table>
<thead>
<tr>
<th>PCB SENSOR</th>
<th>Low Yield Cost</th>
<th>Breakdown</th>
<th>Medium Yield Cost</th>
<th>Breakdown</th>
<th>High Yield Cost</th>
<th>Breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Prepreg materials</td>
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<td></td>
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<td></td>
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<tr>
<td>Conductor material</td>
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<tr>
<td>Finish materials</td>
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<tr>
<td>Other materials</td>
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<td></td>
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<tr>
<td>Labour</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Yield losses</td>
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<td></td>
</tr>
<tr>
<td><strong>Total Cost per dm²</strong></td>
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</tr>
</tbody>
</table>

- Due to the high technology process we assume that the rigid PCB has been manufactured by

- The total cost per dm² for the rigid PCB ranges from... according to yield variations.

- The high PCB cost per dm² is due to the advanced technology:

- The largest portion of the manufacturing cost is due to the...
Home Button Assembly Cost

- The *Fingerprint sensor assembly* cost ranges from $1.500 to $1.800 according to yield variations.
- The *Fingerprint sensor* is the most costly for Samsung.
- The *Fingerprint sensor die* represents 45% of the total cost.
- The *Fingerprint sensor* is 40% of the total cost.
- The *die represents* 45% of the total cost.
- The *other parts* (including materials, cleaning, testing, etc.) represent 15% of the total cost.
- The *assembly, test & yield losses* represent 10% of the total cost.
Reverse costing analysis represents the best cost/price evaluation given the publically available data, and estimates completed by industry experts.

Given the hypothesis presented in this analysis, the major sources of correction would lead to a +/- 10% correction on the manufacturing cost (if all parameters are cumulated).

These results are open for discussion. We can reevaluate this circuit with your information. Please contact us:

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