Goodix Under-Display Optical Fingerprint

Latest cost-optimized optical fingerprint sensor in the Huawei P30 Pro smartphone.

SP19506 - IMAGING report by Sylvain HALLEREAU
Laboratory Analysis by Nicolas RADUFE
October 2019 – SAMPLE
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**Goodix TC2403 (Huawei P30 Pro) vs Synaptics FS9500 (Vivo X21 UD)**

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Executive Summary

This full reverse costing study has been conducted to provide insight on technology data, manufacturing cost and selling price of the Goodix Fingerprint under display find in the Huawei P30 Pro.

Synaptics launched the first optical fingerprint scanner on the market in 2018, with a lens-free solution. It was quickly followed by Goodix, also with a lens-free solution. This year, Goodix has launched its second generation optical fingerprint scanner, the first such product to use a lens.

The latest Goodix under-display optical fingerprint scanner has been found in Huawei P30 and P30 Pro, Vivo X23 and NEX S and other smartphones.

This scanner uses optical fingerprint technology that allows integration under the display. The new Goodix technology is radically different from those previously observed. Adding lenses reduces the pixel and CMOS image sensor die areas drastically, while keeping the same scanning area. The sensor die area and cost are much reduced.

Moreover, Goodix has developed a versatile interface component to reduce development time and cost. The sensor and interface component are assembled on an easily-customizable flex to adapt the fingerprint scanner to different smartphones.

The sensor has a resolution of 39,000 pixels, with a pixel density of 5,080ppi. The module's light source is provided by the OLED display. The sensor is connected by wire bonding to the flexible printed circuit and uses a CMOS process.

This reverse costing study provides insight into technological data, manufacturing cost, and selling price of the fingerprint sensor supplied by Goodix. It also compares it with the latest Synaptics fingerprint sensor in Vivo x21 and with the previous version of Goodix’s design.
Huawei P30 Pro Disassembly

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**Fingerprint – Overview**

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Goodix Fingerprint – Cross-Section

Fingerprint sensor is assembled with dual side adhesive on a frame of the smartphone.
Goodix Fingerprint – Die Overview & Dimensions

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Sensor Die Process – MicroLens
Interface Component - Package Opening

- 3 dies in the package and 5 capacitors (2019)
- Die Assembly: 12W bonding

- Goodix Package Assembly
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Flash Front-End Cost

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<th>Medium Yield</th>
<th>High Yield</th>
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<tr>
<td></td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
</tr>
<tr>
<td>wafer (SI 300mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean Room Cost</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Equipment Cost</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Consumable Cost</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Labor Cost</td>
<td></td>
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<tr>
<td>Yield losses Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front-End Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundry Gross Margin</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Front-End Cost</td>
<td></td>
<td></td>
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</tbody>
</table>

The Flash Front-end cost for the Flash Die ranges from $300k to $700k according to yield variations. The largest portion of the manufacturing cost is due to the equipment. We estimate a gross margin of 50% for TSMC, which results in a front-end price ranging from $3.00M to $3.5M. This corresponds to the selling price.

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# Pixel Array Front-End Cost

<table>
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<th>Medium Yield</th>
<th>High Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
</tr>
<tr>
<td>Raw wafer Cost (Si + p-epi)</td>
<td>$50.00</td>
<td>11.2%</td>
<td>$50.00</td>
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<tr>
<td>Clean Room Cost</td>
<td>$26.05</td>
<td>5.6%</td>
<td>$26.05</td>
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<tr>
<td>Equipment Cost</td>
<td>$140.56</td>
<td>30.3%</td>
<td>$140.56</td>
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<tr>
<td>Consumable Cost</td>
<td>$41.37</td>
<td>9.1%</td>
<td>$41.37</td>
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<tr>
<td>Labor Cost</td>
<td>$88.73</td>
<td>19.4%</td>
<td>$88.73</td>
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<tr>
<td>Yield losses Cost</td>
<td>$15.50</td>
<td>3.4%</td>
<td>$15.50</td>
</tr>
<tr>
<td>Sensor Die</td>
<td>$463.62</td>
<td>100%</td>
<td>$463.62</td>
</tr>
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</table>
### Complete System Cost

<table>
<thead>
<tr>
<th>Fingerprint Module Manufacturing Cost</th>
<th>Low Yield</th>
<th>Medium Yield</th>
<th>High Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
</tr>
<tr>
<td>Fingerprint Image Sensor Cost</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>GM185 Component Cost</td>
<td></td>
<td></td>
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<tr>
<td>Lens Barrel</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Filter &amp; Housing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passives (Capacitors &amp; Resistors)</td>
<td></td>
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<tr>
<td>Connector 2x15 Positions</td>
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<tr>
<td>Flex PCB</td>
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<td></td>
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<tr>
<td>Assembly Cost</td>
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<td></td>
<td></td>
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<tr>
<td>Yield Losses Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subcontractor Gross Margin 15%</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Component Cost:

- Sensor Die
- Complete Module Fingerprint

The complete system cost ranges from $2.30 to $2.41 according to yield variations.

- The Fingerprint sensor cost represents 34% of the component cost.
- The GM185 component cost represents 25% of the component cost.
- The Lens Barrel cost represents 29% of the component cost.
- The other components of the SMT and the final assembly cost represent 15% of the total.

We estimate a gross margin of 15% for the ODM, which results in a complete module cost ranging from $2.30 to $2.41. This corresponds to the price to the OEM.
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- Qualcomm® Snapdragon Sense™ ID 3D Fingerprint

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